SPECIAL ISSUE #110

CLEAN COOLING

Putting together all the pieces of the sustainable cooling-for-all puzzle

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The Social Implications of Clean Cooling

Accelerate has been primarily focused on educating the world about the value of natural refrigerants and related sustainable cooling technologies. Our goal has been to enable the informed transition away from environmentally damaging fluorinated refrigerants of all varieties.

We will continue in that mission, only now we have expanded it to a much broader and holistic concept called Clean Cooling, which is the subject of our cover story (page 28).

Clean Cooling is a multifaceted idea first defined several years ago by Professor Toby Peters of the University of Birmingham, U.K. In recent months, shecco, publisher of *Accelerate*, has been working with Peters and his colleagues to refine the definition, whose current version can be found at https://bit.ly/2WQs39D.

shecco and Peters are also leading a collaborative project to develop a standard Clean Cooling process – a series of questions by which cooling projects can be audited. Peters and shecco welcome feedback on the definition and standard that are developed.

The cover story explores the meaning of Clean Cooling and its many components, which includes natural refrigerants, efficient cooling, and other elements that aim to reduce the demand for cooling and the energy expended on it.

What's most interesting to me about Clean Cooling is that it goes beyond addressing the business and environmental impacts of cooling – important as they are in a warming world – to consider its social implications, particularly in the developing world. Though often taken for granted, cooling, whether in refrigeration or air conditioning, is of fundamental importance for food, health and physical well-being; yet more than one billion people lack access to cooling for these purposes.

Many media outlets recently covered a new study that concluded that by 2070 between one and three billion people will be exposed to mean annual ambient temperatures that are warmer than anywhere on Earth in 2020. They will need access to cooling to survive.

Moreover, it turns out that all 17 of the United Nation's Sustainable Development Goals (SDGs) – which range from eliminating poverty and hunger to providing decent work and sustainable cities – can be facilitated by cooling.

Thus, Clean Cooling calls for developing accessible, affordable, financially sustainable and scalable cooling systems that provide "Cooling for All."

How can this be accomplished in developing countries with low per-capita incomes? Most of the answers are still to be determined, but already innovative financial mechanisms like cooling-as-a-service (CaaS) are bringing efficient cooling to communities around the world.(See page 74 for an example in South Africa.)

Even in the developed world, Clean Cooling standards will require businesses to ensure that their employees are working in safe and productive conditions.

Clean Cooling, in effect, takes cooling from being regarded merely as a piece of equipment or a service, to being viewed, like healthcare, as a basic human right. ■ MG

Michael Garry
Editor in Chief

In this issue

// Europe, Middle East & Africa

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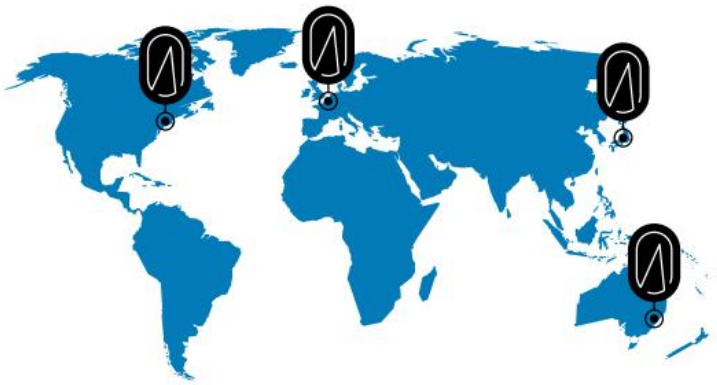
ACCELERATE

ADVANCING CLEAN COOLING



ABOUT *ACCELERATE*

Brought to you by the worldwide experts in clean cooling news, *Accelerate* is the first global publication written for and about the most progressive business leaders working with clean cooling solutions, including natural refrigerants and other sustainable technologies and resources, in all HVAC&R sectors. It builds on the legacies of *Accelerate Magazine* and six regional magazines: *Accelerate America, Accelerate Europe, Accelerate Australia/New Zealand, Accelerate Japan, Accelerate China* and *Accelerate Asia*.

ABOUT ACCELERATE24.NEWS

Accelerate24.news is a 24-hour global website providing up-to-the-minute news on clean cooling solutions, including natural refrigerants and other sustainable technologies and resources, in all HVAC&R sectors. Leveraging the expertise of our journalists and analysts in North America, Europe, Australia and Japan, Accelerate24.news builds on the expertise and reach of R744.com, Hydrocarbons21.com and Ammonia21.com, the leading marketplace websites on CO_2, hydrocarbons and ammonia over the past decade.

Sign up here to receive a regional Accelerate24.news newsletter highlighting the top stories, delivered every other Thursday.

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Issue #110

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Editorial Calendar for Accelerate Special Issues, 2020-2021

Each Special Issue of *Accelerate*, published six times annually, addresses a specific topic aimed at advancing Clean Cooling – sustainable cooling for all – in commercial, industrial and residential HVAC&R markets around the world.

These Special Issues target end users and other key stakeholders, including manufacturers, contractors, policy makers, the financial community, academic experts and others.

Each Special Issue will take a deep dive into a particular topic, with a main story and secondary articles, guest writers, thought leader interviews, infographics, surveys and market research.

In addition to the topics listed at right, other potential topics include: technology innovations, mobile air conditioning (MAC), data center cooling, ice rink refrigeration, servitization of cooling, digitalization of cooling, alternative cooling technologies, renewable energy and HVAC&R, and regional HVAC&R markets.

The Special Issues are available online https://bit.ly/3841iCJ; in addition print copies are distributed at major industry trade shows and conferences.

Accelerate Special Issues take full-page advertising as well as fractional ads.

The editorial calendar is subject to change by the publisher.

Special Issue #110
July 2020
Clean Cooling: Putting together all the pieces of the sustainable cooling-for-all puzzle

Special Issue #111
September 2020
Food Retailers Pursuing Clean Cooling Around the World
Ad Deadline: August 17

Special Issue #112
November 2020
How Regulations and Standards are Driving (or Inhibiting) Clean Cooling Around the World
Ad Deadline: October 15

Special Issue #113
January 2021
A Look Ahead at the Major Clean Cooling Trends for 2021
Ad Deadline: December 15

Special Issue #114
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WE NEED A CLIMATE-FRIENDLY RESPONSE TO COVID-19'S IMPACT ON COOLING

Demand for cooling services will likely rise due to the pandemic. The response needs to be both smart and ambitious.

– By Dan Hamza-Goodacre

Over recent weeks, as the world grapples with a global pandemic that is turning our lives upside down, a number of stories have emerged looking at how COVID-19 is affecting air pollution and carbon emissions levels around the world. In many places, there has been a drastic drop in emissions, notably from transportation, construction, and heavy industry.

But what about emissions from cooling? After all, cooling for buildings, products and people uses huge amounts of energy, often inefficiently, and releases fluorinated gases (f-gases) that are far more potent than carbon dioxide in causing climate change. As such, the emissions from cooling alone could offset reductions in other areas and eat up the remainder of allowable global emissions, if we are to meet the international goal of limiting global warming to 1.5°C (2.7°F).

It's likely that COVID-19 will affect demand for cooling in at least five categories:

Cooling in buildings. Billions of people across the world have been asked to stay at home to avoid fueling the spread of the disease. For some, this might be an isolating and inconvenient experience, but nonetheless a comfortable one. For others, however, this could mean being cramped in a small space, with little to no light and ventilation. Temperatures in the Southern Hemisphere and the tropics are already hot enough to require an air conditioner or fan. As the weeks of lockdown turn into months, and temperatures rise in the Northern Hemisphere, people will feel the need for cooling. For some, this will not just be about comfort. When fevers are rising, cooling could be a matter of life or death, especially for the elderly and vulnerable.

Not only can we expect a surge in demand for the energy and f-gases required for such cooling, but an uptick in demand for air conditioners, central cooling systems, and fans. In today's uncertain economic climate, many will opt for the cheapest cooling appliance they can get their hands on, which is very rarely efficient or climate friendly. On the flip side, demand for cooling in offices, shops, and other commercial buildings will likely drop. How this nets out remains to be seen. What we know now, however, is that home cooling systems are already typically less efficient and clean than commercial and public ones.

Domestic refrigeration of food and drink. As restaurants, cafes, pubs, and other food service venues shut their doors, billions more people will be eating at home. In the U.K. in the first few weeks of the crisis, an additional US$1.2 billion (£1 billion) of food was bought and stored in fridges, freezers, and cupboards at home. The result is greater domestic demand for energy and f-gases to keep food and drink chilled, as well as an increase in sales of fridges and freezers to store the vast amounts of food being hoarded. Economic pressures and lack of supply impact purchasing choices, and undermine demand for the most efficient, clean appliances.

As with cooling in buildings, the systems and technologies for refrigeration at home are typically less efficient than in commercial and public settings. Therefore, as demand for refrigeration drops in restaurants, hotels, and the like, this reduction might be offset by the less-efficient refrigeration technologies used at home.

Cold chains. With people on lockdown at home, and producers and supermarkets working overtime to deliver more food and drink, the "cold chains" associated with these deliveries are expanding. The U.K. government recently extended the hours when deliveries can be made. The U.K.'s major supermarket chains (as is likely the case in other countries) are also all on huge recruitment drives to ensure supply can meet the inflated demand. As the majority of refrigerated trucks in the world run on diesel or gasoline (very few are electric), we are likely to see a spike in emissions from these vehicles, both in terms of f-gases from refrigeration and tailpipe output.

Medical necessities. Surging demand for hospital beds already has many health care systems in turmoil. Patients need to be kept stable and drugs kept from spoiling, and doctors, nurses, and other care staff need working conditions that enable them to perform their best and save lives. Cooling systems can bring welcome relief during sweltering temperatures in packed hospitals. And tragically, the many that succumb to the virus will need to be kept cool in mortuaries. All of this will drive a macabre demand for cooling across the globe.

Dan Hamza-Goodacre is Non-Executive Director, Kigali Cooling Efficiency Program (K-CEP), and part of the COP26 High-Level Climate Champions team.

This article originally appeared, in slightly different form, in K-CEP's What's Cool Now Quarterly Report on May 26.

> *"In today's uncertain economic climate, many will opt for the cheapest cooling appliance they can get their hands on, which is very rarely efficient or climate friendly."*

When, hopefully, a vaccine emerges for COVID-19, there will be a race to produce and dispatch doses to every corner of the world. The task of rapidly scaling up access to the vaccine will require a huge effort and will need to cater to a vast range of communities, from those in urban settings to those in hard-to-reach locations, and everyone in between. Since many vaccines spoil if they're not kept in a very specific temperature range, typically 2°C-8°C (36°F-46°F), this means that new cold chains will need to be established in certain parts of the world, in a way that is clean and efficient. If these vaccines are not kept cool, they will not be viable, and we risk unknowingly releasing the virus back into society.

Data centers. The lockdown is shifting economic activity to the web as never before, driving an immediate spike in demand for energy in data centers. Energy consumption for cooling IT equipment in data centers can account for over 40% of total data center energy consumption, so efficient cooling for data centers is essential for reducing operating costs. While this spike in demand may decline when lockdowns are lifted, the shift in behavior, contracts, and agreed practices – whether working from home, average broadband speed contracted by households, or the use of Zoom for family interaction – will most likely not return to a pre-COVID-19 norm.

SMART REBUILDING

As with many of the unfolding impacts of COVID-19, plans are needed. Governments are responding with a sense of emergency. Businesses, banks, civil society, the United Nations system, and the general public are focused and listening like never before. The collective brainpower of humankind will solve this problem, but decision-makers across the globe must solve it in smart ways that rebuild the global community so that it is stronger than before. When it comes to cooling specifically, the response needs to:

Be driven by urgently needed research. We need urgent analysis of the changes to, and potential growth in demand for, cooling in the areas identified here, along with the associated implications for climate pollution and the economic impact of cooling systems and appliances. Managing cooling-related costs and efficiencies in the economic recovery will support a quicker return to healthy economies and public balances. We must avoid locking in second-class cooling systems for decades to come, with their high pollution and operating costs.

Boost sustainable solutions. The response to COVID-19 needs to take advantage of business models and financial mechanisms that reap the rewards from more efficient, climate-friendly technology, such as "cooling as a service" (e.g., instead of buying a commercial fridge, a business can contract for a certain amount of cooling provided), and "pay as you save" (e.g., when a customer is provided with more efficient cooling technology, such as an air conditioner, and pays back the cost over time using the energy cost savings). Such models in turn make climate-friendly cooling options – which tend to require a larger up-front investment, but with lower lifetime cost – more attractive to buyers.

Maximize job opportunities. Many cooling solutions, such as passively cooled buildings (through the use of efficient design and building materials instead of energy-consuming technology) and cooling by nature (green parks and spaces), create local jobs. Highly skilled professionals like engineers can help optimize cold chains and industrial processes, and the service industry can help with finance and contracts. More research and development can help establish the most feasible cooling solutions that serve people, the planet, and businesses. Taking a holistic and local view of how to provide cooling – for example, though building retrofits rather than, say, a VAT freeze on AC sales – can better support local jobs.

Perhaps more than ever, cooling is essential to the health and prosperity of the entire human race. Fortunately, cooling is already a huge industry – US$134 billion per year, according to *The Economist* – and staffed by a corps of dedicated cooling professionals in public service, business, academia, NGOs, international organizations, and philanthropy. Ideas, support, and collaboration are already plentiful, as encapsulated by the Cool Coalition, launched at the UN Secretary-General's 2019 climate summit. In overcoming this crisis, we must be ambitious and build back better.

Let's seize this moment to make a cooler and more sustainable world possible for all. ■ DHG

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Why Natural Refrigerants Are Better than HFOs

Along with the many practical drawbacks of HFOs and HFO/HFC blends, we do not know what effect these chemicals will have on the environment over the long run.

– By Wynand Groenewald

Over the past few years more emphasis has been placed on the refrigerants we are using. Under the Kigali Amendment to the Montreal Protocol, HFC refrigerants with a high global warming potential (GWP) are being phased down, leading to the need for alternative solutions.

Natural refrigerants such as CO_2, NH_3, hydrocarbons, air and water have been making good progress toward becoming the mainstream solution for refrigeration applications, but other fluorinated chemicals are also being offered.

Chemical companies have been under scrutiny since the 1980s, first with the ban of CFC-based refrigerants that lead to the depletion of the ozone layer. This led to the development of HCFC alternatives (notably R22), which were soon replaced by HFCs, which have been the most common refrigerants since the early 1990s. But now that HFCs are being phased down worldwide, the answer from the chemical companies is to develop low-GWP alternatives known as HFOs. The question is whether or not these refrigerants will have a short lifespan like their predecessors.

Are we being fooled again to believe that the fourth generation of chemical refrigerants is a solution to high-GWP refrigerants?

WHAT ARE HFOs?

First, we need to understand what, exactly, are HFO refrigerants. HFOs (hydrofluoroolefins) are unsaturated HFCs with molecular double bonds.

There are primarily two pure HFOs on the market, namely R1234yf and R1234ze, which have a GWP value of four and seven, respectively and zero ozone-depleting potential (ODP). These HFOs, however, are somewhat flammable and designated as A2L refrigerants. Therefore, charge limitations and placement need to be considered. R1234yf is currently used in small refrigeration applications and also mobile air conditioning (MAC) systems. R1234ze is primarily used as a blowing agent for foams and in some chillers.

These refrigerants have a relatively low volumetric refrigeration capacity, and concerns about their long-term stability in stationary systems have been raised.

Already there are a few red flags for me. Other than worries about the flammability and stability of these refrigerants are concerns recently raised about the environmental impact of HFO refrigerants. Studies have found that R1234yf

> *"There is a natural refrigerant available for every refrigeration application, that presents no harm to our planet and has been tried and tested all over the world in all climates."*
>
> – Wynand Groenewald

decomposes in the atmosphere within two weeks of its release to form trifluoroacetic acid (TFA); TFA then combines with moisture in the air, and descends to Earth in rain, potentially contaminating our drinking water.

There is already an increase of R1234yf in the atmosphere (found in 71% of samples over Europe in 2018), showing that we cannot rely on containing it within a refrigeration system. Moreover, there may be other environmental headaches we have not found yet, as these substances have not been around long enough to be properly assessed. So we can ask the question: By using HFOs are we creating another refrigerant-related environmental crisis?

Greenpeace has recommended that HFOs be banned from use in aerosols, restricted via quotas, and listed in the annex for controlled substances regulated under the Kigali Amendment. The NGO also urged the chemical industry to pay for mitigating the risk presented by these refrigerants to the environment. How long before these refrigerants are banned, and the consumer needs to move to an alternative?

Already, German car maker Daimler has begun moving away from using R1234yf in MAC after assessing the safety and environmental impact of the refrigerant, and using CO_2 as a refrigerant instead.

WHAT ABOUT LARGE SYSTEMS?

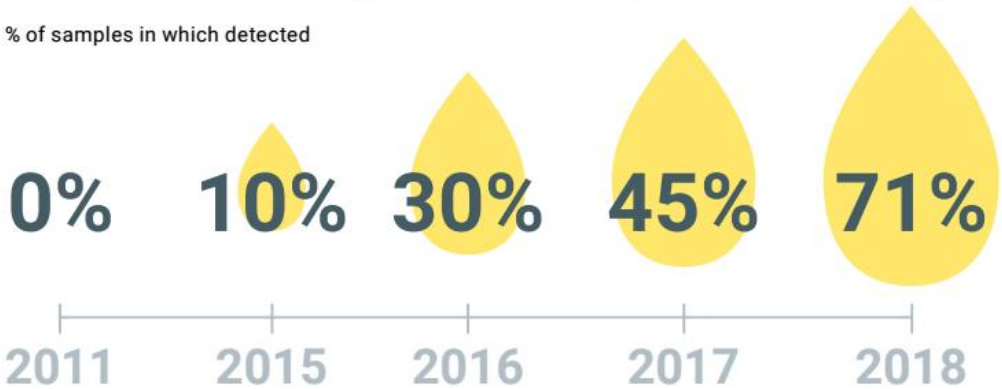
So how do HFOs fit into larger refrigeration systems? As mentioned, there are primarily two pure HFO refrigerants available, and they are restricted due to their flammability. So what is being promoted as an alternative for larger refrigeration systems that use the ODS R22 and high-GWP HFCs like R407, R404A, R507A or R134a?

The alternative refrigerants are being marketed and sold under the umbrella of HFOs, but they are actually blends of HFOs and HFCs. The correct term for these refrigerants should be HFO/HFC blends.

Ironically, for an HFO to be suitable for larger applications, and as a drop-in gas to replace previously used HFCs – that is, meet volumetric refrigeration capacity, flammability and lower-GWP requirements – the HFO needs to be mixed with HFCs. But the lower the GWP, the higher the chance for flammability; it is a continuous trial-and-error process to get a refrigerant that has a lower GWP and still a reasonable flammability.

Even with lower GWPs, all known HFO/HFC refrigerant blends have a GWP ranging from 600 to 1900, which is still far above that of natural refrigerants, and above the 150-GWP maximum being incorporated into many f-gas regulations.

Detection of R1234yf in the Atmosphere Over Europe



Source: Empa, Update of "First observations of the fourth generation of synthetic halocarbons HFO-1234yf, HFO-1234ze(E) and HCFO-1233zd(E)." Measurements taken at Jungfraujoch, Switzerland.

The reality is that if you buy a low-GWP refrigerant blend to replace an HFC refrigerant, you are still buying an HFC refrigerant, just mixed with other chemicals.

Questions have also been asked about how these blends perform over the long run in terms of thermodynamic properties, toxicity and chemical reactivity with materials and oils used in refrigeration systems. Not enough testing has been done to answer these questions.

Some replacement HFO/HFC blends, such as R448A and R449A, have issues with high discharge temperatures where additional cooling injection is required to reduce the strain on compressors.

In addition, with HFO/HFC blends, no one has stated what happens if a small leak occurs – which chemical leaks out first? Every molecule used has a different size and different properties, making it evaporate or condense faster or slower than others. So does a continuous leak combined with topping up of refrigerant lead to a different composition within your refrigeration system? Varying compositions create temperature glide and make designing these systems much more difficult.

Then there is the high cost of low-GWP HFOs; you are paying top dollar for refrigerants that may not adhere to future regulations. Why pay more and have the burden of continuously keeping up with new refrigerants and keeping different solutions in stock? Why not standardize?

IS THERE A FUTURE FOR HFOs?

I have come to the conclusion that there is not a long-term future for HFOs and HFO/HFC blends. My advice to any end user would be to not invest in a solution that won't adhere to future regulations.

Along with the practical drawbacks mentioned, my biggest concern is that we do not know what effect these chemicals will have on the environment over the long run. Not only do HFO/HFC blends not adhere to sustainable GWP values, but those containing R1234yf are contributing to the creation in the atmosphere of TFA, which is ending up in our water systems.

There is a natural refrigerant available for every refrigeration application, which presents no harm to our planet and has been tried and tested all over the world in all climates. The sensible way to safeguard your system, lower costs and simplify your inventory is to make use of natural refrigerants.

They are the only future-proof solution! ■ WG

Wynand Groenewald, a mechanical engineer with a masters degree in CO_2 heat pumps, is a South Africa-based independent consultant. He has 15 years of experience in design, manufacturing, installation and commissioning of CO_2 refrigeration systems for the commercial and industrial sectors in South Africa, Australia and the U.S.

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Letters to the Editor

HFCs DILEMMA IN AUSTRALIA

Regarding "NGO Praises China's Plan to Regulate HFCs (page 27), Australia is continually flooded with R410A- and R32-based pre-charged split air conditioning units from China. Yet the Australian HFC phase down started in January 2018.

Unlimited importation of HFCs in pre-charged equipment is legal in Australia, and the commercial reality caused by this legislation on the ground is much worse than the political fraternity appears to be able to imagine.

This unfortunate mechanism for energy waste is a commercial reality in Australia within the entire built environment. It has been for three decades. Almost all KPIs are oriented towards minimization of capital costs.

The technical solution to this problem doesn't require a "Global Cooling Prize." It requires the application of known industrial refrigeration technologies (low-charge ammonia chillers) within areas previously reserved for HFC-based unitary equipment. It requires a complete technology transformation, but the total supply chain is ill equipped to deliver that.

On the demand side the energy-conservation solutions are ready. They are cost-effective and the impacts of their implementation will be expedient and create job opportunities for the ~300,000 individuals directly involved in the HVACR industries in Australia.

Stefan Jensen
Managing Director
Scantec Refrigeration Technologies
Brisbane, Australia

TFA IS ONLY HALF THE STORY

In regard to "Canadian Researchers Find Elevated Levels of HFO-1234yf Byproduct in Arctic Ice" (page 26), this is only half the story. Besides the long-term effects and the irreversible pollution that is happening, HFO-1234yf can be deadly when it is exposed to a hot surface or a flame, due the toxicity of the combustion products.

Our position is:

1. With the first chemical refrigerants (CFCs, HCFCs), we didn't know they had an ozone-depletion potential (ODP). After a lot of damage to the environment, we abolished them.

2. For the second series of chemical refrigerants (HFCs), we did not know they had a high GWP. Now they are being phased out.

3. With the HFOs (HFO-1234yf), we know or suspect that they are harmful to the environment because of acidification. Why take a risk when we know we don't need them? We can avoid this risk by using natural refrigerants.

Collin Bootsveld
Project Engineer
Peter Basteleus
Department Head
Colruyt Group
Halle, Belgium

THE IMPACT OF MAINTENANCE

Regarding "Refrigerants' Major Role in Saving the Planet (Project Drawdown)," *Accelerate Magazine*, April-May 2019, mere preventative maintenance tasks such as coil cleaning and filter replacement on existing air conditioning and refrigeration units/systems alone could slice another 15Gt in GHG emissions by 2050. My source is a 2018 study by The Carbon Trust commissioned by the Kigali Cooling Efficiency Program (K-CEP). It has an immediate potential not shared by refrigerant management or alternative refrigerants – if only "the cats could be herded." We've found that all stakeholders are fiercely resistant to this idea, possibly because it is highly labor intensive.

Richard Fennelly
COO
CoilPod
Cortlandt Manor, New York (U.S.)

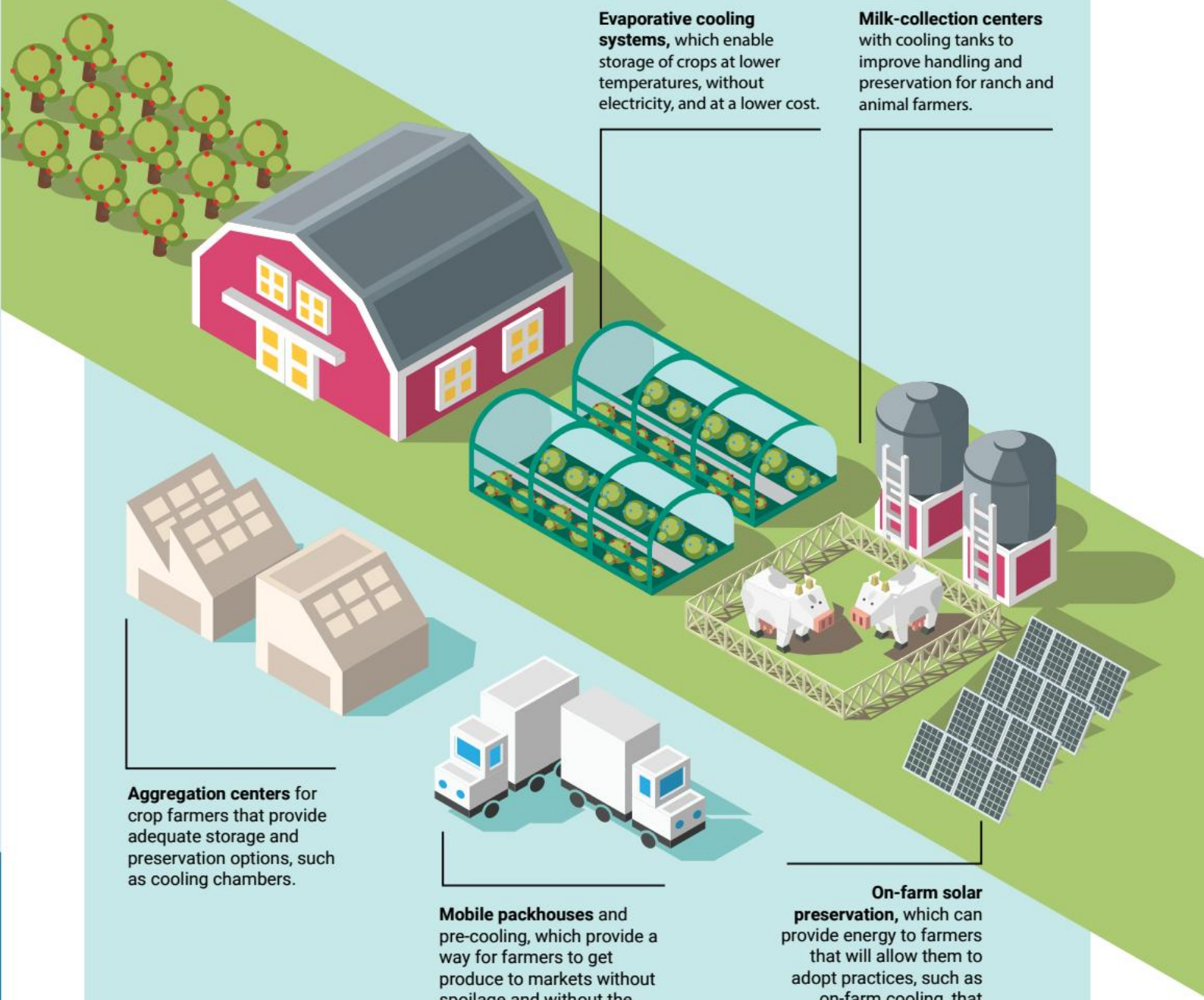
LETTERS ARE WELCOMED!

Accelerate Magazine invites readers to submit letters to the editor to michael.garry@shecco.com. Letters may be edited for clarity or length.

How Better Cooling Can Prevent Food Loss

shecco Base

A recent study by the World Resources Institute – "Reducing Food Loss and Waste: Setting a Global Action Agenda" – offers several cooling-related solutions to food loss in developing countries, including:



Evaporative cooling systems, which enable storage of crops at lower temperatures, without electricity, and at a lower cost.

Milk-collection centers with cooling tanks to improve handling and preservation for ranch and animal farmers.

Aggregation centers for crop farmers that provide adequate storage and preservation options, such as cooling chambers.

Mobile packhouses and pre-cooling, which provide a way for farmers to get produce to markets without spoilage and without the need for large capital outlay.

On-farm solar preservation, which can provide energy to farmers that will allow them to adopt practices, such as on-farm cooling, that reduce post-harvest loss.

Kigali Update

Ninety-six governments (including the European Union) have accepted, ratified or approved the Kigali Amendment to the Montreal Protocol as of June 25, 2020.* In 2020, five governments have done so to date: The Holy See on June 17, Bangladesh on June 8, North Macedonia on March 12, Lebanon on February 5, and Mozambique on January 16.

The Kigali Amendment was enacted on October 15, 2016, by 197 governments (plus the EU) in Kigali, Rwanda; it took effect on January 1, 2019. The Amendment calls for the phase down of the production and use of HFCs by developed and developing countries following the acceptance, ratification or approval of the amendment by each country.

The 49 developed (Non-Article 5) countries started with a 10% HFC phase down in 2019 (compared to a baseline of average HFC production/use in 2011-2013), except for Belarus, the Russian Federation, Kazakhstan, Tajikistan and Uzbekistan, which start with a 5% phase down in 2020. All developed countries will end with an 85% HFC phase down by 2036. **So far, 32 developed countries plus the EU have accepted, ratified or approved the Amendment.**

The 148 developing (Article 5) countries fall into two groups. The majority will start a freeze in 2024 at a baseline of average HFC production/use in 2020-2022; those countries will end with an 80% HFC phase down by 2045. The other Article 5 countries (Bahrain, India, Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, and the United Arab Emirates) will start a freeze in 2028 at a baseline of average HFC production/use in 2024-2026; those countries will end with an 85% HFC phase down by 2047. **So far, 63 developing countries (including both groups) have accepted, ratified or approved the Amendment.**

Here is a list of the 96 governments (including the EU) that have accepted, ratified or approved the Kigali Amendment as of June 25.

* Based on data from United Nations Treaty Collection (https://bit.ly/2pg0sgF)
** With territorial exclusion in respect of Greenland
*** For the European part of the Netherlands

shecco Base

Developed (Non-Article 5) Countries

Participant	Acceptance(A), Ratification, Approval(AA)
Andorra	Jan 23, 2019 A
Australia	Oct 27, 2017 A
Austria	Sep 27, 2018
Belgium	Jun 4, 2018
Bulgaria	May 1, 2018
Canada	Nov 3, 2017
Croatia	Dec 6, 2018
Czech Republic	Sep 27, 2018 A
Cyprus	July 22, 2019
Denmark**	Dec 6, 2018 AA
Estonia	Sep 27, 2018
European Union	Sep 27, 2018 AA
Finland	Nov 14, 2017 A
France	Mar 29, 2018 AA
Germany	Nov 14, 2017 A
Greece	Oct 5, 2018
Holy See	June 17, 2020
Hungary	Sep 14, 2018 AA
Ireland	Mar 12, 2018
Japan	Dec 18, 2018 A
Latvia	Aug 17, 2018
Lithuania	Jul 24, 2018
Luxembourg	Nov 16, 2017
Netherlands***	Feb 8, 2018 A
New Zealand	Oct 3, 2019
Norway	Sep 6, 2017
Poland	Jan 7, 2019
Portugal	Jul 17, 2018 AA
Slovakia	Nov 16, 2017
Slovenia	Dec 7, 2018
Sweden	Nov 17, 2017
Switzerland	Nov 7, 2018
United Kingdom of Great Britain and Northern Ireland	Nov 14, 2017

Developing Countries (Article 5)

Participant	Acceptance(A), Ratification, Approval(AA)
Albania	Jan 18, 2019
Argentina	Nov 22, 2019
Armenia	May 2, 2019 A
Bangladesh	Jun 8, 2020
Barbados	Apr 19, 2018
Benin	Mar 19, 2018
Bhutan	Sep 27, 2019
Burkina Faso	Jul 26, 2018
Chad	Mar 26, 2019
Chile	Sep 19, 2017
Comoros	Nov 16, 2017
Cook Islands	Aug 22, 2019 A
Costa Rica	May 23, 2018
Côte d'Ivoire	Nov 29, 2017 A
Cuba	June 20, 2019
Democratic People's Republic of Korea	Sep 21, 2017
Ecuador	Jan 22, 2018
Ethiopia	July 5, 2019
Gabon	Feb 28, 2018 A
Ghana	Aug 2, 2019
Grenada	May 29, 2018
Guinea	Dec 5, 2019
Guinea-Bissau	Oct 22, 2018
Honduras	Jan 28, 2019
Jordan	Oct 16, 2019
Kiribati	Oct 26, 2018
Lao People's Democratic Republic	Nov 16, 2017 A
Lebanon	February 5, 2020
Lesotho	Oct 7, 2019
Malawi	Nov 21 , 2017
Maldives	Nov 13, 2017
Mali	Mar 31, 2017 A

Participant	Acceptance(A), Ratification, Approval(AA)
Marshall Islands	May 15, 2017
Mauritius	Oct 1, 2019
Mexico	Sep 25, 2018 A
Micronesia (Federated States of)	May 12, 2017
Montenegro	Apr 23, 2019
Mozambique	January 16, 2020
Namibia	May 16, 2019 A
Niger	Aug 29, 2018
Nigeria	Dec 20, 2018
Niue	Apr 24, 2018
North Macedonia	Mar 12, 2020
Palau	Aug 29, 2017
Panama	Sep 28, 2018
Paraguay	Nov 1, 2018 A
Peru	Aug 7, 2019
Rwanda	May 23, 2017
Samoa	Mar 23, 2018
São Tomé and Príncipe	Oct 1, 2019
Seychelles	Aug 20, 2019 A
Senegal	Aug 31, 2018
Somalia	Nov 27, 2019
South Africa	Aug 1, 2019
Sri Lanka	Sep 28, 2018
Togo	Mar 8, 2018 A
Tonga	Sep 17, 2018
Trinidad and Tobago	Nov 17, 2017
Tuvalu	Sep 21, 2017
Uganda	Jun 21, 2018
Uruguay	Sep 12, 2018
Vanuatu	Apr 20, 2018
Vietnam	Sep 27, 2019 AA

shecco to Hold World's First Global Virtual NatRef Trade Show September 1-2

The virtual expo will take place live around the world over a 24-hour period, with an exhibition hall, webinars, and networking opportunities.

— By Michael Garry

ATMOsphere, the event division of clean cooling accelerator shecco (publisher of *Accelerate*) will hold a Virtual Trade Show for the natural refrigerants marketplace, which will take place live around the world over a 24-hour period September 1-2. The event will be free to attend.

"We are proud to announce a brand-new Virtual Trade Show, which will be the first in the world for the cooling industry," said Marc Chasserot, CEO of shecco. "It will bring hundreds of companies and thousands of individuals together to exchange and learn about the latest natural refrigerant technology solutions from the comfort of their home – so save the date."

The event's website (https://atmo-marketplace.com) provides details, including pricing, on becoming an exhibitor with a virtual booth, as well as tailor-made solutions, webinars, and private meeting rooms. A frequently asked questions (FAQ) section addresses all aspects of the event. Registration for the free event will be available at https://atmo-marketplace.com.

Encompassing every time zone, the Virtual Trade Show will start on September 1 with Europe, the Middle East and Africa, followed by North, Central and South America, and finishing with the Asia Pacific region on September 2. (This sequence has been updated since the original announcement of the event.) The website will be accessible for one month after the live event.

During the 24-hour live event, exhibitors will be able to interact with participants through real-time chat, audio and video capabilities. Company delegates will be represented by personalized avatars of their actual images, making them easily recognizable to attendees. Products will be visible via 3D renderings, and marketing material will be available via download.

"Easy to navigate and visually captivating, the Virtual Trade Show allows visitors to click through the exhibition halls, attend webinars, and network, recreating the feeling of a physical event," said Marc Chasserot, CEO of shecco.

When arriving at the Virtual Trade Show venue, attendees will have several options, including visiting the auditorium to join a live presentation. There will also be pre-recorded, on-demand sessions to be watched any time at the attendee's convenience.

Attendees can also choose to visit the exhibition hall, with booths hosted by natural refrigerant companies and organizations, including a hall map enabling visitors to see who is present.

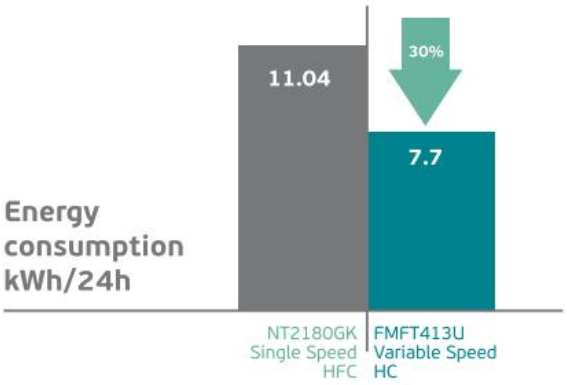
The Virtual Trade Show is designed to give attendees access to the latest natural refrigerant solutions without having to leave their homes (or offices) during the COVID-19 pandemic. "The pandemic is going to make life very difficult for trade shows this year, so we felt that this was the right moment to launch such a service," Chasserot added. ■ MG

The combination of natural refrigerants with variable speed technology creates dual benefits for refrigeration

They provide the benefit of having a better temperature control.

Variable Speed and R290 improve energy efficiency

Energy consumption reduced*



* Based on a frozen island case study

20% Average pull-down time reduction

Enabling the compressor to run at lower, energy-saving speeds

Soft Start

Decreases stress on the motor, helping to extend the machine's lifespan and ensure the cooling aspects of your business stay up and running.

Discover all that our **digital solutions** can do to support your business. Access: *embraco.com*

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New Mission for Refrigerants, Naturally!

Having met its original objectives for consumer brands, the NatRefs group is focused on small organic-food retailers via the Refrigerants, Naturally! for Life project.

— By Nicholas Cooper

It's not every organization that can look at its work and declare, "mission accomplished."

But Refrigerants, Naturally!, a Königstein, Germany-based international association promoting natural refrigerant technology, did just that with a post on its website in June 2018 (https://bit.ly/3eyTCLi).

In 2004, the members of Refrigerants, Naturally! together with Greenpeace and UN Environment, set out to achieve 100% f-gas free procurement in new point-of-sale systems, wherever technically and legally feasible.

By the end of 2017 four Refrigerants, Naturally! members – Coca-Cola, PepsiCo, Red Bull and Unilever – had collectively implemented 7.25 million natural refrigerant units (CO_2, propane, or isobutane). At that point, three of the companies had reached their 100% natural refrigerant procurement goal, with the last member company to reach that goal in 2020.

So the companies collectively decided to officially end their active engagement in the Refrigerants, Naturally! Initiative at the end of 2017, "creating space for new ventures looking at other aspects of cooling to be addressed by a new generation of companies," said the announcement.

Focus on small retailers

Last year, Refrigerants, Naturally! appointed a new project team, which continues to promote natural refrigerants in store equipment. However, the focus has shifted from large consumer brands to small players in the organic food retail (OFR) sector in Europe under an EU-funded project called Refrigerants, Naturally! for LIFE (RefNat4LIFE). In particular, RefNat4LIFE promotes climate-friendly cooling alternatives for refrigeration, air-conditioning and heat pump (RACHP) equipment among these retailers. (shecco, publisher of *Accelerate*) is a partner in the RefNat4LIFE project.)

The new focus is on "translating the technological advances and experience from the big players to the smaller ones," said René van Gerwen, a co-founder of Refrigerants Naturally! who is now a member of the project team as well as Managing Director of Entropycs, a Dutch company specializing in services related to natural refrigeration.

Looking at smaller retailers is appropriate since their cumulative impact in Europe is "at least as important" as that of the household names, said van Gerwen.

Training and education are particularly important for retailers in the OFR sector, who operate under smaller margins than Refrigerants, Naturally!'s original partners. Thus, the program aims to "increase the uptake of training for service personnel of equipment using climate-friendly alternatives," according to RefNat4LIFE's website (https://www.refnat4life.eu).

To that end,, RefNat4LIFE plans to launch a "massive open online course" (MOOC) about refrigeration, air conditioning, and heat pump technology in late 2020, according to its website. The anticipated outcome is two modules, one for contractors and the other for retailers.

To support MOOC, Refrigerants, Naturally! is in discussion with RealAlternatives, a project promoting education in natural refrigerant technology, said van Gerwen. This will maximize the impact of education in natural refrigerant technology in Europe, while reducing "duplication and parallel working," he said. ■ NC

shecco Guide Puts Global Transcritical CO_2 Installations at 35,000

Part 2 of three-part World Guide analyzes the transcritical CO_2 market, a policy update, articles on convenience store applications, as well as case studies.

– By Michael Garry

When shecco (publisher of *Accelerate*) started collecting data in 2008, the company counted only 140 installed transcritical CO_2 systems – all of them in Europe. Today, this number is an estimated 35,000 systems globally as the accelerated phase down of environmentally harmful fluorinated refrigerants drives the search for more climate-friendly alternatives.

The global market for this technology, with a regional breakdown of installations, is among the topics addressed in Part 2 of the three-part "World Guide to Transcritical CO_2 Refrigeration," assembled by the ATMO Intelligence (market development and research) division of shecco. The document is available for free download at https://bit.ly/2zVmmij.

"As the use of transcritical CO_2 refrigeration systems increases at a rapid rate around the world, it has become apparent that there is great need for reliable information from a neutral source," explained Ilana Koegelenberg, Market Development Manager at shecco. "As such, this guide will specifically look at the potential of transcritical CO_2 – today and in the future."

Part 2 of the Guide, which includes three chapters, is based on a global industry survey as well as an in-depth data collection drive that engaged manufacturers around the world. The document also has a policy update, articles on convenience store applications and more traditional commercial refrigeration uses, as well as case studies.

> *"Our hope is that the guide will serve as a resource to help drive the accelerated uptake of this highly sustainable and energy-efficient HVAC&R technology."*
>
> – Ilana Koegelenberg, shecco

"Our hope is that the guide will serve as a resource to help drive the accelerated uptake of this highly sustainable and energy-efficient HVAC&R technology," said Koegelenberg.

Part 1 of the Guide was published in May and highlights the history of CO_2, its key characteristics, basic system descriptions, and includes a chapter on practical, real-life transcritical CO_2 applications around the world. It can be downloaded for free at https://bit.ly/2XL20RP.

The complete Guide, including Part 3, will be live by the end of July 2020, and launched with a webinar. Part 3 will look at industrial applications as well as future market trends, including barriers and drivers for the uptake of transcritical CO_2 around the world. ■ MG

World in Brief

IIAR Seeks Technical Papers for 2021 Conference

The International Institute of Ammonia Refrigeration (IIAR) has issued a call for technical papers for its 46th Natural Refrigeration Conference & Heavy Equipment Expo, scheduled for March 28-31, 2021.

The 2021 conference will take place in Palm Springs, California.

IIAR has invited experts to submit papers on topics "where actions, testing, or data accumulation are used to prove or demonstrate the outcome of applied methods, and could be reasonably applied to other similar situations."

For more information on how to submit, click here https://bit.ly/2XSPHDe.

IIAR will provide exhibitor information in July and attendee information in August. ■ MG

Australian Food Waste Linked to Faulty Cold Chain

A new report looking at the causes of food waste in Australia attributes AU$3.8 billion (US$2.63 billion) in wasted food to "breaks and deficiencies in the cold food chain."

The report, titled "Study of Waste in the Cold Food Chain and Opportunities for Improvement," was published in May.

In specific categories, Australia loses 25% of its annual fruit and vegetable production, 3.5% of meat and seafood production, as well as 1% of annual dairy production value, the report said.

The study identifies practices that would cost-effectively reduce perishable food waste, including better food handling, reduced time outside refrigerated environments during transfer, more accurate measurement of food temperatures, and better cohesion and monitoring at all steps in the cold chain. ■ NC

Researchers Find Elevated Levels of HFO Byproduct in Arctic

A new Canadian study looking at the composition of Arctic ice cores since 1990 points to the accumulation of trifluoroacetic acid (TFA), an atmospheric byproduct of HFO-1234yf, which is raising concerns about TFA's long-term effect on the environment and human health.

The study, which determined the content of the ice cores from the Devon Ice Cap in Nunavut, Canada, on a yearly basis, verified that levels of "persistent compounds" (scPFCAs) including TFA, have increased since 1990, following the adoption in 1987 of the Montreal Protocol; that is the global treaty that led to the replacement of ozone-depleting CFC and HCFC gases by HFCs, and, more recently, by HFOs.

"We observe the importance of CFC replacements in the increased deposition of TFA," said the study.

Cora Young, the corresponding author of the study, is quoted by the BBC in a May 14 article as saying that the levels of scPFCAs found in the Arctic ice is "on the order of 10 times higher now than we saw before the Montreal Protocol."

The study was published on April 23 in *Geophysical Research Letters*. ■ MG

ASHRAE on HVAC's Role in COVID-19

The risk of spreading SARS-CoV-2 (the virus that causes COVID-19) is generally linked to direct transmission of droplets from someone who is coughing, sneezing or even talking a few feet away. However, there has been much discussion of whether the virus can be transmitted through the air as an aerosol, and the role of HVAC systems in this transmission.

As an authority on HVAC, ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) has weighed in on the issue through its Epidemic Task Force. In regard to airborne transmission, ASHRAE's position is: "Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled."

Ventilation and filtration provided by heating, ventilating, and air-conditioning systems, ASHRAE added, "can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air."

Moreover, ASHRAE said, "unconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection." And so the organization's conclusion is that, "in general, disabling of heating, ventilating, and air-conditioning systems is not a recommended measure to reduce the transmission of the virus."

Additional information from ASHRAE can be found at https://bit.ly/2CoMHGt. REHVA (Federation of European Heating, Ventilation and Air Conditioning Associations) offers COVID-19 guidance at https://bit.ly/2N7vP9d. ■ MG

Viessmann to Launch R290 Heat Pump

German manufacturer Viessmann Group plans to introduce an energy-efficient propane (R290) version of its Vitocal heat pumps – the 300-A Pro, which will be able to deliver both heating and cooling simultaneously, with a combined coefficient of performance (COP) of up to 10.

The launch was scheduled to happen in August 2020. However, then came COVID-19, and "the market launch of the new units will be significantly delayed due to the Corona pandemic," said Wolfgang Rogatty, Head of Trade Media at Viessmann.

A tested COP of up to 10 means that the 300-A Pro "offers the maximum efficiency in its output class by a wide margin, as well as particularly low operating costs," according to a press release from Viessmann.

The R290 air-to-water heat pump is planned in four sizes, with outputs ranging from 79 to 316kW (22.5 to 89.9TR) for heating and 77 to 307kW (21.9 to 87.3TR) for cooling. If higher capacities are needed, the 300-A Pro units can be combined in cascade, resulting in a capacity of up to 1,264kW (359.4TR) for heating, and 1,228kW (349.2TR) for cooling (with four units combined).

Such capacities make the 300-A Pro suitable for large residential buildings, neighborhoods, commerce and industry, according to Viessmann.

The patented circuitry in the 300-A Pro's heat exchanger enables the unit to carry out both cooling and heating operations in parallel, said Viessmann. ■ TS

Survey Seeks Feedback on EU F-Gas Changes

ATMO Intelligence (a division of *Accelerate* publisher shecco) invites air-conditioning and refrigeration stakeholders to participate in a survey (https://bit.ly/3fifquH) that assesses the F-Gas Regulation, sector by sector, while also looking into what should be included in an upcoming revision of the regulation.

Respondents select the sectors they are active in and complete a custom survey. "With these results, we will produce a comprehensive report that will be shared with policymakers across the EU to drive more progressive change," said Ilana Koegelenberg, Market Development Manager at shecco.

Once completed, the report will be freely available for download. The survey should take no more than 15-20 minutes. ■ MG

New Roadmap to Improve Energy Efficiency of Cold Storage

Star Refrigeration, a Glasgow, U.K.-based industrial refrigeration company, has created a "six-stage" roadmap to help cold storage facilities optimize energy consumption and reduce their carbon footprint.

The roadmap was developed in response to rising energy prices, according to the summary on Star's website.

"The roadmap gives a clear route to achieving success through practical insight into effective techniques which have been proven to reduce energy costs and carbon emissions," said Star's Director of Sales, David Wallace.

The map consists of six targets for users to consider: planning, building construction, refrigeration system and design, maintenance, analysis and monitoring, as well as system controls optimization. ■ NC

NGO Praises China's Plan to Regulate HFCs

The Environmental Investigation Agency (EIA)-U.S. a Washington, DC-based NGO, issued a statement on May 21, praising China for proposing a new national plan to regulate HFCs.

The plan would extend China's existing ozone depleting substance (ODS) regulations to also cover HFCs and strengthen monitoring and enforcement of existing measures.

Under the plan, China would regulate HFCs consistent with implementation of the Kigali Amendment, including a quota system that gradually reduces the production and consumption of HFCs for controlled uses such as refrigerants, foaming agents, fire extinguishing agents, solvents, cleaning agents, and aerosols.

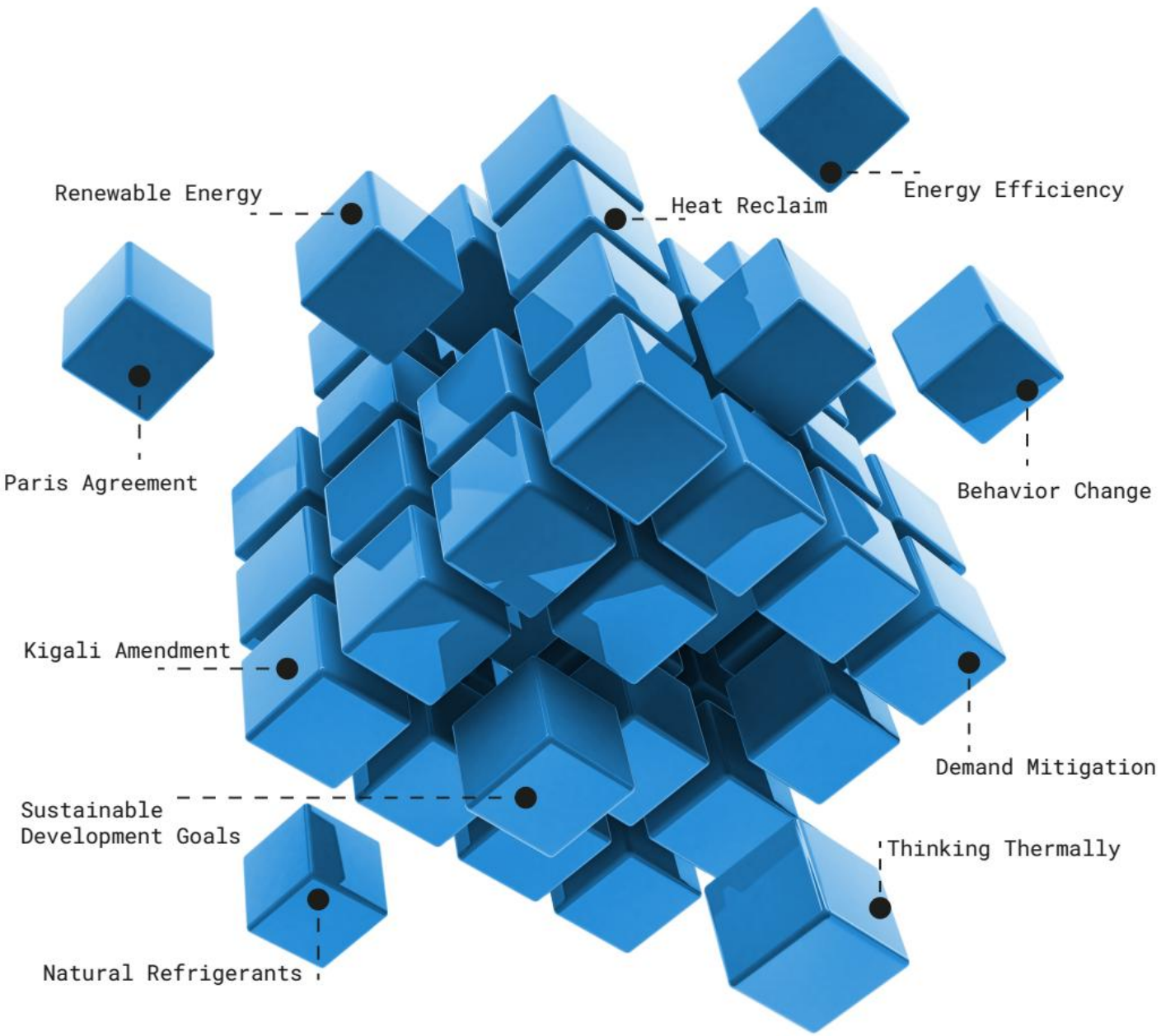
China is the world's largest producer of these gases, and manufactures about 70% of the world's air conditioners.

"This draft plan demonstrates a clear intent to tackle these potent greenhouse gases," said Avipsa Mahapatra, Climate Campaign Lead, EIA-U.S. "EIA commends China for initiating this comprehensive process to implement the Kigali Amendment and strengthen enforcement of existing controls over ozone-destroying chemicals,"

China has not yet officially ratified the Kigali Amendment to the Montreal Protocol, which seeks a roughly 85% phase-down of HFC production and use by 2047. ■ MG

CLEAN COOLING

Putting together all the pieces of the sustainable cooling-for-all puzzle



Professor Toby Peters of the Centre for Sustainable Cooling, in conjunction with shecco, is refining the definition of Clean Cooling, and developing a process for auditing whether cooling projects fulfill the definition.

– By Michael Garry

Over the past five years, three global agreements of immense importance to the future of humanity have been enacted: the United Nation's Sustainable Development Goals (SDGs), the Paris Agreement on climate change, and the Kigali Amendment to the Montreal Protocol on HFC reduction.

The SDGs, born at the UN Conference on Sustainable Development in Rio de Janeiro in 2012, encompass 17 urgent environmental, political and economic challenges around the world. They were adopted by world leaders in September 2015 at the UN Sustainable Development Summit 2015 in New York City, and went into force in January 2016.

Around that time (December 2015), the UN Climate Change Conference (COP 21) was held in Paris, where 196 governments negotiated and drafted the Paris Agreement on climate change; it was signed the following April in New York City, and has been ratified by 189 governments as of June 2020. Its objective: keeping the rise in global temperatures since the industrial revolution well under 2°C (3.6°F), preferably no greater than 1.5°C (2.7°F).

To support the goals of the Paris Agreement, the Kigali Amendment to the Montreal Protocol was enacted on October 15 2016, by 198 governments (including the European Union) in Kigali, Rwanda; it took effect on January 1, 2019. The Amendment calls for the phase down of the production and use of HFCs, which are potent greenhouse gases, by developed and developing countries, targeting a roughly 85% reduction compared to baselines by 2047.

While these three global treaties all aim to dramatically improve the environmental, economic and social health of the world during the 21st century, they each go about it in different ways. But there is one, often overlooked, area of overlap that is essential to the realization of all three: cooling or, to be more precise, "Clean Cooling."

"Clean Cooling sits at the intersection of Paris, Kigali and the SDGs," said Toby Peters, Professor in Cold Economy at the University of Birmingham, U.K., and Co-Director of the Birmingham-based Centre for Sustainable Cooling, who first defined the concept several years ago. He has written extensively about it, including a study called "A Cool World: Defining the Energy Conundrum of Cooling for All." (See "Meeting the Demand for Cooling in a Warming World," *Accelerate Magazine*, July-August 2019.)

Clean Cooling, Peters explained, is the link that shows how the three treaties are not separate entities but are in fact interrelated; moreover, it is the linchpin that "enables you to deliver all three simultaneously," that is, meeting basic societal needs while protecting the environment, he said.

> *"The criteria for the Global Cooling Prize are fully aligned with the intent of the Clean Cooling definition."*
>
> – Iain Campbell,
> Rocky Mountain Institute

Clean Cooling, which dramatically raises the bar on current norms, is Peters' call to arms. "If we're going to hit our targets, we have to challenge the world to be more aggressive," he said.

The implementation of Clean Cooling would not only help countries achieve the goals of the three major treaties, but in so doing would also deliver what Peters calls "Cooling for All." Over a billion people now lack adequate access to cooling for food, health and physical well-being, according to Sustainable Energy for All "Chilling Prospects" reports. Moreover, unchecked warming will result by 2070 in 1-3 billion people being "exposed to mean annual temperatures warmer than nearly anywhere today," said a study, "Future of the human climate niche," published in May in the *Proceedings of the National Academy of Sciences*.

Toby Peters

> *In simple terms, we need a step-change intervention to reduce the energy consumption of cooling by 70% by 2050.*
>
> – Toby Peters, University of Birmingham

The concept of Clean Cooling – as a "gold standard" for sustainable cooling – is currently being refined by Peters and colleagues in concert with shecco, publisher of *Accelerate* and in discussion with external experts. Its current definition can be found at https://bit.ly/2WQs39D. Peters expects the definition to evolve over time as cooling solutions and strategies improve.

He stressed that Clean Cooling is an attempt to get beyond "nebulous terms" like sustainable cooling. "I see technologies using refrigerants with a 1,900 GWP, or transport refrigeration running on diesel, called sustainable; they might offer incremental improvements, but they are not sustainable," he said.

Peters and shecco are also, over the course of 2020, leading a collaborative project to develop a standard Clean Cooling process – in effect, a series of questions by which cooling projects can be audited. This process could be employed by a variety of stakeholders, including end users, planners, banks, and governments. They will welcome industry feedback on the definition and standards that are developed.

Iain Campbell, Senior Fellow at the Rocky Mountain Institute (RMI), which developed the Global Cooling Prize, said he agrees that there is a need for a clearer definition of sustainable cooling "that reflects both long-term aspiration while still being in reach, and is a definition that can be applied with rigor and transparency." The criteria for the Global Cooling Prize "are fully aligned with the intent of the Clean Cooling definition," he added.

Among the organizations seeking to facilitate the use of efficient cooling in developing countries is the Swiss group BASE (Basel Agency for Sustainable Energy), which is helping companies offer the cooling-as-a-service (CaaS) financing model. Thomas Motmans, Sustainable Energy Finance Specialist for BASE, sees Clean Cooling as aligning with CaaS and other financial instruments.

"A standard for clean cooling resulting from an auditable and certifiable process will be a valuable tool to support financial instruments, as it will support investors building portfolios of sustainable projects to better understand what they are investing in," said Motmans.

A SYSTEMS APPROACH TO CLEAN COOLING

Since 2015, as an output of the University of Birmingham (U.K.) Policy Commission, Professor Toby Peters has been advocating for a systems approach – "Clean Cooling" – to meet our cooling demand sustainably (economically, socially and environmentally); it considers all technical, socio-economic and environmental inputs, outputs, and other aspects of providing cooling.

Here he summarizes the systems approach to cooling that can be developed along a value chain with the following elements:

Planning cold: Identify cooling service demands in a needs-driven manner, taking full account of what would be required to meet the United Nation's 17 Sustainable Development Goals (SDGs).

Important to understand is that in e-vehicles and e-logistics, cooling accounts for 3%-7% of passenger transport energy consumption today, but could grow to 24-26% by 2050, as drive technologies improve, temperatures rise, and warmer regions motorize.

Making cold: Harness unused or "waste" resources such as cold-water bodies; "wrong time" renewable energy (wind, solar); waste cold (from LNG regasification) and waste heat; or ambient heat sinks (ground source, sky cooling).

There is an opportunity to explore harnessing free cooling – as well as synergies among processes, waste resources and cooling needs – that can further reduce the cooling requirement.

Storing cold: Store energy thermally, in physical mass (energy walls) or phase-change materials (ice) to make use of cyclical changes in ambient heat sinks and supply of electric energy, at lower costs.

It's important to recognize that thermal services could be better served by thermal storage solutions rather than electric-to-electric batteries.

Moving cold: Use new energy vectors and materials to move thermal energy; for example, liquid air or nitrogen can be employed for cooling and generating mechanical energy.

It's important to understand cooling (demand and supply) as an important factor in infrastructure planning, whereby it is taken into account in decisions like where to locate a data center, a food aggregation hub, or an LNG terminal – even how to build a new city.

Using cold: Reduce cold loads by lowering cooling demand (such as via insulation), increasing equipment efficiency, and replacing refrigerants with high GWP.

The key is to highlight behavior change and demand mitigation strategies likely to be effective, while maintaining required service levels. Also consider substitutes for cooling solutions, with much lower energy use. For example, fast transportation of vaccines by airborne drones in rough terrain can deliver safe products, without the need for mobile cooling.

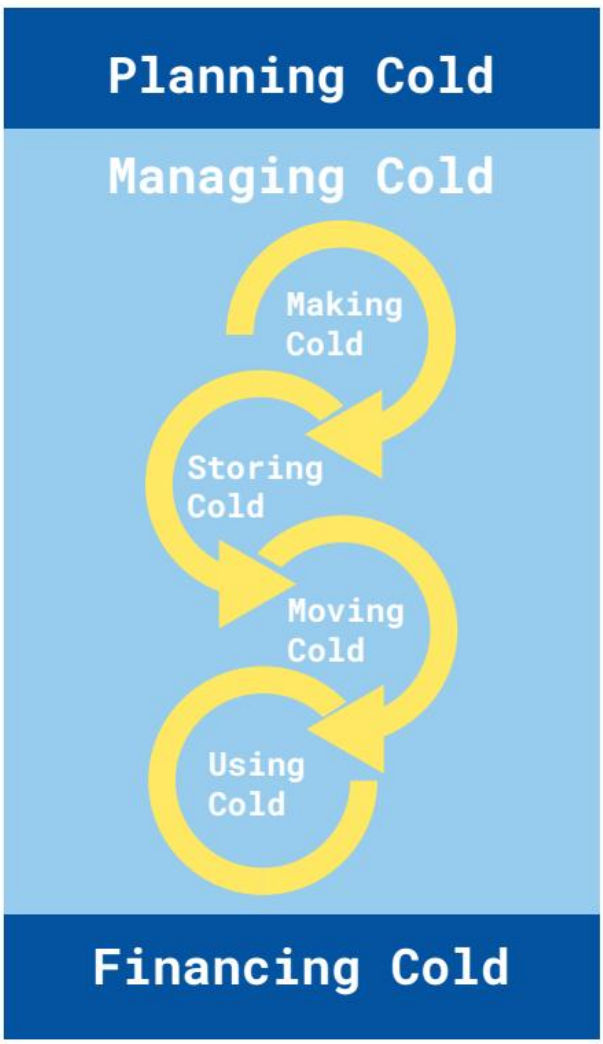
Managing cold: Make cooling systems smart via real-time monitoring of cooling needs and performance (with sensors), load adjustments (with controls), and integrated system management and storage. Deliver cooling only where and when needed while optimizing system-wide impacts.

Not least, there is the need to ensure the correct installation and maintenance of cooling units, in the absence of which inefficient energy use and refrigerant leakage rates above 25% are possible and safety provisions may be missed.

Financing cold: Ensure access to cold but also improve human decision-making and modify behavior through smarter financing options (like pay-for-use), instant visibility of system status and consequences, integration of external costs/benefits (carbon pricing), marketing of alternative energy sources (such as waste heat) and other incentives.

Further information on Clean Cooling is available at https://bit.ly/2Nhu7ll.

A SYSTEMS APPROACH TO CLEAN COOLING INCLUDES THESE ELEMENTS:



THE SIZE OF THE CHALLENGE

If Clean Cooling has an ambitious agenda, it is because the scale of the challenge – achieving all three global treaties – is so immense, noted Peters. The numbers tell the story.

To begin with, "the warming world is adding an estimated 13 to 19 cooling appliances per second, and we could see more than 9.5 billion in use by 2050, up from approximately 3.6 billion today," Peters said. But in order to deliver access to cooling for all who need it, this number could be closer to 14 billion appliances "without step-change intervention in how we deliver cooling," he said.

With all of those appliances, and meeting the "cooling needs of all" implied by the 17 SDGs, cooling by itself, without intervention, could account for 17-18Gt CO_2e emissions per year at a time when many are targeting net zero. An acceptable cooling number to hit climate targets might be 2Gt, which won't be possible "unless we massively change how we do cooling," Peters said, "That's the size of the problem."

In terms of energy consumption, delivering cooling for all, while meeting the new demand for air conditioning in developing countries, could rack up an estimated 19,500tWh (terawatt hours) of energy annually by 2050 without mitigation measures, Peters said. However, under the Paris agreement goal of preventing global warming from exceeding 2°C, no more than 6,300tWh or cooling would be acceptable, according to data provided by the International Energy Agency (IEA). (Relying on renewables is not the answer because cooling for all could consume 63%-104% of the total renewable energy generation projections for 2050, Peters added.)

How then to get from 19,500 tWh to 6,300tWh? Peters believes it can only happen through a firm global commitment to Clean Cooling. "In simple terms, we need a step-change intervention to reduce the energy consumption of cooling by 70% by 2050," he said, "It requires us to radically rethink cooling."

Achieving the 2050 goal "in reality requires integrated solutions that meet the targets between 2030 and 2040, given the 10-12 year lifespan of cooling equipment," Peters said. To that end, a room air conditioner that is five times more efficient than conventional models is on the horizon as a result of the Global Cooling Prize, organized by a global coalition led by the Government of India and RMI. Eight finalists who have developed highly efficient AC systems will compete for a US$1 million prize, which will be announced in March 2021.

But Peters, who is a judge for the Global Cooling Prize, stressed the need for "countries to recognize what can be achieved and adopt regulations so that affordable AC units consuming 80% less energy become standard by 2030."

A COOLING MOSAIC

Efficient equipment alone will not be enough to "deliver Paris" and the other global accords, Peters said. That requires Clean Cooling.

Clean Cooling, as it pertains to air conditioning and refrigeration, in both stationary and mobile applications, encompasses a wide array of elements – akin to a mosaic that gives form to many pieces.

In its essence, Clean Cooling is "resilient cooling for all who need it, without environmental damage and climate impact and with the optimal use of natural and thermal resources throughout the lifespan of the cooling system," Peters said.

But Clean Cooling starts with "a quantitative assessment and understanding of the need for cooling," he said. For end users of cooling, it means changing the question from "How much electricity do I need?" to "Have I thought about what cooling service I need?" he added. This means considering not only the total cooling load, but also the steps that have been taken to minimize the load, and the available energy resources, before the equipment is even installed. Peters calls this "thinking thermally" – not about how much electricity is needed, but how much cooling.

So it is not enough to install an energy-efficient air conditioning system in a building to achieve Clean Cooling, explained Peters. The building itself needs to be designed to reduce the cooling demand via steps like white roofs, shading and natural ventilation "to mitigate the need for mechanical cooling." In addition, such a building would seek to instill behavioral or system changes to maintain a "reasonably comfortable temperature" of, say, 24°C-26°C (75°F-79°F) while minimizing room humidity. A computer center would need to leverage "free cooling" during lower ambient temperature periods. A supermarket would need to have doors on all of its coolers, and reclaim the coolers' waste heat to make hot water.

And then the equipment itself has to be accessible, affordable, financially sustainable, flexible, scalable, targeted, safe and reliable, according to the model definition.

Clean Cooling does not stop at installation. It continues with a committed maintenance program – something often neglected today – to ensure that equipment keeps up peak efficiency, and includes the latest digital monitoring and control systems. It is estimated that upwards of 25% of AC emissions could be cut today via optimization, monitoring and maintenance. But for that to happen, it will be essential to train a sufficient number of technicians to work with natural refrigerants in the latest AC and refrigeration systems.

In addition to offering best-in-class efficiency, Clean Cooling equipment uses refrigerants that have little to no global warming potential (GWP) or wider environmental impacts. That means natural refrigerants (CO_2, hydrocarbons, ammonia, water and air) are a fundamental part of Clean Cooling, except in rare and urgent instances where they are not available or can't be supported by technicians. Over time, as natural refrigeration becomes more mainstream globally, the exception will be dropped.

Clean Cooling also applies to mobile air conditioning (MAC). Like stationary AC, MAC will experience increasing demand as global temperatures rise, to the point where up to 24%-26% of the electrical demand in an electrically powered vehicle used in hot, humid climates could be for cooling by 2050, said Peters. (It is now about 3%-7% of a vehicle's fuel consumption.) To reduce demand, cars will likely need to be designed with better insulation, along with having more efficient MAC systems, he noted.

Most car manufacturers have switched to R1234yf refrigerant (an HFO), though some, like Daimler, are starting to employ CO_2 as the refrigerant.

As with climate change mitigation, natural resource conservation is a byproduct of Clean Cooling. By using cooling to prevent food loss, farmers are able to conserve massive amounts of natural resources like water and land, Peters noted. The efficient use of natural resources in equipment is another mark of Clean Cooling. To that end, it may be better to use ice rather than lithium batteries for cooling energy storage, Peters said.

Clean Cooling is not done inside a social vacuum; it takes into account the basic human needs for food, health and comfort. "So, if you are building a factory, alongside mitigating cooling demand, you check that the staff will be kept safe and productive," said Peters. In an agricultural setting, Clean Cooling specifically must include cold chains for food and medical needs to meet both SDG and climate targets. This means "integrated, seamless and resilient networks of interconnected refrigerated and temperature-controlled storage, aggregation, distribution and process points, and transport modes."

RENEWABLES AND OTHER ENERGY SOURCES

Energy management is a critical feature of Clean Cooling.

Importantly, energy for Clean Cooling does not need to come from electricity, stressed Peters. It can also be run on low-grade waste energy (absorption chillers), trigeneration (power, heat, cold) or other thermal energy (including. solar). "Waste" cold from liquefied natural gas (LNG) regasification can be used, while geothermal energy, bodies of water and sky cooling can effectively provide free energy for cooling. In hot dry climates, water evaporation is commonly employed for cooling. Likewise, energy can be efficiently and cost-effectively stored in phase-change materials, like ice or even tanks of water, not just batteries.

Indeed, these alternatives will be increasingly required given that cooling (thermal services) is one of the fastest-growing energy sectors, observed Peters. That needs to be recognized, he added, as the global transition to renewables is implemented, and the energy system is designed for a variety of needs, including new services, e-vehicles and e-logistics, intermittent generation, flexible loads, peak energy demands, and multiple energy resources requiring different operating conditions.

Thus, Clean Cooling is cognizant of how communities use cooling, such as when peak demand takes place; it endeavors to alleviate the burden that peak demand places on the power grid (including variable renewable energy generation) by switching to thermal storage, such as blocks of ice created when demand is low. "In many hotter climates, a significant percentage of peak electricity demand is to drive ACs," noted Peters.

Meeting the challenge of cooling and the transition to renewables simultaneously needs "integrated approaches using bundles of technologies that leverage all energy resources, including untapped synergies between thermal sources and sinks," said Peters. It will also mean "delivering added value from system optimization, allowing new economic values to be captured, and ensuring resilience and optimized energy management across the transport and built-environment."

In effect, Clean Cooling calls for holistic thinking that includes, not solely the technological domain, but also energy sources, energy storage, manufacturing strategies, social, ecological and economic considerations, governance, policy, finance, business, education and training, he said. For Peters, this will preclude "sub-optimal solutions due to adopting a siloed business-unit perspective and a lack of understanding of local needs and requirements."

In short, he said, Clean Cooling calls for a systematic approach to cooling along a value chain with the following elements: planning, making, storing, moving, using, managing and financing cold. (See sidebar, page 31.) He sees this as part of an "interconnected cold eco-system designed for circularity."

WHO USES CLEAN COOLING?

Peters foresees Clean Cooling standards being used by a variety of stakeholders, including end users, banks, and governments.

The UN is already asking governments to develop National Cooling Action Plans (NCAP) that meet the needs of communities and contribute to a country's Nationally Determined Contribution (NDC) to the Paris agreement. However, Peters believes that many NCAPs are failing to assess a country's total cooling needs. "If you don't know how much cooling is needed to meet your goals – feed your population, deliver vaccines, keep people safe and productive – then how can you have a robust plan?" he asked.

To assist countries in determining their cooling demand, Edinburgh, U.K.-based Heriot-Watt University, where Peters is a Senior Research Fellow in Transformational Innovation for Sustainability, has recently released a "cooling needs assessment tool," he said.

In order to fulfill Clean Cooling's vision of a world with cooling for all, banks and other institutions will need to employ creative solutions, such as CaaS, a pay-as-you-go "servitization" model that eliminates onerous first costs for the end user. "Such a model could be especially helpful to farmers in developing countries with cold-chain equipment, and also help city dwellers pay for more efficient AC units," noted Peters. District cooling is another scheme that could distribute cooling more economically.

Motmans of BASE said his organization would see a "strong value" in using a Clean Cooling standard to evaluate CaaS projects. "Setting clear standards would motivate cooling users and investors alike to seek 'clean cooling certified' CaaS providers, and would motivate the latter to innovate to reach such a standard," he said.

The CaaS model, added Motmans, incentivizes technology providers to implement Clean Cooling strategies, such as passive cooling, to minimize cooling demand prior to installing the cooling system, and preventive maintenance in order to maximize operating efficiency. "With CaaS, the technology provider has the incentive to implement those strategies that will reduce the lifecycle cost of the plant, because these will reduce the costs to deliver the cooling service to the customer," he said.

To jumpstart Clean Cooling in India, several projects are underway. For example, a "Centre of Excellence (COE)" in the form of a pack house that will showcase modern refrigeration technologies is being developed in Haryana state, India, to improve and integrate the local cold chain and help reduce food loss. The COE project has broad support and is being undertaken by a partnership of the AgriTech Sector Team in the U.K. Department for International Trade, the British High Commission India, as well as the Haryana State Government.

In addition, researchers from the University of Birmingham and Heriot-Watt University have launched a project in India with Shakti Sustainable Energy Foundation and the Consortium for Energy Efficiency (CEE) to help try to engineer an efficient clean cooling COVID-19 vaccine-logistics mechanism.

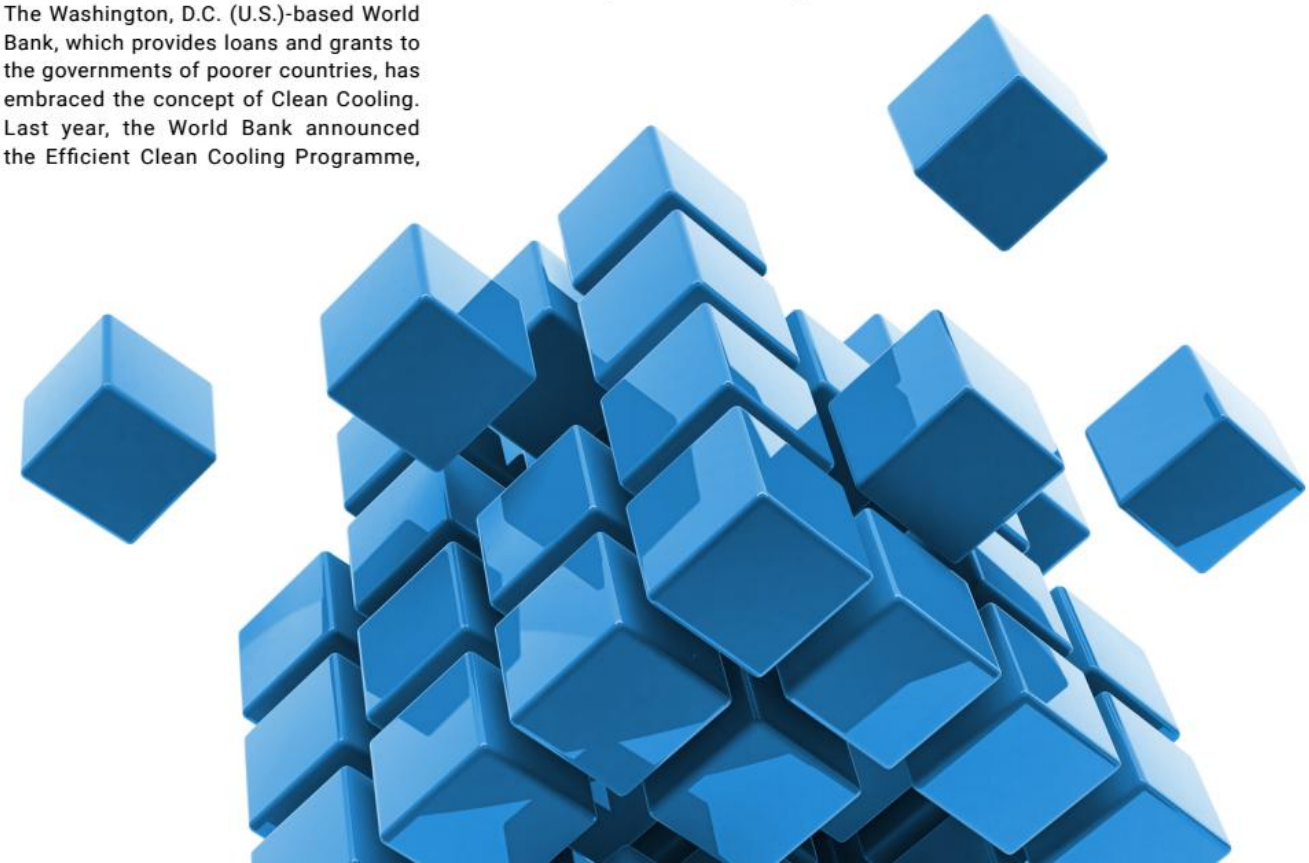
Banks could employ Clean Cooling standards to force loan applicants to pare the cooling cost of a project. For a building loan, "the first question is, have you mitigated the cooling demand?" said Peters. "Don't get me to fund an air-conditioning system until it's the smallest size because you designed the building properly. Then, can you confirm that the AC is at the highest efficiency and the refrigerant is natural? If not, then it's back to the drawing board."

The Washington, D.C. (U.S.)-based World Bank, which provides loans and grants to the governments of poorer countries, has embraced the concept of Clean Cooling. Last year, the World Bank announced the Efficient Clean Cooling Programme, designed to accelerate the uptake of sustainable cooling solutions (air conditioning, refrigeration and cold chain) in developing countries. Led by the World Bank's Energy Sector Management Assistance Program (ESMAP) and the World Bank's Climate Change Group, the program received a $3 million grant from the Kigali Cooling Efficiency Program (K-CEP) to ensure that efficient, clean cooling is included in investment projects and to mobilize further financing.

The bank also last year announced that it was developing a "roadmap" that will help it look at projects at a "system level," considering all of the energy and thermal elements.

In promoting Clean Cooling as an aspirational standard for the world, Peters is trying to orchestrate a shift in the way people generally perceive energy. Instead of simply equating energy loads with electricity, they should understand that energy also includes cooling (thermal energy), he believes.

"When we talk about energy, people think of electricity and don't realize that in many countries the biggest growth in energy demand is cooling loads," he explained. "We need to start thinking thermally. That's the challenge." ■ MG



Americas

End User
Embracing Heat Reclaim, Canadian Ice Rink Slashes Natural Gas Usage

Policy
Making Sense of the HFCs Regulatory Chess Board

Policy
Ammonia Regulations in the Age of Trump and the Coronavirus

Events

1. **June 26**
   World Refrigeration Day
   https://worldrefrigerationday.org/

2. **June 29 - July 2**
   2020 ASHRAE Virtual Conference
   https://bit.ly/3cShlnT

3. **September 1-2**
   shecco Virtual Trade Show on natural refrigerants
   https://atmo-marketplace.com/

4. **December 1**
   Cooling-as-a-Service (CaaS) Global E-Summit
   Basel Agency for Sustainable Energy (BASE)
   https://bit.ly/2C2pHwF

5. **January 25-27**
   AHR Expo
   Chicago
   https://ahrexpo.com

Embracing Heat Reclaim, Canadian Ice Rink Slashes Natural Gas Usage

Dufferin Arena in Stratford, Ontario, cuts natural gas bill by two-thirds, electricity costs in half, on way to net-zero.

— By Michael Garry

Alfa Laval heat exchanger for transferring heat from ammonia to glycol

By employing a natural refrigerant with a zero GWP and superior thermodynamic properties, ammonia-based refrigeration systems are intrinsically good for the environment. But the environmental benefits of such a system don't have to stop there.

Dufferin Arena, in Stratford, Ontario, Canada, not only uses an ammonia chiller to maintain its ice rink, but also leverages the waste heat from the system (1,200MBH at full-load capacity) to drastically reduce its reliance on natural gas. In addition, the arena makes use of an "ice battery" during the winter to reduce its use of the electrical grid, and employs variable-speed drives (VFDs) for Bitzer compressors and cooling-tower fans. The building also features a "green" roof garden, polymer glass for daylighting, and lighting upgrades; solar panels are in the plans for 2021.

Originally the site of an outdoor rink, the Dufferin Arena was built in 1971 and remodeled with its current refrigeration system – the Eco Chill low-charge (130lbs) ammonia chiller from Canadian manufacturer/contractor Cimco, with a capacity of 80TR (281kW) – in 2010; the remodel expanded the facility from 20,000ft² to 30,000ft². It was recently the subject of a webinar hosted by Cimco.

"The existing facility when I came in 2009 was horribly inefficient and needed upgrades to bring it to modern standards; it was a real energy pig," said Jim Bryson, manager of community facilities for the city of Stratford, during the webinar. He also oversees three other ice rinks in Stratford as well as an art gallery, swimming pool and other facilities.

The upgraded refrigeration technology, along with other efficiency measures, has cut Dufferin Arena's annual electricity bill by about CA$53,000 (US$38,463) – more than 50% – compared to another comparably sized, single-rink arena in Stratford.

In terms of natural gas, the use of heat from the refrigeration system cuts annual natural gas costs by about CA$6,000 (US$4,355), approximately two-thirds, compared to the other arena.

In its use of heat reclaim, the Dufferin facility is staking out relatively new ground among ice rinks "Typical arena refrigeration systems do not have heat recovery, and are wasting all of that free heat and dumping it out of the condenser," said Brad Wilkins, Cimco's U.S. Recreation Project Team Lead, during the webinar.

The Dufferin Arena's energy upgrades represent one step in Stratford's goal to generate net-zero emissions by 2035. "That's a very aggressive target, and it may be affected by what we're doing today with COVID-19," said Bryson. "However, it's achievable, and comes down to retrofitting a lot of buildings."

Heat reclaim plus ice battery

The Dufferin arena uses three Alfa Laval plate-and-frame heat exchangers to execute heat reclaim. (Another is utilized for chilling the glycol via ammonia evaporation.) The first heat exchanger receives hot ammonia gas from the compressors, which sheds the heat to glycol returning from the ice rink. The hot glycol is then used to heat the dressing room and hallway area, to melt snow and ice gathered by the Zamboni in the snow-melting pit, and to warm a concrete path used by the Zamboni.

The hot glycol is also channeled to a second heat exchanger where it pre-heats potable boiler make-up water. Finally, the hot glycol is sent to a third heat exchanger where excess heat is rejected to water, which is directed to a rooftop Evapco water tower.

To reduce the energy consumption of the compressors, the facility maintains a Cimco ice battery – a large insulated container filled with ice – on the roof. During the winter, when temperatures in Ontario drop below -15°F (-26°C), glycol can be chilled in the ice battery rather than through the chiller system, and channeled to the ice rink. "Only if [the rink] doesn't capture the desired temperature will the compressors kick on," said Bryson.

However, since the ice battery system doesn't generate waste heat, a small back-up boiler using natural gas steps in.

The rehabilitation of the Dufferin Arena cost CA$4 million (US42.9 million), half of it coming through the Canadian federal government's Recreational Infrastructure Canada (RinC) energy-efficiency program. The refrigeration system itself, including heat reclaim, cost about CA$930,000 (US$675,000).

In obtaining the other half from the city government, Bryson presented a year-by-year breakdown in the operational cost savings of the project over 75 years, compared to that of the existing facility. He applied RETScreen clean energy management software (available at https://bit.ly/3dfnewp) to do the calculations. "Where a lot of project managers fail is they just talk about the [initial] capital cost, not what it's going to cost over 75 years," he said. "When you show why this is cheaper, then the politicians start to understand."

Bryson encourages municipal managers and other not to give up on ambitious projects. "You're going to be challenged by people who don't have your vision," he said. "But when you are told no, try and try again." ■ MG

System Specs

The Dufferin Arena's ammonia chiller system includes the following:

Chiller: Cimco Eco Chill (ECO80) ammonia/glycol

Ammonia charge: 130lbs

Chiller capacity: 80TR (281kW)

Waste heat: 1,200MBH at full-load capacity

Temperature of cooled glycol: 15°F (-9.4°C) supply; 17.5°F (-8.1°C) return

Surface ice temperature: 20°F (-6.7°C) to 21°F (-6.1°C)

Chiller compressors: Bitzer

Plate-and-Frame heat exchangers: Alfa Laval

Cooling tower: Evapco

Controller: Cimco 6000e

Ice temperature monitor: Cimco Eco Sense

Ice Battery: Cimco

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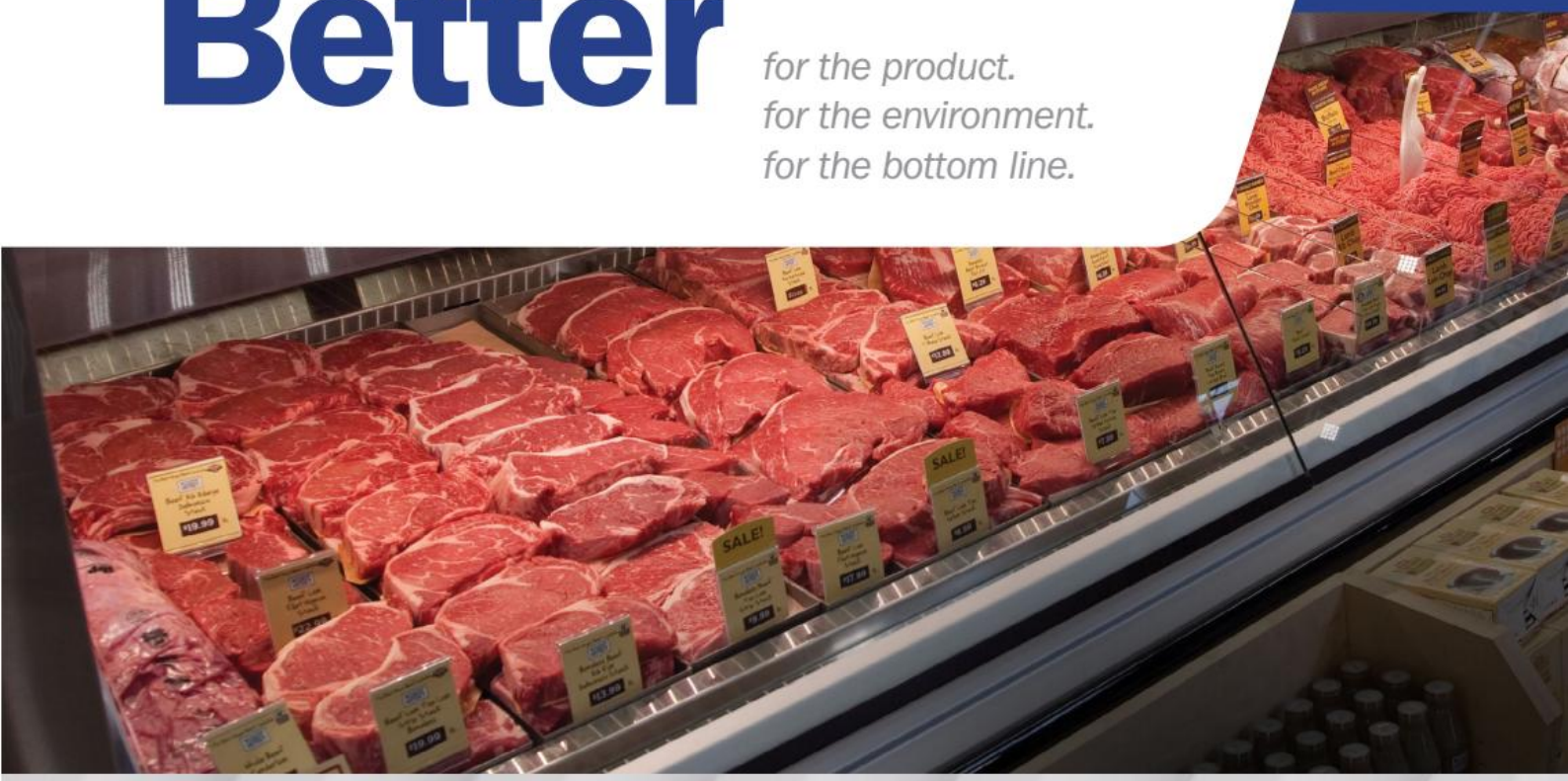

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Ammonia Regulations in the Age of Trump and the Coronavirus

Enforcement by EPA and OSHA has been relaxed during the pandemic, while many EPA risk-management amendments have been rescinded.

– By Michael Garry

The U.S. industrial refrigeration industry, reliant on the use of ammonia cooling systems, has historically been required to adhere to a raft of regulations governing the safe use of the slightly flammable, potentially toxic and certainly malodorous refrigerant.

Under the Trump administration, with its focus on deregulation, some of those regulations, which are most stringent for systems with more than 10,000lbs of ammonia, have been eased. And during the coronavirus (COVID-19) pandemic, there has been a further reduction of regulatory oversight on ammonia plants.

Those trends were the subject of a Regulatory Update on May 18 given online as part of the International Institute of Ammonia Refrigeration (IIAR) virtual conference, held to replace the March physical event that was cancelled because of the pandemic.

In terms of regulatory enforcement, on March 26 the U.S. Environmental Protection Agency (EPA) issued a "guidance" that acknowledged that "some things are not practicable [for industrial refrigeration companies] to do during the pandemic," said Lowell Randel, vice president, government and legal affairs for the Global Cold Chain Alliance, and President of the Randel Group, who led the Regulatory Update as he has done for a number of years at the IIAR conference.

However, the EPA guidance advised companies with environmental compliance obligations to "act responsibly under the circumstances in order to minimize the effects and duration of any noncompliance caused by COVID-19," noted Randel. Companies still have to document how COVID-19 was the cause of the noncompliance, and the decisions and actions taken in response. "It's not a blank check," he added.

The U.S. Occupational Safety and Health Administration (OSHA) will continue to investigate ammonia-safety complaints during the pandemic, but it won't be doing in-person inspections. "It will be more phone call, fax or letter," said Randel. The agency will also, like the EPA, exercise "enforcement discretion" but expect companies to "document good faith efforts to comply."

OSHA expects all companies to provide a safe environment for employees during the pandemic, and Randel advised "making sure you have a plan for PPE (personal protection equipment), sanitation and social distancing." IIAR members have been able to order free masks from the U.S. Federal Emergency Management Agency (FEMA), though future orders will be done through state emergency management agencies

No more audit concerns

One of the key regulatory changes made by the Trump administration in regard to ammonia refrigeration took place last November, when the EPA rescinded nearly all of the significant Obama administration amendments to the Risk Management Program (RMP) Rule.

Randel, who has been representing the ammonia refrigeration industry in regard to RMP amendments for a decade, noted that the industry had "significant concerns" about a now-rescinded third-party audit amendment, which required audits to be done by an independent entity, "So now you don't have to worry about using someone for consulting and developing safety programs, and have them also do audits," he said.

But the RMP still requires companies to coordinate with emergency responders at least annually – something Randel believes is important "regardless of the status of regulations."

Lowell Randall, GCCA

Randel also spoke about a new regulation that went into effect in February. The U.S. Chemical Safety and Hazard Investigation Board (CSB) an independent agency that works closely with EPA and OSHA, now requires companies to report, within eight hours, accidental chemical releases that result in a fatality, serious injury or substantial property damage (US$1 million or more).

In most cases, Randel noted, IIAR members are already required to report ammonia releases to the U.S. National Response Center (NRC). So the CSB reporting requirement may be satisfied by submitting the NRC identification number to the CSB "within 30 minutes" of submitting a report to the NRC. "This is the most likely scenario for IIAR members," said Randel.

Again, because of the pandemic, the CSB is offering a "one-year grace period" for the reporting requirement, said Randel. "I don't expect heavy-duty enforcement; CSB will be focusing on education now."

IIAR is also working closely with NIOSH (National Institute for Occupational Safety and Health) as the latter prepares to review the IDLH (immediately dangerous to life or health) level for ammonia. The ammonia trade group would like to see the current level (300ppm) returned to 500ppm, and is proposing that air purifying respirators (APRs) be authorized for use with up to 1250ppm of ammonia "to perform critical life safety tasks and emergency procedures," Randel said. ■ MG

For NH_3, Model Codes Mostly Defer to IIAR

In the online Regulatory Update on May 18 presented as part of the International Institute of Ammonia Refrigeration (IIAR) virtual conference, Jeff Shapiro, President of Austin, Texas (U.S.)-based International Code Consultants, gave his annual overview of the multifaceted model codes arena as it pertains to ammonia refrigeration.

His main takeaway: that the 2021 Model Codes – which have been either published or are pending – are now primarily referring to IIAR standards when it comes to ammonia safety, rather than promulgating their own rules.

For example, the 2021 International Mechanical Code (IMC) and the 2021 Uniform Mechanical Code point to IIAR standards 2-5, while ASHRAE-15 subscribes to IIAR 2.

The last remaining "puzzle piece" that does not yet completely defer to IIAR ammonia safety standards is the 2021 International Fire Code (IFC), noted Shapiro.

The IFC references IIAR 2 but has additional "overlapping requirements" pertaining to emergency shutoff, ventilation controls, emergency pressure control systems and refrigerant discharge and treatment, he said.

But some progress has been made, such as IFC requiring emergency pressure control systems for ammonia only in machinery rooms, not outdoor or portable equipment; and only health-risk evaluations for ammonia discharges (not fire or environmental evaluations).

In the 2024 IFC – for which comments have a January 2021 deadline – Shapiro will propose "entirely deferring to IIAR standards" for ammonia refrigeration. "All of the other model codes and ASHRAE-15 have done it," he said.

Making Sense of the HFCs Regulatory Chess Board

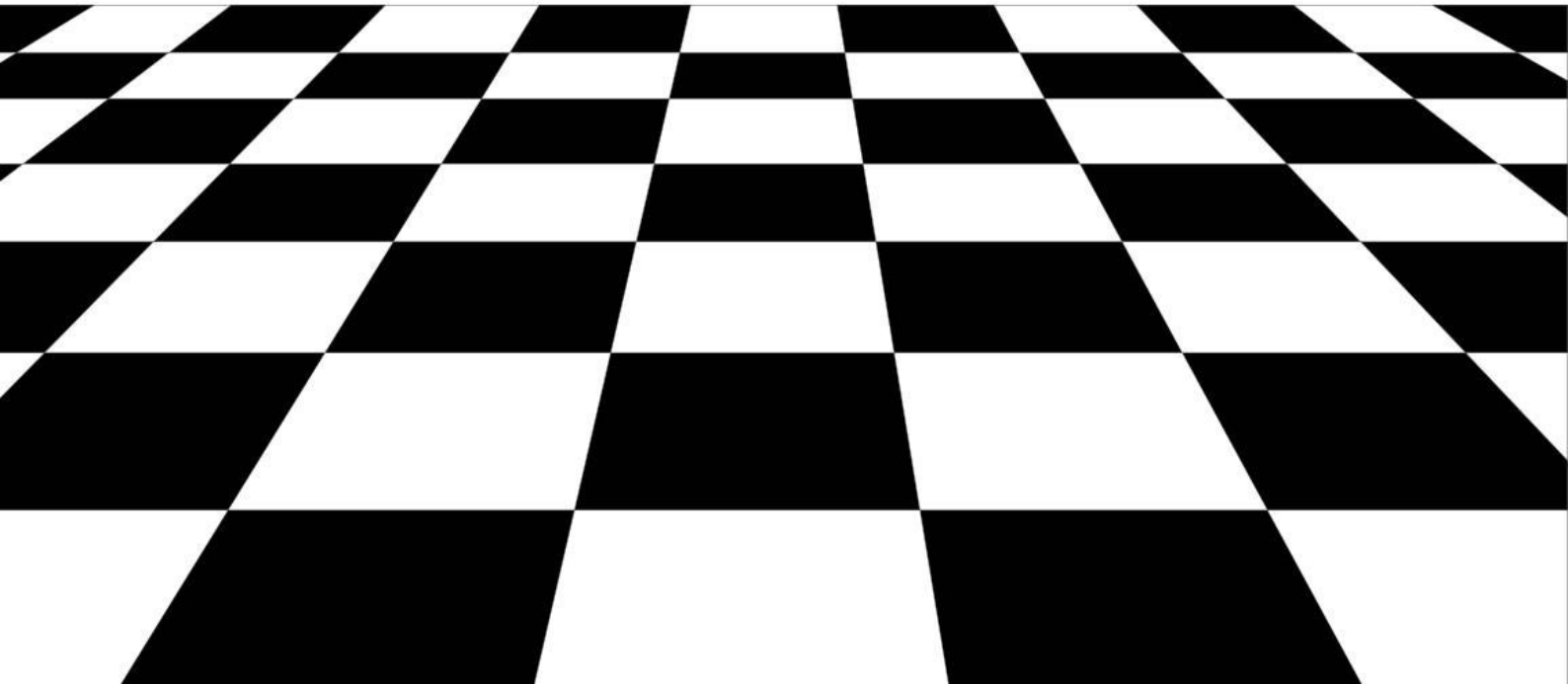
There are many pieces – including states, the federal government and global agreements – and most are moving toward phasing down HFCs.

– By Jennifer Butsch

The regulation of refrigerants continues to be a source of great uncertainty in the U.S. commercial refrigeration industry. At the heart of this issue is the subject of emissions of HFC refrigerants and their potential contribution to climate change.

As global, national and state regulations have targeted the phase down of HFCs in recent years, the industry has seen a shift toward alternative refrigerants with lower global warming potential (GWP). While more environmentally friendly, these emerging options pose additional questions about performance and safety, with many of the lowest GWP alternatives bearing a degree of flammability.

It's a dynamic regulatory mix that has been in flux for several years and unfortunately isn't getting any less complicated. In 2017, the U.S. District Court of Appeals for the District of Columbia (D.C.) Circuit ruled to vacate the Environmental Protection Agency's (EPA) Significant New Alternative Policy (SNAP) Rule 20 (and later Rule 21). The court ruled that the EPA did not have the authority to require those who had already



moved away from using ozone-depleting substances (ODS), and were using HFCs, to phase down to low-GWP refrigerants under the Clean Air Act (CAA) — which was originally intended to only eliminate the use of ODS. Thus, the EPA could no longer enforce the GWP-based guidelines of its 2015 landmark rule.

Despite widespread business and HVAC&R industry objections to the D.C. Court of Appeal's decision, the Supreme Court declined to hear the HFC case in 2018. In response to the D.C. Circuit's decision, the EPA published a "Notification of Guidance," stating that it would not implement any of the HFC restrictions set forth in SNAP Rules 20 and 21. The Natural Resources Defense Council (NRDC) filed a lawsuit claiming that the 2018 Guidance was overly broad because it did not distinguish between ODS replacements and HFC replacements, and that the EPA had not followed proper procedures, as it was published without seeking stakeholder comments.

On April 7, 2020, the D.C. Court of Appeals granted the NRDC's petition, stating that the EPA guidance was procedurally inappropriate. The court agreed that the initial 2017 decision required only a "partial vacatur," not an elimination of the requirements of SNAP Rules 20 and 21 entirely.

All of this legal wrangling has not only delayed the progress of the EPA, one of the world's leading governing bodies on HFCs, but it has left the U.S. without a clear path forward in terms of a unified refrigerant strategy. Since its passage in 2015, SNAP Rule 20 had been the law of the land, and the industry had already made great strides toward meeting its mandates. While the majority of the industry still supports the move toward a more sustainable and environmentally friendly future, court rulings around SNAP Rule 20 and 21 have created many questions about what the path forward will look like.

Making sense of these events and their near- and long-term implications requires an understanding of regulatory developments on the federal, state and international levels.

EPA rescinds HFC leak-repair rule

In response to the 2017 court ruling, the EPA has also rolled back other HFC-related regulations. In particular, it excludes HFCs from the leak repair and maintenance requirements for stationary refrigeration equipment, otherwise known as Section 608 of the CAA.

The updated rule, which had been in effect since 2016, lowered the leak rate threshold in supermarket refrigeration systems from 35% to 20%, and set forth specific requirements pertaining to HFC management. With the rescinding of this rule, refrigeration equipment with 50lbs or more of HFC refrigerant would no longer be subject to these requirements.

Even if the leak repair and maintenance requirements of Section 608 are no longer enforced for HFC systems, an effective leak-repair and maintenance program is still generally recognized as an industry best practice. Other beneficial provisions of Section 608 — including the certified technician program and the refrigerant recovery and reclamation rules — are still in effect.

California fills the regulatory void

In the absence of regulatory certainty at the federal level, many states are adopting environmental regulations that seek to limit the negative impacts of short-lived climate pollutants (SLCPs) such as HFCs. California was the first state to take official action. California Senate Bill 1383, also known as the Super Pollutant Reduction Act, was passed in 2016 and requires that Californians reduce f-gas emissions by 40% by 2030. The California Air Resources Board (CARB) has been tasked with meeting these reductions.

Since 2016, CARB had been using EPA SNAP Rules 20 and 21 as the basis of its HFC phase-down initiatives. With the vacating of SNAP Rule 20 in 2017, CARB moved to adopt its existing compliance dates that were already implemented or upcoming. This first phase of CARB rulemaking took place in March 2018 and helped maintain the progress the state had already made in transitioning from HFC refrigerants.

To strengthen these efforts, California Senate Bill 1013 was signed into law in September 2018. Referred to as the California Cooling Act, this law mandates the full adoption of SNAP Rules 20 and 21 as they read on Jan. 3, 2017. Currently in effect, this law does not require additional CARB rulemaking to uphold compliance dates but does include the following provisions:

- The option to modify compliance dates
- The ability to list or delist refrigerants, regardless of federal status
- Bans on selling, leasing or renting equipment inconsistent with provisions
- The creation of an incentive program to promote the adoption of new refrigerant technologies

Jennifer Butsch is Regulatory Affairs Manager for Emerson. She is responsible for managing activities related to codes, standards and regulations, and actively participates in several industry organizations, including AHRI and ASHRAE

To reach the 40% reductions required by 2030, CARB is also proposing an aggressive second phase of rulemaking that would further impact commercial refrigeration and air-conditioning applications. CARB has held public workshops and invited industry stakeholders to comment on the details of this proposal, which currently states:

- Refrigerants with a GWP greater than or equal to 150 will not be allowed in new stationary refrigeration systems charged with more than 50lbs, effective January 1, 2022.

- Existing food retail facilities with refrigeration systems charged with more than 50lbs must collectively meet a 1,400-GWP average or a 55% greenhouse gas emission potential (GHGp) reduction from 2018 levels by 2030.

- Refrigerants with a GWP greater than or equal to 750 will not be allowed in new stationary air conditioning equipment, effective January 1, 2023.

- Refrigerants with a GWP greater than or equal to 750 will not be allowed in chillers (including process chillers) with temperatures greater than -15°F (-26°C) and ice rinks, effective January 1, 2024.

- Refrigerants with a GWP greater than or equal to 2,200 will not be allowed in new chillers with temperatures ranging from -15 °F through -58 °F (-50°C), effective January 1, 2024.

CARB is planning on finalizing these rulemaking proposals in December of 2020 and is still seeking industry input. In the meantime, industry stakeholders will work with CARB to help establish a mutually accepted approach; Emerson will continue to participate in this process.

With California taking a leadership role on environmental regulations, it's very likely that other states will adopt a similar (if not identical) approach. In 2017, a coalition of 16 states and Puerto Rico emerged to form the U.S. Climate Alliance, with a shared commitment to reducing SLCPs and HFCs. Since then, the Alliance has grown to 25 members — comprising more than 55% of the U.S. population and an $11.7 trillion economy; several of its states have announced plans to follow California's lead on HFC phase downs.

Industry advocates, including the Air Conditioning, Heating, and Refrigeration Institute (AHRI) and the NRDC, have asked for states to be consistent in their approach to adopting CARB's rules.

Safety standards and codes under review

Meeting the targeted emissions reductions in California will likely require the use of lower-GWP refrigerants. But many of these lower-GWP HFO refrigerants and their blends are classified as A2L, or mildly flammable. The natural A3 refrigerant propane (R290) is also becoming more widely used in low-charge, self-contained commercial refrigeration applications. Currently, national and global governing agencies are evaluating the standards that establish allowable charge limits and the safe use of these A2L and A3 refrigerants.

Per a 2019 update from the International Electrotechnical Commission (IEC) to its IEC60335-2-89 standard, A2L and A3 charge limits have been increased for commercial refrigeration systems as follows:

- A2Ls — from 150g to 1.2kg

- A3s — from 150g to 500g for factory-sealed systems, but will remain at 150g for split systems

While the U.S. doesn't rely on the IEC to establish its safety standards, similar efforts to raise A2L and A3 charge limits are also taking place here. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and Underwriters Laboratory (UL) are working to establish new charge limits and mitigations for the use of A2L and A3 refrigerants, with support from industry and various stakeholders.

Once adopted, these standards will serve as the basis for codes that govern building, fire and other local authorities having jurisdiction (AHJ), which will ultimately oversee the applications in which these refrigerants are used. It's important to remember that building codes vary from state to state; thus, the adoption of flammable refrigerants ultimately will take place on local levels and may take years to accomplish.

Kigali Amendment not yet ratified in the U.S.

Amid the regulatory uncertainty in the U.S., it's easy to forget that the Montreal Protocol has been evaluating the global warming potential of HFCs for nearly a decade. In 2016, 197 countries (plus the European Union) met in Kigali, Rwanda, and agreed on a global proposal to phase down HFCs. The Kigali Amendment required – and obtained – ratification from at least 20 countries to take effect on January 1, 2019; to date, 94 countries (plus the EU, but not including the U.S.) have ratified it.

While the U.S. is considering ratification, many industry stakeholders believe it would be beneficial to our current state of regulatory and economic affairs. Ratification could help to establish a framework for future refrigerant regulations that would provide the certainty needed to help the industry and regulatory bodies alike move forward with a unified approach. According to an economic study co-sponsored by AHRI and the Alliance for Responsible Atmospheric Policy, ratifying the amendment could create up to 33,000 jobs in the manufacturing sector by 2027 and is expected to have a positive impact on the U.S. economy. For these reasons, many in the industry are in favor of ratification and have demonstrated this through letters of support to the Senate and the White House.

New HFC bills introduced in the U.S.

The U.S. Senate and the House of Representatives have each penned new bills that would put the EPA in alignment with the Kigali Amendment and restore the EPA's authority to phase down the production and consumption of HFCs over a 15-year period.

- Senate: American Innovation and Manufacturing Act of 2019 (S2754)

- House: American Innovation Leadership Act of 2020 (HR5544)

While the future and timing of these new bills are uncertain, they offer the potential to re-establish a federal standard for HFC management, including guidelines for servicing, recovery, recycling and reclamation. In the best-case scenario, these could provide the industry guidance that individual states need to move forward with a unified approach, remove the legislative burden from the states, and reduce regulatory complexity.

Stay informed and advocate for regulatory uniformity

As 2020 moves on, there are many moving pieces on the regulatory chess board, but also some encouraging signs of progress. California has taken the lead on HFC regulations in the wake of a vacated SNAP Rules 20 and 21, and from all indications, many other states seeking to do the same will adopt this approach. If granted authority by Congress, the EPA likely will work on new regulations to regulate HFCs — the extent of which is still unknown.

Meanwhile, revisions to safety standards governing A2Ls and A3s likely will result in charge-limit increases. These pieces will continue to move in 2020, and Emerson will keep you posted of these developments as they occur.

We at Emerson encourage you to make your opinions heard. If there are opportunities to provide public comments or participate in workshops such as those recently held by CARB, please take advantage of them. As an industry, the more we can push toward a uniform set of rules and regulations, the easier our transition will be into the next, more sustainable generation of refrigeration. ■ JB

Europe, Middle East & Africa

End User
Lidl Net-Zero Store Uses CO_2 Ground-Source Heat Pump

Technology
Transcritical CO_2 in Climates Above 40°C ? No Problem, Says Epta

Event
South African Industrial Operators Embrace Ammonia

Events

1. **June 23-24**
   ATMO/DTI Technical Conference
   Shecco and Danish Technological Institute
   https://bit.ly/2XUVYhy

2. **June 26**
   World Refrigeration Day
   https://worldrefrigerationday.org/

3. **July 27-31**
   IIR Rankine 2020 Conference – Advances in Cooling, Heating and Power Generation
   https://ior.org.uk/events/rankine2020

4. **September 1-2**
   shecco Virtual Trade Show on natural refrigerants
   https://atmo-marketplace.com/

5. **September 17**
   SIRACH Networking Meeting -
   Energy storage for heating and Cooling
   https://ior.org.uk/index.php?cID=140&cType=event

6. **December 1**
   Cooling-as-a-Service (CaaS) Global E-Summit
   Basel Agency for Sustainable Energy (BASE)
   https://bit.ly/2C2pHwF

Lidl Net-Zero Store Uses CO_2 Ground-Source Heat Pump

The Dutch supermarket employs only green energy sources – solar panels and a thermal underground reservoir.

– By Ilana Koegelenberg & Tine Stausholm

As the global climate emergency becomes increasingly evident around the world, many businesses, organizations, and even countries have set a goal of reaching "net-zero" in their greenhouse gas emissions by improving efficiency and using renewable energy.

In the supermarket arena, German retail giant Metro AG In 2017 opened a 12,700m² (136,702ft²) "net-zero" store in St. Pölten, Austria. This store's goal is to use only renewable energy created on site with a 6,000m² (64,583ft²) photovoltaic system on the roof. It was also designed to realize a 60% reduction in energy demand as compared to the Metro worldwide average. (See https://bit.ly/3dSzzqD.)

In November 2018, Canadian retailer Longo Brothers Fruit Markets opened a 40,000ft² (3,716m²) store in in Stouffville, Ontario, Canada, that it described as "near net-zero." The store is equipped to use 35% less energy than other supermarkets and produce 65% of its own energy through renewable technologies, according to Natural Resources Canada, the country's environmental agency. (See https://bit.ly/2XNxjeU.)

One of the latest supermarket chains to try its hand at net-zero is German retailer Lidl, at a 2,057m² [22,141ft²] store/warehouse opened in September 2019 in Woerden, the Netherlands, on the site of an old demolished shop.

An important requirement from Lidl in the planning process for this store was to create an energy-neutral building, meaning that the power consumption of the whole building had to be fully self-sufficient and that no energy bills should be paid at any time during the year. All energy that is used in the store, such as for lighting, heating and cooling, the cashier tills and more, is therefore produced in the store itself from green energy sources, including 1,766 rooftop solar panels as well as thermal energy via a ground-source heat pump.

The Woerden store, like most of Lidl's new stores, cuts its energy demand with LED lighting and efficient HVAC&R systems, and includes other environmentally friendly features like rainwater filtration. The Woerden store is particularly innovative with HVAC&R technology, using two transcritical CO_2 systems – a refrigeration system, and the ground-source heat pump, which is also used as a chiller for air conditioning.

Lidl opened its first store in the Netherlands in 1997, and since 2014 all new stores in the country have been awarded the A++++ energy rating, the highest possible.

Leveraging pre-cast concrete piles

One of the key energy-saving technologies at the Woerden net-zero store is the (50kW/14.2TR) transcritical CO_2 ground-source heat pump provided by Dutch installer Frimex.

The heat pump is connected to special pre-cast concrete piles in the ground underneath the store and the parking lot, which serve as a thermal reservoir. Glycol is circulated via hollow tubes inside these thermal precast piles to transport heat to and from the thermal reservoir, taking advantage of the natural ground temperatures during the year to complement the cooling and heating cycle in the building.

The heat pump can be used to create a comfortable climate inside the store when the refrigeration system doesn't produce

Hot and chilled water tanks for climate control of the store.

enough excess heat to heat the shop through heat recovery during the winter months. Conversely, the heat pump can also serve as an air-conditioning system during the summer by reversing its operation, using the cooler ground temperatures. Hot and chilled water tanks are used for climate control of the store.

A benefit of the system is that, as a result of pumping excess heat back into the thermal reservoir (via glycol), the refrigeration system's CO_2 refrigerant is cooled, increasing the efficiency of the system for the store/warehouse, and reducing the energy needs of the whole building.

Marcel Ganzeboom, Senior Manager in the Construction Department of Lidl Netherlands, and the initiator is of the net-zero project, confirmed the retailer's satisfaction with the technical solutions. "It is a very closed chain of electricity generation and waste streams from cold and heat, which are used immediately or stored immediately," he said. "Very genius to see how it works."

The cooling power behind net-zero

The refrigerated cabinets in the new Woerden store are cooled by German manufacturer Teko's ROXSTAsmart CO_2 rack. The unit offers a medium-temperature capacity of 112kW (32TR) at -8°C (17.6°F) and a low-temperature capacity of 4kW (1.2TR) at -33°C (-27.4°F). This is needed to cool a total of 85m (279ft) of medium-temperature cabinets in the sales area, plus two cold rooms and one freezer room.

The ROXSTAsmart system was installed in a separate plant room above the warehouse, taking up minimal space. It only measures 2.6m by 1.9m by 0.98m (8.6ft by 6.2ft by 3.2ft), including a sound enclosure, three medium-temperature compressors, and one low-temperature compressor.

In addition to aiming for net-zero emissions, Lidl required that no synthetic refrigerants be used, and Frimex opted for CO_2. "By using CO_2, even though it is a greenhouse gas as well, we designed a system with minimal impact on the environment," said Hendrine Kalkman, Head Engineer at Frimex.

While Lidl confirms that the investment costs for the net-zero store were higher than an average supermarket, the expected payback time will be around five to 10 years.

However, Lidl emphasizes that supermarket customers should not pay a premium for the sake of shopping in a sustainable store like this. "We do not charge sustainability to the customer; it is the other way around – it makes the shopping cheaper," said Ganzeboom. ■ IK&TS

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Transcritical CO_2 in Climates Above 40°C? No Problem, Says Epta

The Italian OEM has updated its FTE system and introduced an Extreme Temperature Efficiency (ETE) system that optimizes CO_2 refrigeration in very warm environments.

– By Tine Stausholm

In March 2017, at the triennial EuroShop trade show in Düsseldorf, Germany, Italian natural refrigerant OEM Epta launched the Full Transcritical Efficiency (FTE) solution for improving the efficiency of CO_2 refrigeration systems in any country with any external temperature.

The patented FTE system, Epta said, was based on a very simple design, whereby a low-pressure liquid receiver is used to flood medium-temperature cabinets with liquid CO_2, eliminating superheat and allowing the evaporation temperature of the cabinets – and, ultimately, the efficiency of the system – to increase. (For more details, see https://bit.ly/2UcJfo4.)

"Eliminating superheat by flooding the evaporators is the key to increasing efficiency in all climates and during the whole year," Francesco Mastrapasqua, Epta's Advocacy and Regulatory Affairs Manager, said at the time.

Over the past three years, FTE systems have been widely installed in Europe and the rest of the world, and brought to North America following Epta's acquisition of Kysor Warren last year. (See "Kysor Warren EPTA US takes on North America," Accelerate Magazine, June 2019.)

REPLACING F-GASES WITH CO_2

Life-C4R (Carbon 4 Retail Refrigeration), an Epta project co-financed by the European Union (EU) Life Climate action program, was created to accelerate the dissemination and implementation of very-high-efficiency CO_2 refrigeration systems.

The project aims to replace HCFC and HFC refrigerants with CO_2 in commercial refrigeration in all climates around the world. In addition, it ultimately aims to create an industrial standard that supports policy makers to further push the use of energy efficient natural refrigeration systems.

At the core of the project are Epta's FTE (Full Transcritical Efficiency) and ETE (Extreme Temperature Efficiency) systems. The goal is for these systems to achieve at least 10% in energy savings, and 20% in installation and maintenance savings, compared to existing CO_2 solutions.

In addition to testing the performance of the FTE 2.0 and ETE systems, Epta is doing a full analysis of the new technology's carbon footprint and environmental performance based on Life Cycle Climate Performance (LCCP) standards. Dissemination of the results is also part of the Life-C4R project's requirements.

Running from 2018 to 2021, Life-C4R has three partners, Epta Iberia, Epta SpA and DAAS, a Romanian engineering company founded in 1993, which is now a part of the Epta Group.

In February of 2020, at the most recent EuroShop in Düsseldorf, Epta was back with an updated version of FTE called FTE 2.0, and an entirely new technology called the Extreme Temperature Efficiency (ETE) system. ETE takes the notion of operating transcritical CO_2 systems in hot climates to the next level.

Following several tests and projects worldwide, including in very hot-climate countries like Australia, both FTE 2.0 and ETE are now commercially available.

The two technologies have been developed as part of the Life-C4R project, co-funded by the European Union (see sidebar, page 50).

Like the first FTE system, the new FTE 2.0 relies on flooded evaporation technology to achieve its efficiency. But now, Epta has integrated the low-pressure receiver into the power rack, meaning that no extra space is needed in the technical room, which results in reduced installation and start-up time.

The FTE 2.0 also has an Android/IOS app that provides performance updates, diagnostic alarms, and recommendations for optimization of system operations.

FTE 2.0 can be combined with heat reclaim without losing any efficiency. "With a simple additional heat exchanger, we can use the exhaust heat from refrigeration for space heating, which does not affect the performance of the refrigeration equipment," Mastrapasqua explained.

A MECHANICAL SUBCOOLER

Like the new FTE 2.0, ETE is a very simple solution, allowing end users to run their CO_2 refrigeration systems in all types of climates, even at temperatures higher than 40°C (104°F), according to Mastrapasqua.

"It is an advanced technology using only an additional compressor with a heat exchanger – no complex control logic or any sophisticated component."

ETE will normally be incorporated into a transcritical CO_2 rack, but can be viewed as an "accessory," Mastrapasqua said. The heat exchanger subcools a portion of the CO_2 coming out of the gas cooler, and delivers the refrigerant expanded to an intermediate pressure level by the EEV (electronic expansion valve) to the high-pressure line; this ensures there is no performance loss in warm and hot climates, and at the same time increasing the total energy efficiency, according to Mastrapasqua.

FTE 2.0 and ETE can be used together and are "complementary technologies," Mastrapasqua stressed, helping each other perform "very efficiently," even at very high temperatures.

Francesco Mastrapasqua, Epta

The ETE can be used for both commercial and industrial refrigeration, improving the energy efficiency of any transcritical CO_2 rack, said Mastrapasqua

Epta racks with ETE are modular, and scalable, meaning that there's no limit to capacity in larger industrial applications, according to Mastrapasqua.

Epta recommends ETE for areas where the temperature is between 30°C and 40°C (86°F and 104°F) for most of the year, making it suitable for the Mediterranean or the Middle East.

"But if you want to get the best performance from your system above 40°C (104°F) – and up to 50°C -55°C (122°F -131°F) – you really need both FTE 2.0 and ETE," Mastrapasqua said.

"Using the ETE gives you an effect like if you are reducing the ambient temperature by 10°C -15°C (18°F -27°F)," he added. "You save 15% to 20% energy in those conditions, with no performance loss."

A key selling point of the FTE and ETE technology, according to Mastrapasqua, is that both are "super simple" to install and operate, compared to competing technologies like ejectors and parallel compression. "Mechanically, the FTE system operates with the same components as the basic CO_2 transcritical system, plus the low-pressure liquid receiver – components that any refrigeration company knows very well." ■ TS

South African Industrial Operators Embrace Ammonia

During the first-ever ATMOsphere Cape Town event, two major food processors discuss their experience with ammonia systems.

— By Ilana Koegelenberg

Andre Snyman of Lynca Meats.

The end user panel at the first-ever ATMOsphere Cape Town conference, held on March 10 in South Africa, featured representatives of three retailers and two food processors, all of whom have had positive experiences with natural refrigerants.

The panel was one of more than 20 presentations on local and global market trends as well as new technology and policy, with 150+ attendees from around the world on hand. (ATMOsphere conferences are organized by shecco, publisher of *Accelerate Magazine*.)

In the April-May 2020 issue of *Accelerate Magazine*, we covered what the three retailers had to say about transcritical CO_2 refrigeration. (See "South African Retailers Share Advantages of Switching to CO_2.) In this article, we turn to the food processors' use of ammonia.

LYNCA MEATS UPGRADES TO COST-SAVING AMMONIA

During the end users panel discussion, Andre Snyman, General Manager Lynca Meats talked about how the food processor went from HCFC to ammonia, saving a significant amount of money.

Lynca Meats is located south of Johannesburg and slaughters, debones and processes roughly 3,000 pigs a day. Five years ago, the company decided to expand, and required a partner to assist it with utilities planning. At the time, the Lynca operation was driven by more than 80 simplex refrigeration units, charged with HCFC refrigerant, which was being phased out. It was struggling with downtime and breakages and keeping up with the maintenance of so many systems was a real problem, noted Snyman.

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Luckily, Lynca met South Africa-based energy solutions provider Energy Partners (EP), which could assist with measuring and improving efficiencies. Among other things, EP helped with the upgrading of the refrigerant system.

Lynca's first job was to install a flexible refrigeration system that could handle its primary duties (chilling and freezing of meat) reliably and efficiently. To that end, EP designed an ammonia system with a capacity of 792kW (225.2TR) capacity that allowed Lynca to almost double its production within the limitations of its electrical supply. With this system, it managed to replace some of the simplex units; the rest were later replaced with an HFC multiplex system on a cooling-as-a-service (CaaS) model.

Second, by using heat recovery for hot water production and outsourcing its steam facility to EP Steam, Lynca was able to reduce the cost of heating by 37%. Also, a 962kW solar system was added in a power purchase agreement (PPA) to reduce the effective cost of electricity. "On a like-for-like basis, these projects are saving us ZAR1.4 million [US$74,994] per year," said Snyman.

With its CaaS and PPA contracts now in their second year, Lynca's experience with these models has been "very positive," said Snyman. Altogether, the outsourcing exercise has saved the food processor a significant amount in operational costs – in excess of ZAR3 million (US$160,700) per year, according to Snyman. It managed to grow its business by 70% without increasing the electricity bill.

But it's not just about the money. Another benefit was not having to invest capital in non-core utilities, allowing for a more focused expansion of production. "Our management team can focus on the primary production needs, knowing that our utilities are being looked after by a group of specialists," said Snyman.

Lynca Meats is once again looking to expand and Snyman confirmed that it is considering ammonia on a CaaS model.

RCL FOODS' 45-YEAR JOURNEY WITH AMMONIA

Neshen Moodley, Group Sustainability Projects and Innovations Engineer for food manufacturer RCL Foods, spoke about using a large-scale ammonia system in its poultry business.

RCL processes 1,300 metric tons of chicken daily – 11 chickens per second. It has been utilizing ammonia for 45 years without a single fatality. Its systems offer a refrigeration capacity of 47,900kW (13,620TR), which includes 61 compressors (59 screws) and absorbed motor power of 17,170kW. The system configuration is typically two-stage with evaporative condensers. One stage is generally -10°C (14°F) and the other -40°C (-40°F).

Heat recovery through oil cooling and de-superheating is used for the heating process and for cleaning water. Most of the engine rooms are more than 25 years old, but they have been well maintained and can still efficiently sustain the production base load, said Moodley.

He went on to speak about why RCL chose ammonia, and listed a variety of pros such as its low price, that it is a natural refrigerant and readily available, and that it has no temperature glide and can be used in flooded systems. All of RCL's production equipment (such as spiral and carton freezers) requires a flooded design.

Ammonia is also easy to use and it's compatible with normal mineral oils, avoiding the polyester lubricants that have to be used with fluorinated refrigerants and are very hydroscopic, he said. Ammonia is not as greatly affected by moisture in the system or by refrigerant shortages; it is also good for heat recovery.

His list of ammonia's advantages also included:

- It's ideal for pumped circulation in large plants.
- Heat-transfer coefficients are almost double those of fluorinated refrigerants, reducing the size of evaporators and condensers.
- It has a lower gas density, leading to lower pressure drops in suction piping.
- Flooded systems (vs. direct expansion) make better use of evaporator surface.
- Flooded operation is easier than with synthetic refrigerants as ammonia and mineral oil are immiscible – no oil rectifier is needed.

He then spoke about RCL's future with ammonia. "Ammonia is not going anywhere for us," Moodley said. The plan is to maintain its systems while also looking at new technology to optimize the systems and reduce footprints.

In terms of new acquisitions of companies, Moodley said that RCL wants to look at converting them to ammonia, which enables an increased focus on heat recovery as well as water and electricity savings. ■ IK

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Australia & New Zealand

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AUSTRALIAN SUPERMARKET OPTS FOR AMMONIA/CO_2 REFRIGERATION

Retailer expects energy savings to yield a five-to-seven year ROI on premium paid for equipment, one of a small number of ammonia systems installed in stores worldwide.

— By Nicholas Cooper

SCM Frigo's NH_3 Aqua Ultra Chillers and condenser water pump.

Ammonia (NH_3)/CO_2 cascade refrigeration systems have been widely used in cold storage and food processing facilities around the world as an energy-efficient solution that can minimize the ammonia charge and keep it out of the refrigerated space.

However, supermarkets have tended to shy away from NH_3/CO_2 systems, mostly because of the presence of ammonia, a potentially toxic substance with a pungent odor. Around the world, a relatively small number of supermarkets have opted to install this system, including only five stores in the U.S. (See "Should Grocers Fear Ammonia?," *Accelerate America*, April-May 2019.)

Recently, another supermarket has been added to the list of NH_3/CO_2 users – a new large-format retail warehouse in Perth, Australia, operated by a major international membership-based retailer. (The retailer declined to be named for this article.)

Nu-Tech Group, a Sydney, Australia, based contractor specializing in commercial refrigeration, finished installing the NH_3/CO_2 system in January of this year, and commissioned it in February; the 13,206m² (142,148ft²) store opened in March. This the third NH_3/CO_2 project for a retail warehouse that Nu-Tech has carried out.

The retailer chose an ammonia solution after consulting with the Nu-Tech Group. Its decision was "based on the energy efficiency of running a CO_2 plant with mechanical subcooling [using] NH_3," said Adam Walters, Project Manager at the Nu-Tech Group.

"Environmental reasons and the phase down of HFCs were also factored into the move to natural refrigerants," said Walters.

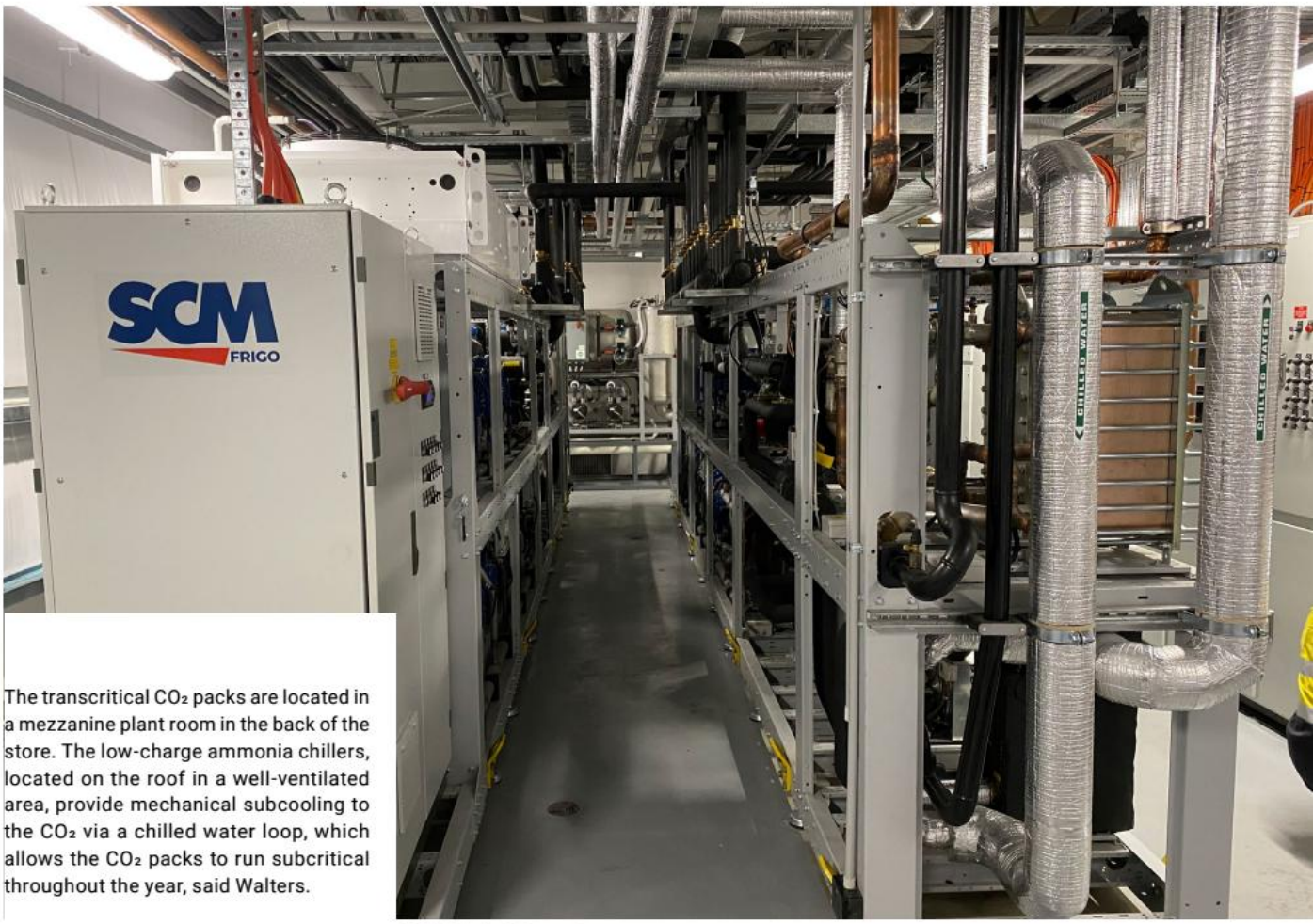
The retailer has gained some experience with a CO_2 cascade system through the previous implementation of R134a/CO_2 hybrid systems (installed by Nu-Tech).

The installation features two SCM Frigo CO_2 packs, using 110kW (31TR) for low-temperature (30°C/-22°F) and 265kW (73TR) for medium temperature (8°C/17.6°F). It also has two SCM Frigo NH_3 Aqua Ultra Chillers, running at 390kW (111TR).

The system also uses two Buffalo Trident gas coolers, a single Buffalo Trident dry cooler, and 39 Buffalo Trident evaporators, all supplied by Bitzer Australia.

In addition, there are 46 Hussmann display cases and Danfoss controls; the cool room contractor was ISD-Solutions.

"The system also includes hot glycol evaporator defrost and hot water reclaim," said Walters.



SCM Frigo's CO_2 packs.

The transcritical CO_2 packs are located in a mezzanine plant room in the back of the store. The low-charge ammonia chillers, located on the roof in a well-ventilated area, provide mechanical subcooling to the CO_2 via a chilled water loop, which allows the CO_2 packs to run subcritical throughout the year, said Walters.

ROI OF FIVE TO SEVEN YEARS

NH_3/CO_2 systems are typically more expensive than alternative systems. At this store, where the system accommodates 11 cool rooms, five preparation rooms and 46 refrigerated cases, the retailer paid a cost premium of approximately 25% over the previous generation HFC/CO_2 cascade, said a spokesperson for the retailer.

Depending on energy costs, a return on investment for the premium "could be anywhere from five to seven years," the spokesperson said.

It is too early to definitively state the energy efficiency gains from the NH_3/CO_2 system, though similar store installations in other parts of the world have enjoyed considerable energy savings. (See "The Pig's NH_3/CO_2 Experiment," *Accelerate America*, September 2016.) The system's efficiency is being "monitored and assessed," Walters said.

The initial signs are promising, and Walters noted that the "system has been running well."

The NH_3/CO_2 mechanical sub-cooling design has been effective, he added, even during the "extreme hot days towards the end of summer," which is important given Australia's increasing heat waves.

SAFELY WORKING WITH AMMONIA

Walters acknowledged that it is unusual for a retailer to use ammonia-based refrigeration in a store, but this installation has not posed any safety concerns, with a relatively small amount of ammonia being used.

"The ammonia units are a low-charge plant and hold around 15kg (33lbs) per chiller," said Walters, adding that each chiller pack has a "full leak detection system built in." (The CO_2 charge is 1 metric ton (1,000kg) per pack.)

Walters noted that the store adheres to all regulatory safety requirements for NH_3 and CO_2, but the site does not need to be licensed for dangerous goods due to the low quantity of refrigerant.

The main challenge associated with the system, he said, has been "merging the typically industrial NH_3 solution with the more commercial CO_2 supermarket solution". For that, local staff and contractors have spent time working with Nu-Tech to understand the dynamics of the plant. "Onsite training, ongoing remote monitoring and tech support are also supplied," Walters said.

Installations such as these may become more common in future. "As the industry moves further towards natural refrigerants, the energy efficient NH_3/CO_2 system is a viable solution for commercial applications," he said. ■ NC

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Entertainment Center Uses Hydrocarbon-Based Air Conditioning During Sweltering Summer

Popular landmark venue installs 22 Polaris units to cope with record-setting temperatures in Australia.

– By Nicholas Cooper

A very popular entertainment andfunction center in Sydney, Australia, is the latest company to install hydrocarbon-based air-conditioning units from Polaris Technologies.

Polaris, a Sydney-based OEM, has supplied more than 85 hydrocarbon AC systems for light-commercial applications in Australia over the past year, opening the HVAC market in the country to hydrocarbon systems. (See "Hydrocarbon HVAC Systems Gaining Traction in Australia," *Accelerate Magazine*, March 2020.)

The large venue in Sydney's southern suburbs, which has been in operation for over 25 years, installed Polaris' "HideAway Series" ducted packaged units in January to help the owner deal with sweltering summer temperatures in Australia.

The HideAway Series, which doesn't require outdoor units, uses .5kg (1.1lbs) of M60 hydrocarbon refrigerant per unit; this blend from Engas consists of under 35% propane, more than 60% propylene, less than 5% isobutaine, and less than 1% butane.

The venue's HVAC installation took place during what was a record-breaking Australian summer (December-February), with temperatures on the exposed National Park site north of Sydney exceedeing 47°C (117°F), noted Tony Power, Principal at Polaris Technologies. HideAway units operate up to an ambient temperature of 60°C (140°F).

They can do this because hydrocarbons have a higher critical temperature than f-gases, and thus "a greater cooling capacity was available during extreme heat wave conditions, Power said." Moreover, he added, in high ambient temperatures such as these, "the energy savings to this client will be in the order of 20% - 25%."

The owner's response to the installation has been positive, Power said, "They understood the environmental benefits and were pleased with the energy savings."

> *"One hundred percent of the customers have commented that hydrocarbons will be their preference going forward."*
>
> – Tony Power, Polaris Technologies

HideAway 10 kW (2.8TR) hydrocarbon AC unit

A challenging site

The entertainment center consists of three buildings that require quiet, reliable and durable cooling units; twenty-two "plug-and-play" HideAway hydrocarbon units were installed with a total of 214 kW (61TR) cooling capacity. The Polaris units were the only ones installed.

The units have operated "without fault" though running continuously, said Power.

The fact that HideAway units don't require outside units or piping resulted in "big savings" in installation costs, said Power.

The use of discreet units without pipework is important to any building owner, including this one, Power noted. "Leaks can be a problem at an entertainment or function venue with heavy items being constantly moved around the site." The HideAway uits "offer almost zero risk of refrigerant leaks to the atmosphere," he added.

Installation contractor Harbour City Air Conditioning, based in Frenchs Forest, Sydney, observed the units' performance in hot weather, their low discharge pressures, low running amps, as well as the absence of strain on the equipment.

Power said Polaris is getting an increasing number of inquiries wanting to learn more about natural refrigerants, GWP and potential energy savings. Still, there is a lack of local literature promoting the uptake of hydrocarbon systems, and some HVAC contractors take the position that "'It's never been used before, why should we start now?'" he acknowledged, adding that it will take time and effort to increase the uptake of hydrocarbon systems in Australia.

But progress is being made. "There are so many positives around hydrocarbons, and resistance from specifiers has fallen significantly," said Power. "And as a manufacturer, the use of Engas M60 has far surpassed MEPS [minimum energy performance standard] levels."

"Harbour CIty Air and other contractors have now completed multiple commercial projects using the systems in commercial projects," added Power. "One hundred percent of the customers have commented that hydrocarbons will be their preference going forward." NC

Celebrating 100th Anniversary, Contractor AJ Baker & Sons Looks Ahead to a NatRef Future

With a book, website and other activities, the Australian company – a major supplier of CO_2 and hydrocarbon refrigeration – marks its centenary.

— By Nicholas Cooper

AJ Baker & Sons turned 100 in May. For the Perth, Australia-based contractor specializing in refrigeration design, installation, servicing, and maintenance, it was a moment to reflect on its history, and look to future trends as a key supplier of natural refrigerant systems.

AJ Baker began celebrating its centenary on May 1, under the heading "100 Years Fresh." The company is marking the occasion with a dedicated section of its website (see https://bit.ly/3gqPRc1), as well as a book.

"We planned a large celebration in June 2020 and secured [Western Australia] Senator Michaelia Cash to open the celebration," said Mike Baker, Managing Director at AJ Baker. Due to the COVID-19 pandemic, "this has been put on hold for now."

So, to reflect the company's achievements, AJ Baker has assembled resources such as photographs, pamphlets, and texts outlining its history. These are updated regularly on the company website.

The website builds on the work of Shannon Lovelady, a local historian, archivist and curator at the Museum of Perth.

Lovelady "arranged to digitize a gold mine of photos, letters and documented history discovered in the company archives," said Mike Baker. "Shannon was so excited she proposed a book be written to ensure this history is not lost." The book will be released later in 2020, he added.

From printing-house agent to NatRef supplier

AJ Baker was founded in 1920 by mercantile agent Albert John Baker. The business began as an agent for Frearsons, an Adelaide-based printing house, expanding later that decade to other products, including Avery Scales.

In 1931, AJ Baker became the sole Western Australian distributor for Amat-Ice Refrigerators, and sold its first refrigerator. The company subsequently branched out into refrigeration installation, installing its first supermarket system in Perth, in 1955.

Over the past 15 years, AJ Baker has experienced a period of significant expansion, from a one-state (Perth) business to one that is in all five mainland Australian states. The company now employs more than 240 people in six branches (two in Perth), making it one of the largest privately owned refrigeration contractor businesses in Australia.

In recent years, AJ Baker has been regularly supplying and installing natural refrigerant-based refrigeration systems. "We started with hydrocarbon freezers for the supply to a major international supermarket chain here in Australia," said Mike Baker.

Its original hydrocarbon refrigeration supplier, AHT Cooling Systems, based in Rottenmann, Austria, has since been joined by other manufacturers like Epta and Criocabin. "The majority of European manufacturers are now moving to offering hydrocarbons as their base or standard refrigerant," said Mike Baker.

AJ Baker also works with transcritical CO_2 systems, installing its first system in April 2014. As of May 2020 the company had installed 27 transcritical systems for supermarkets.

According to Mike Baker, AJ Baker has installed seven transcritical CO_2 systems for a major supermarket chain, as well as 20 systems in independently owned stores under the Independent Grocers of Australia (IGA).

AJ Baker prioritizes training for system efficiency and user safety, said Mike Baker.

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A display from the late 1940s at the Perth Royal Show, in Perth, Australia, where AJ Baker & Sons showcased its range of household and commercial refrigerators in a corporate pavilion.

For example, a new training center being established in Victoria will showcase a transcritical CO_2 pack that Epta has custom-designed and built for training. The company has also recently partnered with the Technical and Further Education (TAFE) South Australia (SA) training academy to develop virtual-reality content for a hydrocarbon refrigerant training module.

AJ Baker began importing Epta's Costan brand display cabinets in 1994, and is currently importing the Bonnet Neve brand. "We import display cabinets from four of their European factories, as well as their China and Thailand factories," said Mike Baker. "This provides multiple supply chain, design and value proposition offerings, allowing us to tailor-make our offer to our customers."

As well as importing cabinets, AJ Baker has worked with Epta in designing refrigeration packs since 2007, importing its first pack in 2008.

For Epta's transcritical CO_2 systems, prototype testing of design enhancements has led to improved energy efficiency, enabling the systems to be used "in harsh climates," said Mike Baker.

"Our close collaboration has allowed for standard designs being implemented for our larger customers, tailoring design features to their requirements," he said.

An inevitable trend

Mike Baker said that AJ Baker's use of transcritical CO_2 systems was part of a trend in Australia to "reduce and/or eliminate the need for HFC refrigerants."

"The growth of natural refrigerants will be inevitable, given the market forces with lowering supply of HFCs into the future, plus the replacement of HFCs by equipment manufacturers," he said.

Transcritical systems not only reduce GWP, but also offer improved energy savings and a "reduction in overall environmental impact."

"It is the future – 'old' HFC gases are banned in Europe and market forces here in Australia will drive their price up dramatically in the future."

Likewise, Mike Baker described hydrocarbons as the future of refrigeration for small integral units. "We will see hydrocarbon refrigerated units become the standard going forward," he said. "They are more energy efficient as well as being quieter and environmentally friendly." NC

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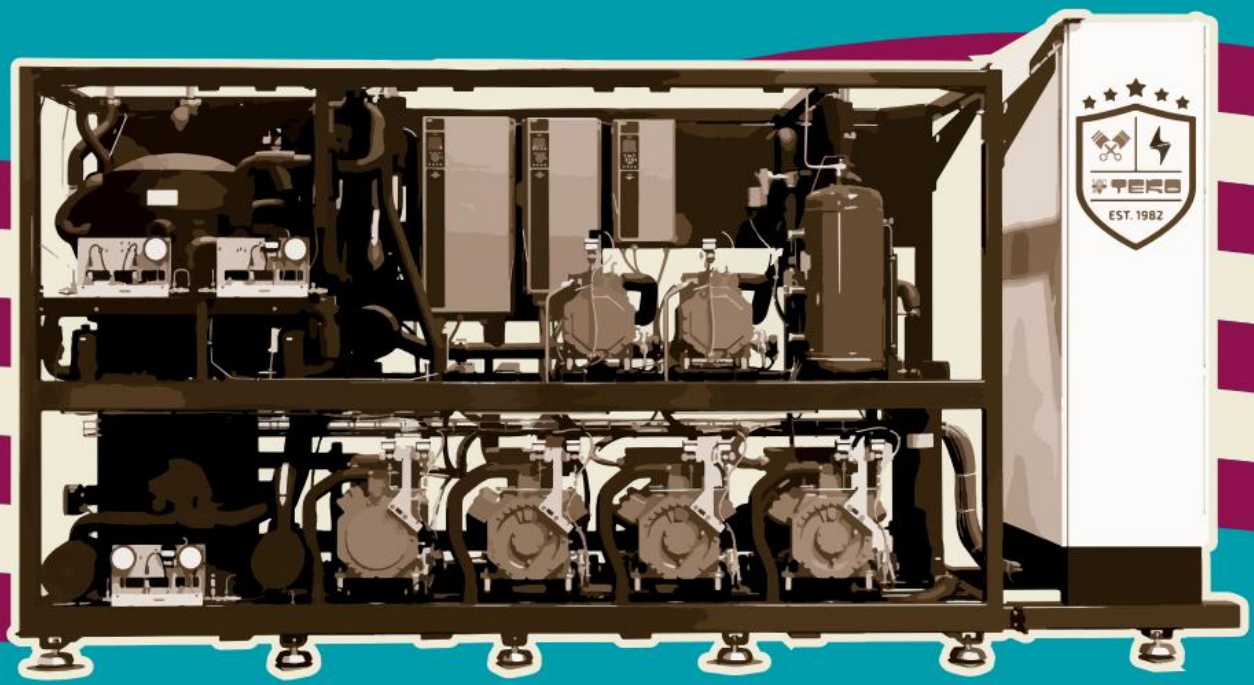

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Cold Chain Innovation Hub in Philippines Launches Video Series

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   World Refrigeration Day
   https://worldrefrigerationday.org/

2. **July 9-11**
   Cold Chain Philippines 2020
   Manila, Philippines
   https://bit.ly/3cRZaij

3. **August 19-21**
   China Refrigeration 2020
   Chongqing, China
   https://bit.ly/3cTPLqi

4. **September 1-2**
   shecco Virtual Trade Show on natural refrigerants
   https://atmo-marketplace.com/

5. **December 1**
   Cooling-as-a-Service (CaaS) Global E-Summit
   Basel Agency for Sustainable Energy (BASE)
   https://bit.ly/2C2pHwF

REBUILDING AFTER AN EARTHQUAKE

Yokohama Reito is constructing a NatRef-based, solar-powered fish sorting and freezing facility in an area devastated by the Great East Japan Earthquake.

— By Devin Yoshimoto and Tomoro Sato

Kesennuma City, located in Japan's Miyagi Prefecture, is a coastal town known as one of the country's largest commercial fishing bases. In March 2011, it was completely devastated by tsunami waves and subsequent fires — ignited by fuel from the town's fishing fleet — in the Great East Japan Earthquake.

One of the casualties of the quake was a fish processing, storage and distribution plant operated by Yokohama Reito, a major Japanese cold storage provider with about 50 facilities; the plant lost its freezing section.

But on April 24 of this year, Yokohama Reito broke ground on a new fish sorting, processing and cold storage facility in Kesennuma City, where the company has been since 1968.

Construction of the facility is scheduled to be completed by June 2021.

"In 2011, due to the Great East Japan Earthquake, our freezing facility suffered catastrophic damage," said Toshio Yoshikawa, Chairman and Representative Director of Yokohama Reito, in an article on the Japanese trade journal LNEWS (https://bit.ly/2U6gzNw). "However, miraculously, our refrigerated warehouses, offices, and processing plants remained intact and through the effort of all of our employees, we were able to resume business."

"Today," he added, "10 years after the nightmarish disaster, we've started construction on a new state-of-the-art facility."

MADE OF REINFORCED CONCRETE

To protect it against future earthquakes, the new facility will be made of reinforced concrete and include areas for fish sorting, quick freezing, processing and storage as well as administrative and office space. Also taking into account the threat of earthquakes and tsunami waves, the facility's machine and electrical rooms will be located on the second floor and roof.

Three NH_3/CO_2 refrigeration systems will supply cooling for 21,130m³ (746,195ft³) of low-temperature frozen storage space. In addition, five direct-expansion ammonia refrigeration systems will cool five 90m³ (3,178ft³) quick-freezing rooms. Finally, one CO_2 refrigeration system will handle the medium-temperature fresh fish storage area. (Yokohama Reito declined to name the supplier of the refrigeration systems.)

The facility will also feature a 567kW photovoltaic solar power generation system, a 3.8kWh lithium-ion storage battery, LED lighting and a building energy management system. According to Yokohama Reito's

latest investor's guide (https://bit.ly/2VcAdIo), 12 of the company's distribution centers have solar power generating systems in Japan. These systems generated 3.48 million kWh of electricity during the 2019 fiscal year (ending September 30, 2019).

GROWING USE OF NATREFS IN COLD STORAGE

Yokohama Reito, based in Yokohama City, Japan, is one of the largest users of natural refrigerant-based systems for cold storage warehousing in Japan. It has installed several NH_3/CO_2 systems and CO_2 condensing units for its cold storage facilities in the past few years. (See https://bit.ly/3cyGm7K and https://bit.ly/3coK6Zn.)

According to the investor's guide, the company has a total of about 2,450,000m³ (86,520,933ft³) of cold storage capacity. It currently uses natural refrigerants in approximately 60% of this space.

In Japan, a large percentage of cold storage facilities still use R22, though this is decreasing, while at the same time, the use of natural refrigerants is increasing, according to data from the Japan Association of Refrigerated Warehouses (JARW).

"Among our members, the use of R22 has dropped from nearly 80% in 2012 to 58% in 2018," said Shigekatsu Koganemaru, Vice-Chairman of the Environmental Safety Committee of JARW, who spoke during the ATMOsphere Japan 2020 conference (organized by shecco, publisher of *Accelerate Magazine*) in February in Tokyo. "In the same time, the use of natural refrigerants has gone from 17% to 31%."

And while large companies like Yokohama Reito continue to push for the use of natural refrigerants in the country, the majority of the cold storage operators in Japan are small- and medium-sized businesses for which the adoption of natural refrigerants is more difficult.

Reaching these business owners to educate them about the benefits of switching to natural refrigerants will be the key going forward, Koganemaru said.
■ DY

"TODAY, 10 YEARS AFTER THE NIGHTMARISH DISASTER, WE'VE STARTED CONSTRUCTION ON A NEW STATE-OF-THE-ART FACILITY."

– Toshio Yoshikawa, Yokohama Reito

Yokohama Reito At-A-Glance

▶ Headquarters: Yokohama, Japan

▶ Founded: 1948

▶ Total refrigerated warehouse storage capacity: 2,450,000m³ (86,520,933ft³)

▶ Net sales for FY 2019: JPY¥139,970,000,000 (US$1.3 billion)

▶ Yokohama Reito's main business consists of providing cold storage services (20.2% of sales in FY2019) and selling marine, agricultural and livestock products, both domestically and overseas (79.8%)

Source: Yokohama Reito, Investors' Guide 2019

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Members of the Cold Chain Innovation Hub (CCI-Hub) project team at TESDA, with Franziska Menten of UNIDO (third from left), Jan Dusek of shecco and CCI-Hub (fifth from left), Carlo Aguilar of UNIDO (fifth from right), Fausto Abadines of shecco and CCI-Hub (fourth from right) and Adnan Atwa of UNIDO (third from right).

Cold Chain Innovation Hub in Philippines Launches Video Series

The Manila-based HVAC&R exhibition and training center's videos will provide updates on activities and other information; industry contributions are still sought.

— By Devin Yoshimoto

> *"We are excited and looking forward to working together with the global industry on this important project for the Philippines."*
>
> – Edward Dela Rosa, TESDA

The Cold Chain Innovation Hub (CCI-Hub), a Manila, Philippines-based center for sustainable HVAC&R technology exhibitions and training, has announced that it is launching a video series to support its mission.

The CCI-Hub was launched last year as part of an initiative called the "Global Partnership for improving the Food Cold Chain in the Philippines." (See, "Reinventing the Food Cold Chain in the Phillipines," *Accelerate Magazine*, November-December 2019.) The initiative is jointly led by the United Nations Industrial Development Organization (UNIDO) and the Department of Environment and Natural Resources of the Philippines (DENR). shecco (publisher of *Accelerate Magazine*) is one of the project's key executing partners.

The video series will provide updates on activities and cover technology, policy and sustainability topics related to the food cold chain. The series will feature expert interviews, webinars, video explainers, case study coverage, news and more. Videos are available for viewing on CCI-Hub's YouTube channel (https://bit.ly/2V9owCe).

"We've launched this video series to communicate more directly with our community in this time of limited movement and travel restrictions," said Jan Dusek, Head of Global Partnership for the cold chain initiative, and COO and head of APAC for shecco.

"We hope that these videos will be an informative and engaging way to help continue building awareness for the project and a sustainable food cold chain in the Philippines," added Dusek. "We also see this as being the first step in laying the groundwork for hosting a substantial online library of resources for the community."

The video series is part of the development of the "Knowledge" section of the CCI-Hub website. Online resources have become a growing area of focus during the coronavirus pandemic.

"In addition to the video series, we are also developing our plans to build out an online e-learning platform, as well as other ways for community members to connect, interact, engage and learn remotely," said Dusek.

This is being done in collaboration with the Philippines' Technical Education and Skills Development Authority (TESDA). On March 10, TESDA was announced as the official national entity that will host the CCI-Hub at its central office in Metro Manila. (See https://bit.ly/36O3zBx.)

"We are excited and looking forward to working together with the global industry on this important project for the Philippines, especially at this crucial time of need for more nationwide skills, training and infrastructure development," said Edward Dela Rosa, Chief TESDA Specialist.

Industry Contributions Sought

The CCI-Hub is also currently seeking contributions from industry stakeholders, with the deadline extended through June 30.

"This is an open call to all cold-chain related technology manufacturers, service providers, organizations, or associations worldwide," according to a statement released on May 7 on the CCI-Hub website (see https://bit.ly/2Xlr4yI). "By contributing to this project, you will have the chance to exhibit your products, services and data through the CCI-Hub platform and increase your visibility. You will also gain valuable access to key clients and decision makers along the entire fast-growing Philippines cold chain market."

The project is seeking contributions of:

- Innovative and energy-efficient cold chain equipment (systems, modules, components, etc.) for demonstration and training purposes.

- Relevant market/industry reports, assessments or analyses, case studies, etc.

- Training materials, programs, curriculum, modules, etc. (printed or online).

- Other relevant products, services or expertise.

Those interested are asked to download and fill out the questionnaire at https://bit.ly/2ZUzw9T. Once completed, the document should be attached to an email and sent to Jan Dusek at jan.dusek@shecco.com.

The "Global Partnership for improving the Food Cold Chain in the Philippines" project aims to identify, develop and stimulate the application of low-carbon, energy-efficient refrigeration innovation technologies and business practices for use throughout the food cold chain to increase food safety and food security.

It is funded by US$2 million from the Global Environment Facility (GEF), with US$25 million in co-financing (in-kind, grants and loans). The CCI-Hub will serve as the project's main platform for providing an ecosystem of technical resources, training, knowledge sharing and stakeholder collaboration.

For more information on the project, visit the website at https://cci-hub.org/.

Those interested in staying up-to-date on project announcements can sign up for the official newsletter at https://bit.ly/3eGVv8o.
■ DY

Energy Star Facilitator Embraces NatRefs

SESCO, which has helped U.S. supermarkets get more than 1,000 EPA Energy Star Certifications for HVAC, has joined NASRC to further its work with natural refrigerants.

– By Nicholas Cooper

Supermarket Environmental Services Co. (SESCO) has helped more supermarkets qualify for U.S. Environmental Protection Agency's Energy Star recognition than any other U.S. company, leading to more than 1,000 certifications for HVAC systems.

That accomplishment was cited by the North American Sustainable Refrigeration Council (NASRC), a nonprofit promoting natural refrigerants in the grocery sector, when SECO joined the group as a silver member last December.

Based in Kernersville, North Carolina (U.S.) SESCO uses an integrated approach to HVAC, consisting of customized design, equipment procurement, supervised installation, and control system optimization. "We work with owners to provide HVAC systems designed specifically for the unique needs of supermarkets," said Jeff Ollis, Corporate Special Projects Engineer at SESCO, in an interview with *Accelerate Magazine*.

SESCO joined NASRC "to stay close to the issues that drive our industry and that are important to our customers," said Ollis.

Working with low-GWP technology is already part of the job. SESCO has "done several HVAC systems that interface with natural refrigerant [refrigeration] systems for heat reclaim," said Ollis.

HVAC systems themselves generally use HFCs, though progress is being made globally in developing propane (R290)-based AC equipment along with chillers that employ R290, CO_2 and ammonia.

Jeff Ollis, SESCO

More than 3,000 projects

Over the past 20 years, SESCO has completed more than 3,000 supermarket projects, according to its website (https://www.sesco-hvac.com). With careful design, the company engineers energy savings and reduced demand for cooling. "For one client, our approach resulted in 40% less connected horsepower for fans and 38% less cooling tons," Ollis said. "For another we provided a 50% horsepower reduction and improved the store environment."

"Those are significant savings in first cost, lifetime operating energy, and maintenance costs," he noted. "It is also a significant reduction in HFC refrigerants at the facility."

Food retailers often see paybacks in the "five-year range," Ollis said. "However, very often there are factors that deliver positive cash flow from the day one."

Planning helps maximize efficiency, but afterwards, SESCO continues to oversee installation and commissioning. "We provide the equipment and controls for installation, and follow through with commissioning of the systems to ensure proper performance," noted Ollis.

Finally, SESCO ensures the systems work now and in future. "We also work with the owner's team for training and control system optimization," said Ollis.

Summarizing SESCO's "Build, Own, Operate, and Maintain (BOOM)" approach, Ollis said that "by analyzing the facility needs of the various departments, we then design the HVAC system as a whole, paying attention to how the different departments influence each other."

"For SESCO and our clients, sustainable systems mean more than unit efficiency," he added. "It means systems that can be maintained so they can have high performance throughout the operating life." ■ NC

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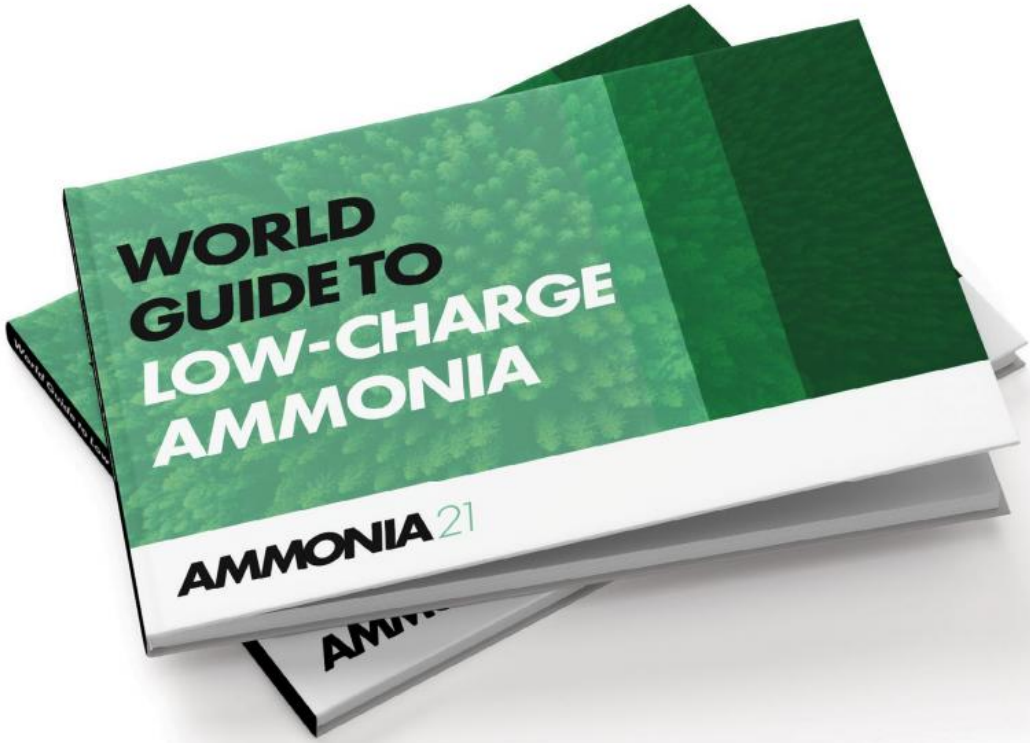

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COOLING AS A SERVICE ENABLES SOUTH AFRICAN FRUIT PACKER TO UPGRADE

Afrupro is a South African fruit-packing company.

Afrupro modernized its ammonia chiller system without any capital costs, saving 20% on its annual electricity bill.

— By Ilana Koegelenberg

In South Africa, companies like fruit packer Afrupro Packers are prime candidates for the cooling-as-a-service (CaaS) business model, a pay-as-you-go scheme that allows end users to install efficient cooling equipment without any up-front capital costs.

This is, in fact, how Afrupro was able to recently upgrade its unreliable, aging ammonia chiller system, improving efficiencies and lowering energy consumption by 20%.

Afrupro Packers does the marketing and packaging of all grades of locally grown avocados and litchi fruits, both in South Africa and internationally. But it found that the maintenance and electricity costs for its ammonia installation were out of control while cold rooms were not maintaining temperature, resulting in product loss.

In addition, during the 2019 season, the glycol tanks were leaking, incurring a cost of more than ZAR2,000 (US$110) per day. After investigating, Afrupro found that old plastic tanks, possibly cracked, needed to be replaced. With the litchi season approaching, a refrigeration upgrade became a matter of urgency.

Afrupro wanted the aging ammonia system removed and replaced with a high-GWP (1,825) R407F multiplex system, which is a common solution in the part of South Africa where the company is located (Tzaneen, Limpopo). But following a thorough evaluation, Energy Partners Refrigeration, a South African solutions provider, proposed an outsourced CaaS cooling solution that Energy Partners would finance, own and optimize. The result would be an upgraded ammonia plant to provide better, more reliable cost-efficient cooling with energy savings.

The upgrade involved the installation of a new liquid receiver (including valves and instrumentation), new stainless-steel glycol tanks, refrigerant piping changed to suit the new design, and a full recommissioning. Existing mechanical controls were replaced with a new computerized control system with remote monitoring capabilities.

The upgrade has proven to be a success. "We don't have any problems with the refrigeration and the cold rooms have never worked as well as they do now – not even when it was new," said Simon Tattersall, Managing Director for Afrupro.

In addition to saving energy compared to the old system, the upgrade is also beneficial compared to the proposed R407F system. Computer modeling of that system (using an internationally recognized tool, PakCalc) showed 9% additional electricity use compared to the upgraded ammonia plant. That equates to annual savings of 58,000kWh, or 61 metric tons of CO_2e emissions avoided yearly.

Using a 20% gas leak rate, which is conservative in South Africa, the CO_2e emission avoidance due to gas leaks comes to 365 metric tons annually. This gives a total project CO_2e emissions avoidance of 426 metric tons annually or 4,260 metric tons over the 10-year contract period.

The CaaS contract

The CaaS agreement between Afrupro and Energy Partners determined that the latter provides an investment of ZAR3.7 million (US$200,000) for the upgrade, and takes ownership of the operations of the system for the decade-long contracted period. This includes a comprehensive maintenance program with remote monitoring and management.

Energy Partners has set up a wholly owned subsidiary, EP Investments, as a vehicle for its energy investments. Projects are financed through a combination of 70% bank funding and 30% own funding (equity).

Under the agreement, Afrupro is responsible, on a monthly basis, only for a fixed "availability fee" and a variable "usage fee" based on the refrigeration required. Energy Partners covers the cost of electricity used for refrigeration.

Control what you measure

Digital controls and analysis, important in any modern HVAC&R installation, are particularly key in CaaS arrangements, since the provider needs to carefully track and optimize cooling usage.

"This site once again taught us that you can only control what you measure, and don't assume anything," said Henk McDonald, Sales Engineer for Energy Partners.

Afrupro's existing mechanical control system was replaced with an HControl Solutions programmable control system. This included several PLCs (programmable logic controllers) allowing for human-machine interfaces (HMIs) for system and cold-room management. Also added: a Supervisory Control and Data Acquisition (SCADA) platform to record temperatures and allow remote assistance. In order to better comply with export standards and reduce temperature variation in products, additional temperature sensors were installed in the cold rooms.

Energy Partners' cooling meter was installed to measure the energy and cooling consumption remotely. With the start of the avocado season so close after completion, there were some problems initially, but with the effective measurement and monitoring in place, these were easily identified and corrected.

The improved system and controls allowed room temperatures to stabilize on the required setpoints. Due to the redundancy built into the system design, no significant downtime was necessary.

Operations are continuing to run optimally and efficiently. Stock losses have been reduced due to monitored temperature control, ensuring further food security in South Africa.

And Afrupro is not done. Plans for the next stage of the system upgrade are being finalized, with a further ZAR4 million (US$226,300) investment. ■ IK

The upgraded ammonia system at Afrupro.

Artists impression of how a Coolar installation might look at a remote health center. Credit: Coolar

A New Way to Cool Vaccines Off the Grid

Coolar's solar-powered refrigerator uses water and adsorption technology rather than compressors.

— By Tine Stausholm

Two decades ago, Greenpeace and the United Nations Environment Program developed Solar Chill, a solar-powered vaccine chiller based on a compressor system using isobutane refrigerant. Since then, about 100,000 have been deployed in remote, off-the-grid locations around the world.

German startup Coolar, based in Berlin, has taken a different approach, developing a new solar-powered refrigerator that uses only water and adsorption technology to achieve stable cooling for vaccines in off-the-grid locations.

Coolar (https://coolar.co/) plans to ask the World Health Organization (WHO) for approval of its technology after receiving feedback from pilot tests in Kenya later this year. Given the need for an eventual COVID-19 vaccine throughout the world, its timing couldn't be better.

The idea for the Coolar technology came to Founder and CEO Julia Römer in 2014 while she was studying for a degree in industrial engineering at the Berlin Institute of Technology (Technische Universität Berlin). For her Master of Science thesis, she investigated the idea, based on the theoretical possibility of scaling down industrial-sized adsorption systems to something refrigerator-sized, suitable for vaccine storage, and other medical uses, anywhere in the world where electricity is a scarce commodity. She concluded that it was feasible, and Coolar was born.

The first fully functioning prototype – a single-cycle mini-bar refrigerator demonstrator – was ready at the end of 2015. That was the year she won second prize (€10,000/US$11,292) in the Darboven Idee Competition for women with promising business concepts.

Since then the Coolar team has worked on improving its prototypes, demonstrating compatibility with 32°C (89.6°F) ambient temperatures in 2018, and recently showing compatibility with outside temperatures of up to 43°C (109.4°F).

The company carried out a successful field test in Tenerife (in the Canary Islands) in the spring of 2019. An upgraded vaccine refrigerator prototype will be tested this summer in Berlin, and later in different locations in Kenya, once worldwide COVID-19 travel restrictions have been lifted.

Funding for the test, and for bringing it to market, comes from the European Union's Eureka Eurostars research and development funding program, with additional funders as well.

One of the important criteria for vaccine cooling is to achieve a stable temperature between 2°C and 8°C (35.6°F-46.4°F). "If [vaccines] are getting too warm, they deteriorate, but if they freeze they're dead so you cannot do anything with it," Römer explained. "Normal refrigerators have evaporator temperatures under zero degrees, like -15°C to -20°C, so you can easily freeze vaccines, or cool them way too far, whereas our system is a naturally freeze-free alternative."

The prototype refrigerators are 90ltr (24 gal) units with an 80W to 90W (0.023TR to 0.026TR) cooling effect. The units include very well-insulated refrigerator cabinets able to withstand the hot climates they are intended for. "We build the motor of the refrigerator, and it's different, but we can use the same cabinets [as other manufacturers]," she explained. The prototype units are also easily transportable on a pick-up truck and the like for remote deployment.

Apart from the vaccine coolers, Coolar is also looking into other medical applications, like cooling of anti-venoms for snake bites, and even cooling of agricultural crops.

How does it work?

The Coolar technology uses very low pressure in the system, less than 10mbar (0.15psi), causing some of the water in the evaporator to evaporate and creating a cooling effect in the fridge compartment. The water vapor then binds to an adsorbent surface, freeing up space in the evaporator for more water to evaporate, keeping the process going and creating a bigger cooling effect. As its adsorbent, Coolar uses silica gel, a readily available material around the world.

A Coolar prototype system
Credit: Coolar

Once the surface of the silica gel is full of water vapor, the cooling process temporarily pauses, and in order for it to restart, the adsorbent has to be dried off via heating; this releases the water vapor from its surface.

The heat required to release the vapor is created by the sun, with a photovoltaic panel connected to the Coolar unit via a heat exchanger. The released vapor then condenses and flows back into the evaporator, completing the cycle.

The heat collected throughout the day dries the silica gel to a point where it is then able to adsorb water vapor throughout the night until the sun rises again for another round of drying. "It's more flexible than a normal refrigerator where you always have to say — if I need the cooling now, I need now the sun," Römer added.

Less solar needed

One of the selling points of the Coolar system is that it doesn't need the same intensity of solar irradiation to keep the system running that a compressor-based solar-powered system does. This means it works better under cloudy conditions, according to Coolar's Business Development Manager Christoph Göller.

Coolar also claims easier maintenance and cheaper running costs than comparable systems. "It contains a lot fewer parts that may become troublesome because we don't have any control electronics or any semiconducting materials that usually deteriorate quickly in environments that have more than 25°C (77°F)," Göller added.

Coolar aims to be price-competitive once serial production starts. "I think the average price of devices licensed by WHO for use in the vaccine cold chain is about US$5,000 or slightly more for the whole system including the photovoltaic collector, and we think we can beat that," Göller said. ■ TS

HC/CO_2 Mixtures Perform Well, With Lower Flammability

Propane, isobutane or other hydrocarbons, combined with CO_2, deliver favorable COP and VRC, according to recent study.

– By Tine Stausholm

It is well known that hydrocarbons have great thermodynamic properties, making them efficient refrigerants. The problem is that they are also highly flammable, something that has restricted their wider adoption in the refrigeration industry, particularly for applications requiring large refrigerant charges.

Aiming to reduce safety and regulatory problems arising from the use of hydrocarbons, a team of scientists from Northeastern University in Boston, Massachusetts (U.S.) and Texas A&M University's branch in Qatar has studied the performance of hydrocarbon/CO_2 mixtures in a standard vapor-compression cycle. They found that the mixtures perform "well" in terms of coefficient of performance (COP) and volumetric refrigeration capacity (VRC). The research was published in the *Journal of Energy Resources Technology* in January 2020 (see https://bit.ly/3g1TgND).

While COP is a well-known energy-efficiency indicator to most HVAC&R industry professionals, VRC, which is defined as the refrigeration effect per unit volume of vapor entering the compressor, is less used on a daily basis. However, it is an important factor as it influences the physical size of the equipment, and thus cost.

Mixing hydrocarbons with nonflammable CO_2 has two advantages. First, the mixtures have lower flammability risks than pure hydrocarbons, widening the potential applications. Second, a mixture allows for a lower condenser pressure, and results in a higher critical temperature, than using pure CO_2, again widening the potential (geographical) application areas. Pure CO_2's 31°C/88°F critical temperature works against its performance in ambient temperatures higher than that, though technology improvements have mitigated that effect.

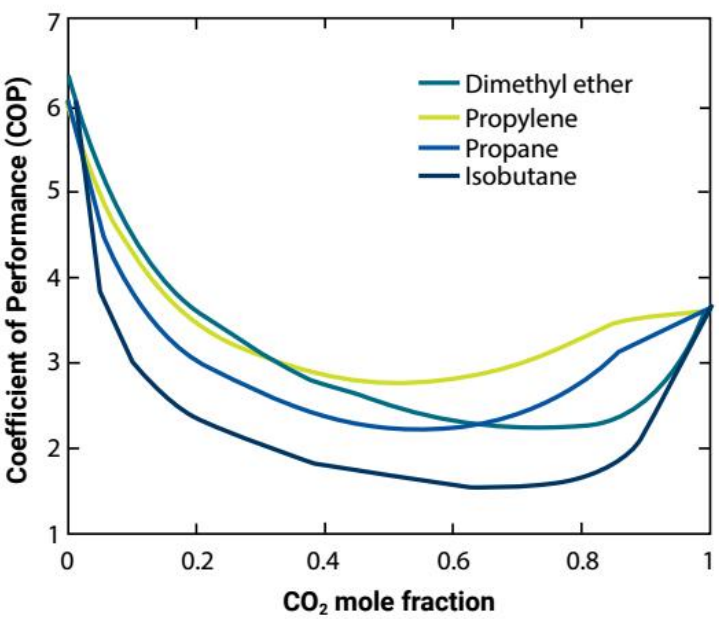
AC and refrigeration studied

The scientists analyzed 15 refrigerants in a standard vapor compression cycle, with the heat transfer fluid in both the evaporator and condenser/gas-cooler at a constant temperature. They simulated two operating scenarios – air conditioning in a tropical climate and food refrigeration.

The researchers found that propane (R290), isobutane (R600a), propylene, and dimethyl ether all performed "favorably" when mixed with CO_2; when the amount of CO_2 in a mixture increased, the COP decreased while the VRC increased. (See chart for more detailed results.)

The best COPs were found in the food refrigeration scenario. Of the four mixtures examined, the dimethyl ether mixture had the highest COP at low CO_2 concentrations, and propylene the highest COP at higher CO_2 concentrations.

The research team also included two mixtures of HFOs and CO_2 in the study, but these showed lower performance metrics than the hydrocarbon/CO_2 mixes. ■ TS



COP of refrigerant mixtures with varying CO_2 mole fractions at food refrigeration operating condition.

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WHAT'S DRIVING THE COLD CHAIN EXPANSION IN THE PHILIPPINES?

A number of factors, including a shift from 'wet markets,' the growing population, and post-harvest needs, says cold chain expert Anthony Dizon.

— By Devin Yoshimoto

The Philippine government's Department of Agriculture recently highlighted the need for additional cold chain infrastructure in the Philippines to help reduce post-harvest food loss. (See "More Cold Storage Facilities Needed in Philippines to Curb Food Waste," *Accelerate Magazine*, April-May 2020.)

But there are several other factors driving the country's growing cold chain. Consumer preferences are shifting from the traditional "wet markets" — where food is sold directly to the public without cold chain intervention — towards purchasing chilled or frozen foods at supermarkets. On the other hand, high electricity prices – the Philippines has some of the highest in Asia – threaten the cold chain industry as the country takes steps to limit greenhouse gas emissions.

One of the leading experts on the Philippines cold chain sector is Anthony Dizon, President of the Cold Chain Association of the Philippines (CCAP).

An electrical engineer by trade, he previously worked in the steel manufacturing industry. He became involved in the cold chain sector in 1997 after working on a cold storage warehouse project in the midst of the Asian financial crisis. He has served as President of CCAP (https://www.ccaphils.org) since the associations' inception in 2002.

In the following interview, Dizon provides his views on what is driving the expansion of the Philippines' cold chain market, the challenges the industry faces, and how CCAP is working with several international organizations and the Philippine government to make sure the growth of the cold chain sector continues.

***// Accelerate*:** How do you view the need for more cold chain infrastructure in the Philippines?

Anthony Dizon: CCAP foresees that the cold chain industry will continue to grow nationwide at a rate of 8% to 10% annually over the next five years. This is being brought about by three major factors, namely: population growth, shifting consumer preferences from "fresh" to chilled or frozen [products] as a result of our awareness-generation campaign on food safety, and access to regional export markets with the opening of the Association of Southeast Asian Nations (ASEAN) economic community.

However, it is necessary to emphasize that the growth of cold chain capacity should be concomitant with the effort to develop agribusiness production sectors in the country, putting emphasis on the respective strengths of different regions.

***// Accelerate*:** Can you describe the general role of wet markets in the Philippines?

Anthony Dizon: The wet market continues to be a social fixture in Philippine culture with the principal purpose of servicing the lower-income strata of the population. However, with the enactment of the National Food Safety Act, even the wet markets are now observably introducing cold chain intervention in their activity, meaning they have started to migrate to selling products in chilled format.

Our hope is that ultimately, the wet markets will evolve into a retail distribution network fully equipped with cold chain technology and equipment.

In addition, Philippine food manufacturers and processors have launched their respective marketing strategies to develop the awareness that food products purchased in supermarkets in frozen/chilled form are actually of better quality and are not necessarily more expensive than those procured in the wet markets.

But as the wet market evolution into cold chain practice progresses, the market shift is expected to be the greatest factor for capacity growth in cold chain infrastructure.

***// Accelerate*:** What are some of the biggest trends resulting from the cold chain growth?

Anthony Dizon: The Philippine cold chain industry has embraced the latest state-of-the-art technologies, as can be seen in the new construction projects recently completed and in the pipeline. This has been brought about by the need to introduce better operating efficiencies to ensure sustainability of investments.

***// Accelerate*:** What are the main challenges the cold chain industry will face in the next few years?

Anthony Dizon: The industry will continue to be confronted with major challenges such as: high operating costs, particularly power; constitutional limitations on foreign investments, which restrict prospective industry growth and access to strategic partnerships; and occasional conflicts in national policies versus local government regulations.

***// Accelerate*:** What opportunities or challenges do you see in minimizing carbon emissions and maximizing the energy efficiency and reliability of the cold chain?

Anthony Dizon: Maximizing energy efficiency will always be a top item on the cold chain industry radar. The concern on carbon emissions is at this time a paradoxical question because of the conflicting perceptions on GWP of HCFCs versus toxicity of ammonia.

***// Accelerate*:** As CCAP President, what are your main areas of focus?

Anthony Dizon: CCAP's principal advocacies are food safety, sufficiency and security. Towards this end, we have been working closely with Philippine government agencies as well as international affiliates to craft strategies and work programs to create awareness and understanding of the benefits of cold chain intervention in the protection of food quality and minimization of food waste.

In addition to our participation in the UNIDO program (see "Reinventing the Food Cold Chain in the Philippines," *Accelerate Magazine*, November-December 2019), CCAP is currently partnered with the USAID [United States Agency for International Development]'s Strengthening Urban Resilience for Growth with Equity (SURGE) project. This undertakes need analysis and lays the groundwork for capacity and capability building in specifically identified locations around the country. We are also looking at participation in a Japan International Cooperation Agency (JICA) sponsored activity aimed at developing a strategy to rationalize the vegetable value chain.

On the local front, CCAP is partnered with the Philippine Institute of Supply Management in providing an introductory cold chain training module in the undergraduate university discipline for supply chain management. ■ DY

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