

JANUARY 2018

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ADVANCING HVAC&R NATIONAL

A M E R I C A

2018
Predictions

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The Internet
of Things

p. 26

AHR Expo
Preview

p. 46

CHARLIE ROGERS

Property Rehabilitation Specialist

Homewise, City of Seattle,
Office of Housing

HOT WATER, COURTESY OF CO₂

SEATTLE APARTMENT
BUILDINGS INSTALL
CO₂ HEAT PUMP
WATER HEATERS

P. 38

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NEW DIRECTIONS FOR 2018

— by Michael Garry

The new year brings with it a desire to make changes, and so at *Accelerate America* we plan to head in a few new directions, which are evident in this issue.

To start, this is the first time our cover story, starting on [page 38](#), looks into a natural refrigerant (CO₂) used in a home appliance (a heat pump water heater) rather than a commercial or industrial system.

This water-heating system, from Japanese manufacturer Sanden, is fairly new to the North American marketplace, and is just finding its way, though it is very popular in Japan and is used in Europe and Australia. Our story describes an installation at a low-rise apartment building in Seattle, where each of 24 town homes replaced an electric-resistance water heater with the much more efficient heat pump water heater.

Another domestic appliance that is beginning to turn toward natural refrigerants is the home refrigerator. As we reported in the November-December issue, the Association of Home Appliance Manufacturers (AHAM) is expecting a transition in domestic refrigerators (as well as air conditioners) to hydrocarbon refrigerants. To facilitate that change, the Environmental Protection Agency has proposed raising the charge limit for hydrocarbons in domestic fridges to 150 g from 57 g. We will continue to follow these developments.

Hydrocarbon-based home refrigerators are already prevalent throughout the rest of the world, in part because of their greater efficiency over HFC models. And that leads to another change in the magazine – a new focus on energy efficiency.

Energy consumption, of course, makes up a large portion of the costs and greenhouse gas emissions of HVAC&R systems, along with refrigerant leaks. So the impact of increasing the efficiency of systems is simply huge. Thanks to energy efficiency, annual U.S. energy consumption is about the same as it was in 2000 even though the GDP has grown by 30%, according to the Natural Resources Defense Council.

We have always addressed the energy savings made possible by natural refrigerants – and will continue to do so – but now we will also look at the efficiencies enabled by ancillary systems that complement natural refrigeration.

For example, our article on the Internet of Things ([page 26](#)) shows how Price Chopper, a New York supermarket chain, has employed display case controllers and electronic expansion valves (EEVs) to gather mission-critical temperature, pressure and valve data in order to improve their performance and efficiency.

In our story on innovative startup technologies ([page 28](#)), we describe the work of SkyCool Systems, whose mirror-like reflective panels leverage “radiative

sky cooling” to passively cool fluids 24-hours a day. The panels, used as the condenser in commercial refrigeration, can provide a 10% efficiency boost; and they could serve as a gas cooler in transcritical CO₂ systems, keeping temperatures below CO₂’s critical point.

In future issues, we will delve into such energy-efficiency topics as thermal storage, LED lighting, store controls, heat reclaim and more. ([See page 54.](#))

A two-pronged approach to improving HVAC&R technology – through natural refrigerants and complementary energy efficiency – has the potential to transform homes and businesses, and change the world.



Michael Garry
Editor

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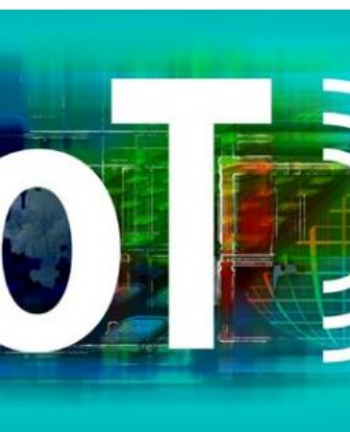
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Publisher

Marc Chasserot

marc.chasserot@shecco.com**Editor**

Michael Garry

michael.garry@shecco.com

VP- Business Development & Technical Editor

Derek Hamilton

derek.hamilton@shecco.com**Junior Reporter**

Elise Herron

Contributing Writers

Pilar Aleu

Marie Battesti

Jan Dusek

Anti Gzikelis

Eda Isaksson

Charlotte McLaughlin

Klara Skacanova

Chuck Toogood

Andrew Williams

Devin Yoshimoto

Ad Coordinator

Silvia Scaldaferrì

Art Director

Charlotte Georis

Graphic Designer

Juliana Gomez

Photographers

Ben Beech

Scott Chasserot

David Ryder

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LETTERS TO THE EDITOR

HYDROCARBON HOME FRIDGES ARE COMING

In regard to the growth of hydrocarbon fridges in the U.S. home appliances market, here are some thoughts. ("[Are Home Fridges in U.S. Turning Toward Hydrocarbons?](#)" *Accelerate America*, November-December 2017.)

I went to Vulkan's training facility in Florida this past January (2017) to get training on its Lokring [solder-free] method of joining tubing. At that time, the instructor indicated that Samsung was using R600a in its high-end model – and that Kelvinator and Whirlpool were moving in that direction. So, as an update to last January, I actually looked at a Samsung model that has R600a in it.

I also contacted Whirlpool Corp. and the customer-service representative referred me to Whirlpool's dealers because they would know first. I contacted a dealer in my area whom I have known for many years, but he knew nothing about it.

I then contacted a supplier, who only said he has heard about it but has not seen it. Then I contacted a domestic servicing agent I have known for many years and his response was that, at meetings, it is mentioned that it is coming, but no date is given.

I also have a document that has a Whirlpool part number on it that is very good at describing the use of the Vulkan Lokring method of joining tubing. This is another indicator that Whirlpool is looking to market R600a. Personally, I don't see how it cannot show up in the U.S. domestic market.

Will this happen now that the Environmental Protection Agency is proposing to raise the hydrocarbon charge limit to 150 g from 57 g? ("[EPA Proposes to Boost HC Charge Limit for Household Fridges](#)," *Accelerate America*, November-December 2017.) I don't believe that will be a deciding factor. After all, Samsung is doing it with 57 g or less and many of the charges I see on the labels are using this amount or less with R134a.

RSES has a Hydrocarbon Manual and training video series, which is basically being used in the commercial market. The RSES HC manual could be used for the domestic market. Having said that, the AHAM (Association of Home Appliance Manufacturers) guidelines target the domestic market specifically. It covers all the information that I believe I would need as a technician, so from that perspective, it is good.

Arthur Miller

Principal

KAM Associates, Apollo, Pa.



THE CAUSE OF ICE RINK ACCIDENT

Thank you for publishing the article that arrived in my inbox this morning. ("[Fatal Ammonia Accident at Ice Rink Sparks Safety Concerns](#)," *Accelerate America*, November-December 2017.)

While the details on the Fernie [ammonia] leak and fatalities are still being investigated, I hope that the results of the investigation are released soon. The importance of the industry knowing the cause and course to take for future prevention of this type of accident may not be well understood by the general public, but for those working in this section of the industry, the information found by the investigation will be invaluable.

One thing that I haven't seen mentioned in any article, from any source, is whether the grandfathering of systems to old code requirements should be re-evaluated in order to force older systems to refit to current code.

Bill Keating

Instructor, Refrigeration Department School of Construction

Southern Alberta Institute of Technology

Calgary, Alberta, Canada

LETTERS ARE WELCOMED!

Accelerate America invites readers to submit letters to the editor at michael.garry@shecco.com. They can be about a recent article; an industry issue that readers would like us to cover in greater detail; or the value of *Accelerate America* and ATMOSphere America in educating the industry about natural refrigerants, including what we can do better. Letters may be edited for clarity or length.

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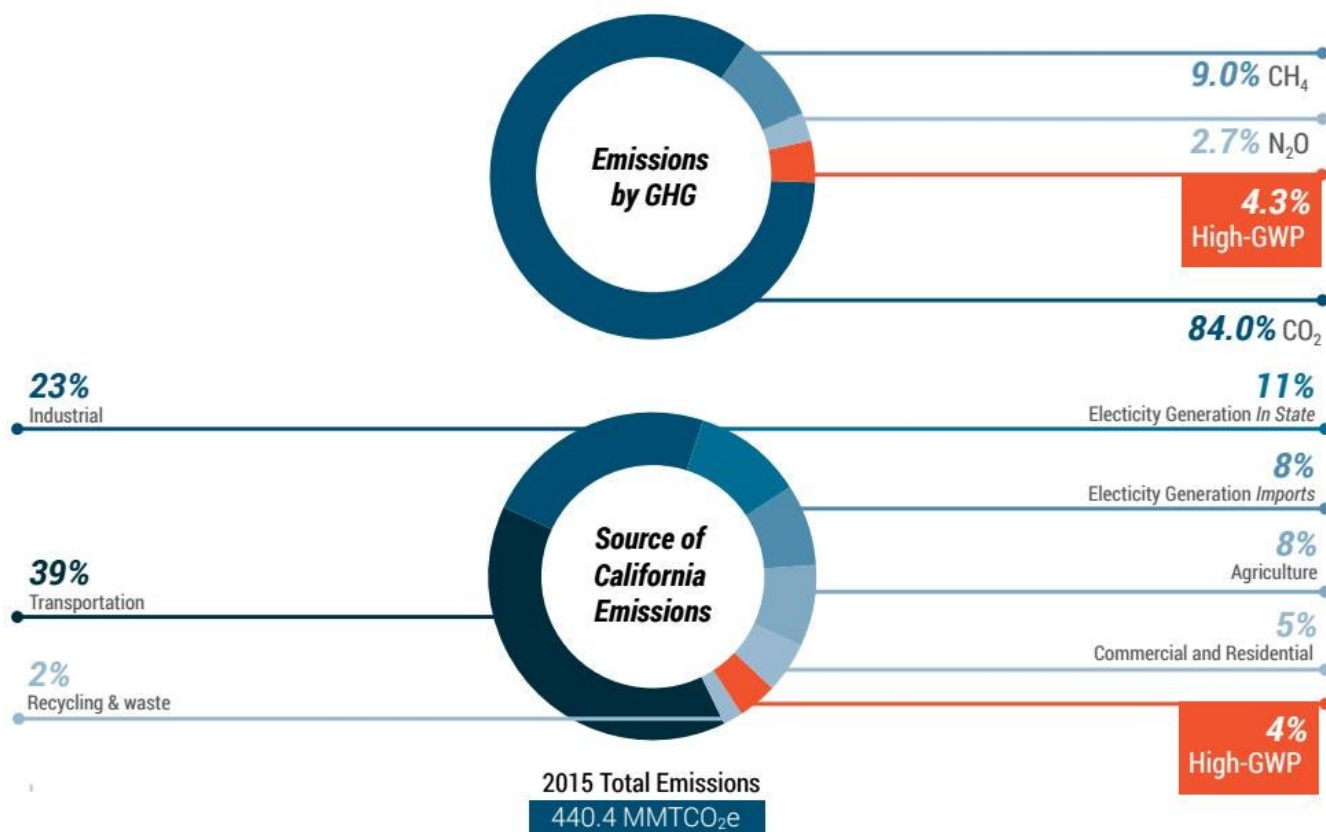
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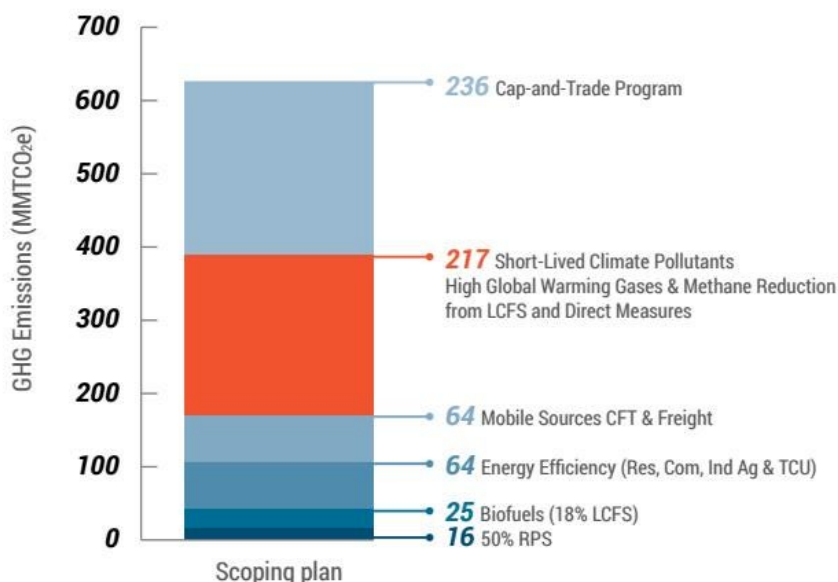
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California's GHG Emissions Targets, Including SLCPs such as HFCs



Estimated Cumulative GHG Reductions by Measure (2021-2030)



Glossary

CFT - Clean Fuels and Technology
CO₂E - CO₂ equivalent
Com - Commercial
GHG - Greenhouse Gas
Ind Ag - Industrial Agriculture
LCFS - Low-Carbon Fuel Standard
MMT - Million Metric Tons
RPS - Renewable Portfolio Standard
Res - Residential
SLCP - Short-Lived Climate Pollutant
TCU - Transportation, Communication & Utilities





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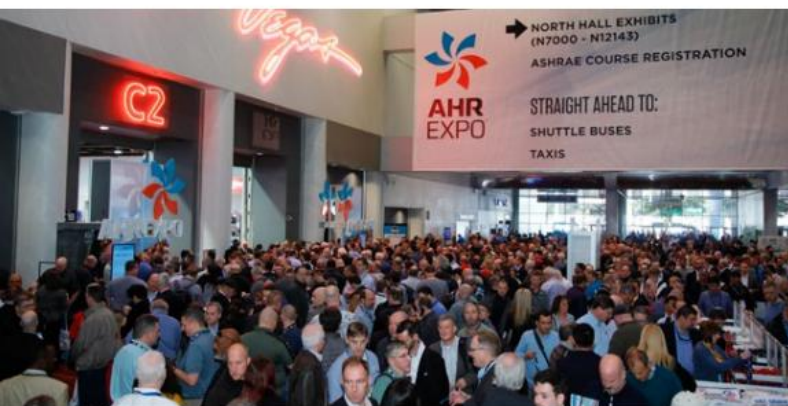
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JAN

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www.ashrae.org
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22-24
Indoor Air Quality Association (IAQA) 21st Annual Meeting, Chicago, Illinois

A technical program will feature over 40 sessions. Attendees will have access to the AHR Expo.


www.iaqa.org/annual-meeting
23-25
DistribuTECH, San Antonio, Texas

Event is for professionals from electric, gas and water utilities.


www.distributech.com

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30-01
International Production & Processing Expo (IPPE), Atlanta, Georgia

The event combines the International Feed Expo, International Meat Expo and the International Dairy Expo.


www.ippexpo.org


FEB

04-08**Cooling Technology Institute (CTI) Annual Conference, Houston, Texas**

Event is intended for manufacturers, owners/operators and suppliers of evaporative heat transfer systems.



www.cti.org/meetings

**11-14****The National Grocers Association (NGA) Show, Las Vegas, Nevada**

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www.thengashow.com



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12-14**Indoor Environment & Energy Expo (IE3) Show, Washington, D.C.**

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www.ie3show.com

**19-21****Energy Design Conference & Expo, Duluth, Minnesota**

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www.duluthenergydesign.com

**19-23****Industrial Refrigeration Workshop, Charlotte, North Carolina**

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conferences.k-state.edu/industrial-refrig/

AMERICA IN BRIEF

ASHRAE Wins UN Environment Award

At an Ozone Awards ceremony in Montreal, Canada, the United Nations Environment Programme (UN Environment) presented the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) with the Partnership Award.

The award presentation was part of the 29th Meeting of the Parties to the Montreal Protocol (MOP 29) in late November. ASHRAE was recognized for its contribution to the progress of the Montreal Protocol on Substances that Deplete the Ozone Layer.

"I congratulate ASHRAE for this well-deserved award honoring its exceptional efforts," said Tina Birmipili, head of the Ozone Secretariat. ■ **EH**

Danfoss to Build Fla. Compressor Plant

Danfoss North America announced last month that it plans to build a Turbocor Compressors facility in Tallahassee, Fla. The new facility will expand the company's existing footprint in Tallahassee, which includes the Application Development Center that opened in 2017. Construction is expected to begin in early 2018 and be completed in 2019.

"In Tallahassee, we have the tremendous opportunity to collaborate with world-class researchers in aerodynamics, power electronics, and magnetic technologies at Florida State University," said Ricardo Schneider, president, Danfoss Turbocor Compressors. ■ **MG**

Ozone Healing Linked To Montreal Protocol

Through direct satellite observations of the hole in the ozone layer, NASA scientists have shown for the first time that atmospheric levels of ozone-destroying chlorine are declining, resulting in less ozone depletion.

The decline is a direct result of the Montreal Protocol's phase-out of CFCs, which contain the ozone-depleting chemicals chlorine and fluorine. Prior to the ban, initiated in 1987, CFCs were commonly used in refrigerators, air conditioning units and even hairsprays.

The CFCs phase-out, and the subsequent decline of chlorine in the atmosphere, has resulted in 20% less ozone depletion during the Antarctic winter than in 2005, the first year that measurements of chlorine and ozone were made by NASA's Aura satellite, according to a new study released by NASA in *Geophysical Research Letters*.

"We see very clearly that chlorine from CFCs is going down in the ozone hole, and that less ozone depletion is occurring because of it," said lead author Susan Strahan, an atmospheric scientist from NASA's Goddard Space Flight Center in Greenbelt, Maryland.

Past studies have demonstrated that the ozone hole is getting smaller while the new study, according to NASA, is the first one to measure the chemical composition inside the ozone hole.

The new NASA study used the Aura satellite's Microwave Limb Sounder (MLS), which measures microwave emissions in the stratosphere.

Total healing of the ozone layer will still take decades. "We're looking at 2060 or 2080. And even then, there might still be a small hole," said Anne Douglass, a fellow NASA atmospheric scientist and the study's co-author. ■ **CM**

Consumer Goods Forum Pushes HFC Ban

The Consumer Goods Forum (CGF), a consortium of about 400 retailers, packaged-goods manufacturers and other stakeholders across 70 countries, resumed its commitment to phasing out HFCs in a new report issued last month at the One Planet Summit on climate change in Paris.

"Our Board approved resolutions on achieving zero-net deforestation by 2020, phasing out HFCs and halving food waste by 2025," writes CGF Managing Director Peter Freedman in the report, titled "Low-Carbon Solutions in the Consumer Goods Sector."

North American members of CGF include Walmart, Kroger, Wegmans, Costco, Sobeys, Amazon, H-E-B Grocery, Coca-Cola, Grupo Bimbo, Campbell Soup, PepsiCo, General Mills and Tyson Foods.

The report notes that natural refrigerants, unlike HFC alternatives, offer a safeguard against future regulatory change. "They provide viable and future-proof alternatives to synthetic compounds, which are increasingly the focus of climate regulations."

"Switching to natural refrigerants is also becoming an economic choice, with the increased availability of efficient technologies and associated energy savings," the report says. Adopting natural refrigerants can also significantly help to combat climate change, the report said.

The CGF report calls for wider adoption of natural refrigerants like ammonia and CO₂ for transport refrigeration. "By 2010, HFCs accounted for about 40% of refrigeration equipment for ships, 70% for road vehicles and 95% for intermodal carriers," it writes. ■ **CM**



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AS TEMPERATURES GO DOWN, REFRIGERATION COSTS GO UP

Cold storage warehouse operators need to be cognizant of the impact that lower temperatures have on efficiency

— By Chuck Toogood



Chuck Toogood
VP of Business Development,
M&M Refrigeration

Charles A. (Chuck) Toogood began his career at United States Cold Storage (USCS) in 1966. In 1983, he became vice president of engineering at USCS, where he remained until retiring in 2010. During his tenure, he managed the design and construction of warehouse space that reintroduced CO₂ as a viable refrigerant in cascade ammonia/CO₂ systems. He joined M&M Refrigeration in 2011.

Refrigerated facility owners, managers and operators are faced with what would seem to be a simple task of keeping things cold and moving product in and out to meet their customers' needs.

The principle may sound simple, but in reality it is a complicated orchestra of multiple disciplines that all need to be focused on the bottom line.

In today's modern cold chain environment, correct temperature control is essential to maintain food quality, nutrient content, shelf life and control of bacterial growth. Daily monitoring of temperatures is necessary to ensure adequate storage conditions.

Optimal refrigerated storage conditions can be achieved when temperatures are maintained usually between 32°F and 40°F (0°C to 4.4°C). Optimal frozen storage conditions can be obtained by maintaining freezer spaces at 0°F (-1778°C) or below.

Nevertheless, one should always first obtain proper storage and handling criteria of the different products handled in your warehouse. Proper storage and handling

of many perishable food products can be found in the Global Cold Chain Alliance, (GCCA) Commodity Storage Manual at www.gcca.org.

In the real world of refrigerated storage and warehousing you are sometimes confronted with the need to provide freezer storage temperatures lower than 0°F to -5°F (-1778°C to -20.56°C). For example, the storage of ice cream will usually require storage temperatures ranging between -15°F to -20°F (-20.11°C to -28.89°C). If your warehouse or a storage room within your warehouse is not designed to provide these lower temperatures, the added cost impact can be substantial.

In general, compressor energy use increases about 2% for every degree that suction temperature is reduced. In addition, there is more room thermal loss, infiltration and defrost penalty. When you include all factors, one could assume about a 2.5% penalty per degree reduction in room -temperature set point.

So, reducing a room from 0°F to -10°F (-1778°C to -23.33°C) would increase the energy use of that room (and any others served by the same suction) by 20% to 25%.

BASIC CONCEPTS

This article is not intended as a clinical dissection of the heat transfer problems of a cold storage facility; it's meant to underscore that as temperatures inside a cold storage space are lowered, the amount of heat to be removed increases, as does the cost of removing a unit of heat.

I would further like to point out a few basic concepts that are related to this problem:

1. There is no unit of "cold"; rather, we deal with units of "heat," traditionally referred to as a British Thermal Unit (BTU). It is defined as the amount of heat required to raise the temperature of one lb. of water by one degree Fahrenheit. And "cold" is recognized as the absence of heat.
2. Temperature within an area or space is a measure of the concentration of heat units and does not necessarily relate to the total amount of heat units present.
3. To maintain a constant temperature in a refrigerated space, we must maintain equilibrium in the concentration of heat units. In other words, we must remove heat units at the same rate at which they enter, or are created, in the refrigerated space.
4. Heat always flows from a higher temperature to a lower temperature.
5. The rate at which heat flows is dependent upon the difference in temperatures, and the resistance to heat flow caused by the material or substance through which the flow takes place – in the case of a refrigerated warehouse, the insulation.
6. The four primary sources of heat in a refrigerated space are transmission losses (the heat flowing through walls, roof and floors); infiltration losses (the heat that enters with warm air through door openings, leaks in vapor barriers such as retarders and normal flow through vapor barriers); product losses (heat generated by product within the space, or heat that must be removed from incoming product because its temperature is above room temperature); and internally created load (heat generated by electrical lights, motors, people and handling equipment operating within the space).

Of the four principal sources of heat, three are directly related to differences in temperature. Therefore, as temperatures change, the heat flow changes. For the most part, cold storage warehouses operate their refrigerated space at temperatures that are lower than those of the surrounding outside space or ambient temperature, and heat must be removed by refrigeration.

Since the temperature of the air that surrounds the refrigerated space varies from hour to hour, from day to day, and from month to month, the heat flow into the space is constantly changing.

EXAMPLES OF HEAT FLOW

Let's take three examples showing heat flow and the resulting annualized tons of refrigeration required when the space is maintained at 0°F, -10°F and -20°F.

For the purpose of this article, let's assume that we have a cold storage warehouse facility with a storage freezer measuring 300 ft long by 200 ft wide by 45 ft high. The storage freezer is serviced from an enclosed and refrigerated loading dock. The walls of the storage consist of five-inch-thick insulated metal panels; and the roof is insulated with eight inches of urethane foam insulation with a white single-membrane roofing material. The freezer floor has been equipped with an under-floor warming system and six inches of insulation.

Warehouse lighting is accomplished with LED fixtures at a rate of approximately one-half W per square ft. It is estimated that four lift trucks will be operating within the refrigerated space at any given time during an eight-to-10-hour day. The room air handling units have the capacity to hold the room at 0°F with a refrigerant temperature of -10°F. There is approximately 36 HP of fan motors.

The estimated frozen product receipts are 600,000 lbs per day at a temperature of approximately +5°F, which equilibrate to room temperature in 24 hours. Air infiltration into the storage freezer is assumed to be one air change per day, occurring in the eight-to-10 hours of operation.

The table on page 16 shows the average annualized load (TR required) for the three examples. In studying these examples, one can readily see the changes in refrigeration requirements as the temperature in the refrigerated space is lowered from 0°F to -10°F and then to -20°F.

Assuming that there are no changes in the room refrigeration units, and restricting alterations to the compressor capacity, the following occurs as the room temperatures are lowered:

1. To lower the room temperature, we must lower the temperature of the refrigerant in the coils; i.e., increase the split. This is accomplished by lowering the pressure of the refrigerant in the coils.
 2. When the pressure of the refrigerant in the coils is lowered, we also lower its specific density; i.e., the gas becomes lighter, and it will be necessary to pump more gas to have the amount of refrigeration required.
 3. As we lower the pressure in the coils, the range through which we compress the refrigerant (its compression ratio) is increased and this increases the amount of work that is required to pump the gas through its cycle.
 4. As the compression ratio increases, the efficiency of the compressor decreases.
- In summary, as temperatures are lowered, it is necessary to handle more gas with decreased efficiency at increased power requirements.
- Finally, I should add that there are some very important areas of increased costs associated with lower temperatures that may be overlooked because they are somewhat difficult to pinpoint. These are:
1. In most cases where temperatures are lowered, an investment must be made in additional low-side compressor capacity, and, in some cases, in intermediate compressor capacity.
 2. In some cases, problems are aggravated by undersized suction lines, resulting in excessive pressure drop and further inefficiencies.
 3. As room temperatures are lowered, the general efficiency of the warehouse labor force decreases.
 4. Also, building maintenance increases, particularly in the realm of insulation and doors. With increased vapor pressure due to temperature differences, air leaks become more critical and require more attention.
 5. Defrosting costs increase due to increased air infiltration, and the corresponding increase in moisture that enters the room.

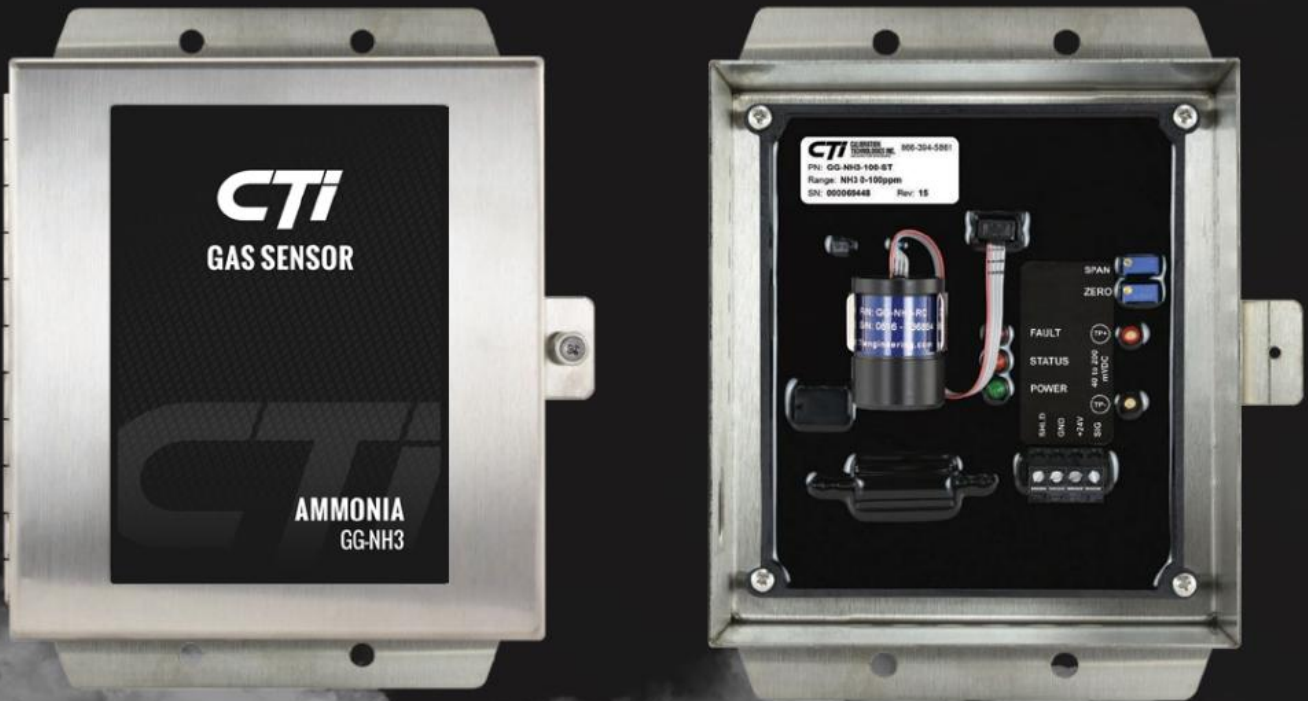
Together, the cost of the above five items could, and probably do, exceed the increased cost of powering the refrigeration. ■ CT

Impact of Temperature on Load

Load Description	Average Annualized Load (tons of refrigeration required)					
	Example #1 0°F		Example #2 -10°F		Example #3 -20°F	
	TR	% of total	TR	% of total	TR	% of total
Transmission heat gain	21.70	27.40%	25.01	25.80%	28.32	24.69%
Product load	4.38	5.52%	13.13	13.54%	21.88	19.07%
Infiltration load	24.07	30.38%	28.21	29.10%	32.35	28.21%
Personnel load	0.36	0.46%	0.39	0.40%	0.42	0.37%
Lighting load	8.53	10.77%	8.53	8.80%	8.53	7.44%
Motor load	13.40	16.91%	13.40	13.82%	13.40	11.68%
Safety factor	3.62	4.57%	4.43	4.57%	5.24	4.57%
Operating time	3.15	3.98%	3.85	3.98%	4.56	3.98%
totals	79.21	100.00%	96.95	100.00%	114.70	100.00%
percentage increase (from 0°F)	0.00%		22.40%		44.81%	

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A TALE OF TWO SECTORS

Spending on refrigeration equipment by food retailers dropped last year while the industrial refrigeration market surged, but technology in both sectors continues to advance

— By Derek Hamilton



Derek Hamilton is vice president of business development and technical editor of shecco America.

“ The advent of [low-charge] packaged ammonia systems has disrupted the market. ”

The new year brings a welcome opportunity to review recent experiences and consider what might lie ahead.

For those of us in the HVAC&R industry, 2017 was definitely a mixed bag. Looking at two sectors in particular – food retail and industrial refrigeration – we see some diverging trends. While the food retail refrigeration market experienced a relatively slow year, the industrial refrigeration market has been stronger than ever, with many companies reporting a record year for sales.

The reasons for the dip in food retail spending on infrastructure (including refrigeration) have been well reported: a combination of “The Amazon Effect” - where Amazon’s purchase of Whole Foods Market led retailers to take stock of their own spending plans - and the uncertainty produced by the federal appeals court ruling that the U.S. Environmental Protection Agency cannot require companies to replace HFCs with low-GWP substances under the SNAP (Significant New Alternatives Policy) program.

Given these two major events, it is understandable that retailers have been expressing caution. The good news is that equipment manufacturers expect the market to rebound in 2018 as delayed projects become more urgent and the regulatory landscape becomes clear.

In terms of the technology being used, we still see the U.S. market playing catch-up with the excellent progress made in Europe, where the majority of new-build, and increasingly retrofit, stores are using natural refrigerants. The continued development of CO₂-based technology means that these systems can now outperform HFC-based systems, even in warmer climates, and the industry is beginning to take note.

In addition to CO₂-only systems, we see continued interest in cascade systems with ammonia or even propane on the high side. These designs can help boost efficiency further and provide an attractive prospect for retailers in all climate zones. Moreover, self-contained display cases using propane are gaining considerable traction in food retail, particularly in smaller stores.

The food retail industry still sees a hurdle where first cost is concerned. Despite the potentially lower total-life-cycle cost of natural refrigerant systems, the competitive first cost of synthetics can still pose a challenge. But

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capital cost premiums for naturals will continue to decrease as production volumes rise and contractors become more familiar with the technology.

Moreover, there is still an opportunity for properly structured incentive programs to help boost the adoption of natural refrigerant-based technologies. At the time of writing, proposals for a California-based incentive program for retrofitting of HFC-based systems (as part of State Senator Ricardo Lara's California Cooling Act) are still under consideration. The industry will be watching California closely in 2018 - a year that is shaping up to be pivotal in the state's fight to reduce greenhouse gas emissions.

THE QUIET REVOLUTION

By contrast, the industrial refrigeration sector enjoyed a bumper year in 2017, with a large number of orders on the books going into the new year. This points to 2018 being another strong year for the sector.

The buzz surrounding low-charge ammonia continues, with more competition in the space driving innovation. The advent of packaged ammonia systems has disrupted the market in a way never seen before, and the "traditional" ammonia industry is slowly realizing that this technology has the potential to change the game for good. Packaged ammonia systems have been deployed in a number of applications, including warehousing, food processing and even HVAC.

The development of low-charge technology is also leading to ammonia being looked at for new applications. Ammonia chillers are now being considered for smaller HVAC applications, as well as in food retail refrigeration as the high side of a cascade system with carbon dioxide. The application of ammonia in locations not previously regarded as suitable for this toxic refrigerant is certainly helped by the move to low charge. Meanwhile, optimized centralized systems in various forms have also enjoyed success.

As this quiet revolution progresses, the industrial refrigeration industry continues to grapple with the issue of how the various codes and standards will deal with these low-charge systems. The IIR has already addressed this issue by forming a committee that is in the process of drafting a low-charge version of its Ammonia Refrigeration Management (ARM) Program for small facilities.

One of the more recent development in the low-charge ammonia story is the advent of "no-charge" ammonia, or carbon dioxide as it is commonly known. Joking aside, CO₂ is enjoying a resurgence with commercial rack technology being scaled up for use in industrial applications.

Carbon dioxide was one of the first refrigerants used in industrial refrigeration. We have now come full circle as we see transcritical CO₂ systems competing for refrigerated warehouse applications that would normally default to the use of ammonia systems. With competitive capital costs and efficiencies in excess of ammonia systems (in cooler climates at least), it seems clear that the growing use of CO₂ for industrial refrigeration is a trend that will continue.

The disparity between the recent fortunes of these two sectors is an interesting one. The U.S. economy is at an all time high, and employment at its lowest rate in nearly two decades. Food manufacturers and warehousing companies are investing in their infrastructure; however, food retailers are feeling the pinch. So where is the disconnect?

Another explanation may be that a strong economy means more disposable income, and this leads to people eating out more often (so restaurant spending goes up and food retail spending goes down). However, there seems to be more to this trend. Is the growth of online food retail beginning to change the market for good? Only time will tell. ■ DH



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2018 PREDICTIONS

End users, manufacturers, a contractor, and an association director weigh in on what 2018 may hold for natural refrigerants in North America

– By Michael Garry



Pete Lepschat

*Engineering Services
Manager*
Henningsen Cold Storage
Hillsboro, Ore

I think 2018 will see increasing momentum toward natural refrigerants in general in all markets. Specifically, in the industrial sector:

- ▶ I predict increasing momentum toward CO₂ systems (both subcritical and transcritical), and to a lesser extent toward low-charge ammonia in new construction.
- ▶ I think that there will be focused development in technologies that will widen the usability and acceptance of CO₂.
- ▶ Without being too negative, I see a limited future for packaged low-charge NH₃ systems. I think other technologies will prove advantageous.
- ▶ As far as upgrades on existing NH₃ systems, I don't see too much of a shift away from conventional, "replacement in kind" methodologies.



Tristram Coffin

*Director of Sustainability &
Facilities*
Whole Foods Market
Northern California Division

I don't foresee any mind-shattering developments in 2018, but I am excited to continue the conversation and see how the industry evolves at an ever-growing pace.

The needle has already begun to move on ejector technologies and advanced control strategies for CO₂ transcritical systems, hopefully to the extent that we will soon have to change the terminology to simply CO₂ DX systems. That is to say, with the right design strategy my hope is we can keep these systems from ever going transcritical as the ambient temperature rises. It will be nice to see ejectors make more of a splash here in the U.S. in the next year. I am optimistic that policy regarding hydrocarbon charge limits will slowly but surely begin to move in the right direction in 2018 and beyond.

As for adoption, to me going natural is a no-brainer. Why wait? The sooner you adopt, the more experience and practice you get, which means the sooner you perfect system operations. I trust others in the industry will begin to share that mentality.



Todd Ernest
CEO
Climate Pros
Glendale Heights, Ill.

We are still seeing adoption of natural refrigerants, and things are seemingly moving in that direction. Some [end users] are taking longer than others, but they are moving

nonetheless. A few of our customers who were using some CO₂ are making indications that they may be moving into CO₂ across the board very soon, so we shall soon see. I suspect that the market will continue on the gradual pace it has been on for the past few years in the upward [direction].



Danielle Wright
Executive Director
North American Sustainable Refrigeration Council
Mill Valley, Calif.

My prediction for 2018 is that California will develop a policy for statewide incentives for the transition to low-GWP (aka natural) refrigerant

systems and equipment. My money is on the California Cooling Act proposed by State Senator Ricardo Lara, but even if this bill doesn't pan out, I predict a similar program to take its place. Between the impending CARB [California Air Resources Board] rulings and the inability of the vast majority of California grocers to comply, something's got to give.



Jeff Gingras
President
Systèmes LMP
Laval, Quebec

I am hoping that the Americans will come to adopt natural refrigerant technology. The Kigali amendment should help the push, as it is a signed treaty. For 2018, the

energy savings aspect should be more apparent as we are starting to see [transcritical CO₂] installations using ejectors, sub-cooling, parallel compression and simplified control strategies.

The Canadian market has adapted natural refrigerant technology, as all initial quotes for commercial and industrial are based on CO₂. This is the future. We foresee an increase in demand once again in 2018.

“In 2018 I see the growth of R290 applications in small-size applications.”



Marek Zgliczynski
Manager of Commercial Refrigeration Product Engineering
Embraco
Joinville, Santa Catarina, Brazil

In 2018 I see the growth of R290 applications in small-size applications.

This trend is visible already in the most recent products sold in 2017. But for bigger size cabinets/compressors, the transition blends are still the main interest, since the [charge-increase] legislation is not ready yet for R290 or A2Ls.



Charles Hon
Engineering Manager
True Manufacturing
O'Fallon, Mo.

Industry adoption of self-contained propane cases: We are continuing to increase our sales of R290, and finalizing more redesigns of equipment. Most of the industry is

holding back, hoping the [Environmental Protection Agency's] SNAP [Significant New Alternatives Policy] reversal will hold up in court. The few companies that are moving forward are being driven by customers.

Policy Impacts: CARB [California Air Resources Board] will be the only driver in the market

Technology development: Supply-chain technology is fully developed and available to the market.

Other sectors: Ammonia is getting some traction in warehousing and could become a player in remote systems (with secondary loops). CO₂ is still fighting to get the efficiencies it needs to displace HFCs. Time is an issue since the existing equipment will be kept as long as possible.

**Kurt Liebendorfer***Vice President*

Evapco

Taneytown, Md.

I see a lot happening in 2018 with Evapcold's low-charge ammonia systems. We are ending 2017 with some very exciting new orders and will be starting 2018 with addi-

tional orders, soon to be awarded. A few of the orders are associated with projects that have been in development over the course of 2017. One of them, in fact, dates back to the development of the project starting in 2016.

This is indicative of the design-build development cycle associated with the food-and- beverage industry. Owners and builders are now recognizing that if they start their building design development process by using packaged natural refrigerant solutions, they are able to recognize real project savings and come out the other end with a lower cost of ownership.

In addition to new orders, in 2018 we are launching the next wave of Evapcold products over the next six to eight months, including dual-compressor penthouse units (providing redundancy and efficiency gains) and much larger chiller packages, up to 350 TR and larger; all of these systems have full-scale units being built and tested at Evapco's R&D complex. We are hard at work with rigorous product performance testing and validation to successfully launch these new fully tested and fully rated products in 2018.

We will also continue in 2018 to be very active in the marketplace educating contractors, owners and regulators on the many benefits of packaged low-charge ammonia systems. We are heavily involved in the development of new industry guidelines, codes and standards that natural refrigerant technologies can greatly benefit from, and that make regulatory compliance much easier. We anticipate new IAR guidelines supporting the application and use of low-charge ammonia systems will be issued in 2018, which will be a great benefit to end users and owners.

**André Patenaude***Director, Food Retail Growth**Strategy, Cold Chain*

Emerson Commercial and

Residential Solutions

St. Louis, Mo.

Industry adoption:

▶ Canadian supermarkets will move ahead with CO₂ transcritical.

▶ U.S. supermarkets with European ownership will continue to move forward with CO₂ booster, CO₂ cascade or R290 options.

▶ Other U.S. retailers will continue with CO₂ demonstration projects to fully understand the total-cost-of-ownership impact for themselves.

▶ CO₂ heat pump discussions in North America will begin, and demonstration projects will start gaining popularity.

▶ There will be continued development and demonstration projects with low-charge ammonia systems.

▶ CO₂ transcritical in larger commercial and industrial facilities will slowly continue to grow.

▶ NH₃/CO₂ cascade systems are starting to displace NH₃ in industrial blast freezing and holding freezer applications. There will be availability of larger-capacity subcritical low-temperature CO₂ compressors, enabling faster adoption.

▶ In rooftop packages, NH₃, NH₃/CO₂ cascade, or CO₂ booster systems may be seen as a viable, non-intrusive option to retrofit existing HCFC facilities as well as in new facilities.

Policy impacts:

▶ The EPA's holding off on the district court appeal may cause some retailers to want to delay equipment change-out.

▶ California's position on HFCs may cause end-user concerns in certain sectors. In North America, we will watch how Europe handles a significant F-gas phase down (a 37% reduction) in 2018.

▶ OSHA [Occupational Safety and Health Administration] continues to drive low-charge ammonia and the move to an increased use of CO₂ in the industrial space.

▶ Impending increased charge limits for A2L and A3 refrigerants may drive development of higher-capacity equipment.

In technology development, there will be:

▶ Larger-capacity CO₂ compressors for medium-temperature and low-temperature applications.

▶ Rooftop packaged equipment for commercial and industrial applications.

▶ Packed R290 equipment for walk-in boxes.

▶ Continued launch of electronic controls.

■ MG

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PRICE CHOPPER LEVERAGES THE INTERNET OF THINGS

Gathering and analyzing data via web-based technologies help optimize system performance for the New York-based chain

— By Elise Herron and Michael Garry

The Internet began as a way of exchanging digital information between human beings operating computers. More recently, it became able to incorporate data directly from objects in the physical world – the so-called Internet of Things (IoT).

The IoT is based on a network of “smart” devices embedded with “software, sensors, actuators and network connectivity that enable those [devices] to collect and exchange data,” said Tom Mathews, president of BaselineES, a Yarmouth, Maine-based engineering consultancy firm, in a presentation last September at the Food Market Institute’s Energy and Store Development Conference.

More specifically for supermarkets, the IoT refers to capturing highly detailed, granular data about store equipment and storing it in the cloud or a data warehouse via the Internet – and then using that data “to more efficiently and/or economically operate this equipment,” he said. With highly granular data comes a high degree of control over nearly every element and functionality of a system.

Data can also be processed by third-party applications to detect performance deviation events affecting maintenance, component performance

and control adjustment. Detailed requests for service can be channeled to a service provider.

Devices that facilitate data acquisition and more efficient operation of equipment go hand-in-hand with natural refrigerant technologies.

For a number of years Schenectady, N.Y.-based Price Chopper, has endeavored to operate its store systems as efficiently as possible. In addition, the chain has installed a few natural refrigerant systems – a CO₂ cascade system (using CO₂ for low temperatures and glycol for medium) at a store in Saratoga, N.Y., and chillers using CO₂ in Colonie, N.Y. The cascade system includes high-efficiency ECM fan motors and LED lighting in all display cases, the use of reach-in doors for cases with new medium-temperature loads and variable-speed fan control for air-cooled condensers.

Benny Smith, vice president of facilities for Price Chopper – a co-presenter with Mathews at the FMI Energy & Store Development Conference – sees cost savings through efficiency as a key to the chain's financial future. "We can't continue to try to just negotiate our way with buying power brute force to lower costs – we need to find ways to actually become more efficient in every way and actually reduce the cost of maintaining our complex store systems."

USE OF CASE CONTROLLERS

According to Smith, one of the chain's first data acquisition efforts was to install electronic expansion valves (EEVs) using case controllers.

"Price Chopper has a leg up on [the industry] because they've been putting case controllers in for a while; they have a lot of sensors and they have a lot of control points," Mathews said.

"It's great to be able to graph and come back and study and analyze [data from the case controllers]," Smith added. "That's what we're doing right now. You've got to be able to analyze and see things [that may happen] in the future."

Case controllers use multiple temperature, pressure and valve sensors to gather data on electronic expansion valves, defrost, lighting and fans, allowing the operator to remotely control all of these components.

Price Chopper has gone on to install sensors in every energy-consuming load in its stores, and link them to a building control system. Those include

refrigeration, lighting, ovens and ventilation systems. The store's data acquisition has helped it optimize energy-efficiency as well as quickly service leaks and other malfunctions.

"This approach brought us tremendous data and control granularity," said Smith. Price Chopper now has "most of the data and control granularity we need or want."

Smith acknowledged that the IoT "means collecting lots more data, from lots more systems, and a very big challenge." To render its IoT more manageable, Price Chopper limits the number of control systems it uses, which reduces "the number of data interfaces required," said Smith. In addition, Price Chopper is negotiating with third parties to help collect, scrub, store, analyze and respond to the data.

There remain some barriers to the data access and collection upon which the IoT depends, including dial-up connections to refrigeration and building control systems, bandwidth limitations to company networks, and less-than-open-protocol access to log data stored in multiple refrigeration and building system controllers.

At the same time, there are a number of enablers of data access, including cellular network connections, segregating IoT communications from other communications (like point-of-sale), virtual LANs, automated off-hours data collection, controllers with web-based access, and third-party data acquisition and cloud-storage services.

Smith noted that "direct digital interfaces" with equipment, rather than an "input/output board interface," allow end users to "see and control everything with just one pair of wires." Direct digital communication interfaces are available from a wide range of equipment vendors, including Danfoss, Carrier, Lennox and Munters.

IoT GOALS

Price Chopper has not yet met all of its IoT goals. For example, it is not yet able to fully diagnose all alarms. The chain's help desk and facilities team "should be analyzing all alarms before dispatching to ensure the problem can't be resolved remotely, without a service call required."

Smith would also like to automatically assess performance of all mission-critical systems to determine if there is "a failure looming that we can avoid."

Other automated actions on Smith's "IoT Wish List": correct and maintain set points; detect leaks; start up and proof seasonal HVAC&R system capabilities ahead of forecasted hot or cold weather; and detect operating issues that can affect system effectiveness, efficiency and lifespan.

He would also like to use chain-wide data and advanced analytics to identify high energy-using stores and equipment that appear to be operating correctly. In addition, he would like to replace most fixed-schedule preventative maintenance with "demand-based maintenance."

"Only the IoT can practically take on this mission," Smith said. ■ **EH & MG**

NEW KIDS ON THE BLOCK

Four startups offer novel ways to remove heat in a variety of settings

– By Elise Herron

In the constantly evolving refrigeration industry, four startup companies – ColdHub, Evaptainer, Phononic, and SkyCool – have come up with systems that meet new cooling challenges and incorporate innovative technologies. Here is a summary of what each offers.

RADIATIVE SKY COOLING

Davis, Calif.-based start up SkyCool Systems has developed mirror-like reflective panels that leverage “radiative sky cooling” to passively cool fluids 24-hours a day.

The panels, which can be used as a condenser in commercial refrigeration, radiates infrared heat at particular wavelengths so it can break through the atmosphere and pass into space. In addition the panels are designed to reflect sunlight during the day.

The SkyCool team was inspired by methods that ancient cultures used to achieve natural cooling effects – passively cooling and freezing water without using electricity. Backed by funding from the U.S. Department of Energy, SkyCool engineered specialized optical coatings that could enable “meaningful cooling throughout the day,” the company said,

“This approach allows our panels to reject heat in a closed loop to the sky, without running a fan or evaporating water,” said Eli Goldstein, SkyCool’s co-founder and CEO. “The cooling panels work by radiating heat to the sky as infrared light. Because the atmosphere is transparent to infrared light, the panels can cool passively, and reach temperatures [up to 20°F] below the ambient.”

Moreover, the panels only need energy to run a water pump, which draws 1%-3% of the total power consumption of typical systems.

Goldstein pointed out that commercial refrigeration represents a large fraction of the energy consumed by cooling systems, and “in the long term, we believe these systems



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are not sustainable." The SkyCool technology is "uniquely positioned as a simple add-on to any refrigeration system to provide a 10%-scale efficiency boost."

By saving 10% of an electricity bill, the cooling panels offer a sub-five-year payback, said Goldstein. And while the focus is on the commercial sector, "our system can fit into any system that has a condenser or similar heat rejection mechanism."

So far, tests of the system have employed R404A as a refrigerant. However, Goldstein sees a lot of potential for installing SkyCool panels in natural refrigerant-based systems,

"We believe that CO₂ and ammonia refrigeration systems are a good fit for our technology," he said. "We're very excited about the potential of using our panels as a gas cooler in transcritical CO₂ systems. We believe our panels could benefit transcritical systems by keeping the condenser side below the critical point." He also sees the panels as an add-on to large ammonia systems, with the goal of improving the underlying system efficiency.

SkyCool is currently scaling up its manufacturing capabilities, and plans to have a market-ready product in 2018.

REDUCING FOOD WASTE

Almost 45% of food in Nigeria is wasted due to a lack of cold storage, according to the Rockefeller Foundation; as a result, farmers lose around 25% of their income annually.

Nigeria-based ColdHubs has developed a solution to this problem— eponymous, 10 ft-by-10 ft-by-7 ft., solar panel-topped boxes that can hold up to three tons of produce and other perishables and extend storage from two to 21 days. The off-grid boxes store 5.7 kWh solar power in batteries, which feed an inverter connected to a refrigeration unit using propane refrigerant; the unit generates a temperature of 41°F (5°C)

ColdHubs are currently being installed at farm co-operatives and markets around Nigeria, where farmers can rent space to store food at a daily rate of \$0.50 per crate. To date, five ColdHubs have been installed in Nigeria, with 287 customers using them.

"Our solar-powered ColdHubs ensure that fresh food is always available, the profits of farmers and traders increase, and food waste decreases," said founder and CEO Nnaemeka Chidiebere Ikegwuono, in a statement.

Similarly, Somerville, Mass.-based start-up Evaptainer has invented portable, water-cooled boxes to address the issue of food waste globally. The group's website estimates that around 21% of the world's population doesn't have electricity, and in Africa specifically around 30%-40% of produce spoils before it reaches the consumer.

EV-8, Evaptainer's flagship product, harnesses the cooling power of water evaporation with no need for electricity. An internal reservoir is filled with tap, well, river or lake water and the walls of the device draw out heat from the interior through evaporative cooling.

The EV-8 has a 2.1-cu-ft (60-l) capacity, can keep food around 15°C to 20°C cooler than ambient conditions and averages about one liter of water usage per day. Evaptainer is currently testing its product in Morocco, and estimates that the final product will cost about \$30.

COMPRESSOR-FREE MEDICAL REFRIGERATION

In the hospital and healthcare industry, Durham, N.C.-based Phononic last year won recognition for its energy-efficient, compressor-free system — the Evolve 5.5-cu-ft Protect Plus undercounter refrigerator. In September, the product earned the Emerging Technology Award from the U.S. Environmental Protection Agency's ENERGY STAR program. Last July it became the first solid-state refrigerator to earn ENERGY STAR certification in the Refrigeration and Frozen category.

The compressor-free refrigerator, which uses CO₂ as a refrigerant, consumes 40% less energy than its competitors, while still meeting the guidelines for controlled storage of pharmaceutical drugs and vaccines, the company said.

"Phononic's award winning refrigerators not only save customers money with superior energy efficiency, they use an innovative technology that reduces their environmental impact," said Ann Bailey, Washington, D.C. branch chief for the ENERGY STAR program. "

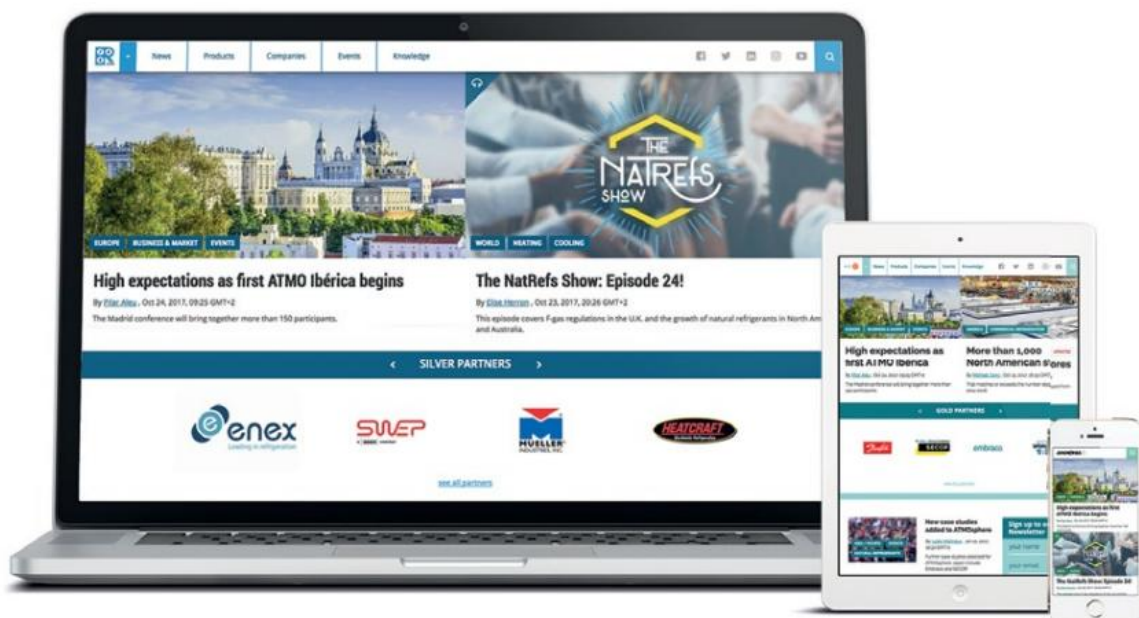
Phononic said its mission is "to disrupt conventional refrigeration markets by providing reliable cooling without the noise, toxicity and other detriments of legacy refrigeration." ■ EH

New SkyCool panels



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A wide-angle photograph of the Golden Gate Bridge in San Francisco, California. The bridge's iconic orange-red towers and suspension cables are prominent against a clear blue sky. The bridge spans a deep blue body of water, with the city of San Francisco visible in the distance on the hills. The title "California's Action Plan" is overlaid in large white serif font across the middle of the image.

California's Action Plan

Its 2017 Scoping Plan describes how HFC reductions and energy efficiency will help achieve the Golden State's 2030 greenhouse gas reduction targets

– By Elise Herron

Last November, the California Air Resources Board (CARB) released a 132-page document titled "California's 2017 Climate Change Scoping Plan," which outlined in detail how the state plans to meet its 2030 greenhouse gas (GHG) targets.

By 2030, California aims to reduce GHG emissions by 40% from 2013 levels. To achieve that goal, the Golden State intends to, among a number of strategies, increase energy efficiency, slash "super pollutants" (like high-GWP HFCs), and invest in disadvantaged communities via its cap-and-trade program.

"California pushes old boundaries, encounters new ones, and figures out ways to break through those as well," the Scoping Plan reads. "This is part of the reason why California has grown to become both the sixth largest economy in the world, and home to some of the world's strongest environmental protections. And, we have seen our programs and policies adopted by others as they seek to protect public health and the environment."

HFC REDUCTIONS

Per a state health and safety code, CARB monitors emissions of seven different GHGs, including HFCs. Of the 440.4 million metric tons (MMT) of CO₂e emissions recorded in 2015, high-GWP HFCs accounted for 4.3%.

HFCs are one of the super-polluting short-lived climate pollutants (SLCPs) covered by Senate Bill (SB) 1383, passed in 2016. The bill requires the implementation of a "Short-Lived

Climate Pollutant Strategy" that includes a 40% reduction in HFC gases – along with a 40% decrease in methane and 50% cut in black carbon – by 2030.

"SLCPs [...] are powerful climate forcers that have a dramatic and detrimental effect on air quality, public health, and climate change," the Scoping Plan reads. "These pollutants create a warming influence on the climate that is many times more potent than that of carbon dioxide."

Last March, CARB officially adopted the SLCP Strategy, which proposes to limit use of high-GWP refrigerants and to create an incentive program encouraging use of low-GWP refrigerants. It includes prohibitions on refrigerants with a GWP greater than 150 for new stationary refrigeration equipment containing 50 or more lbs of refrigerant, and refrigerants with a GWP greater than 750 for new stationary air-conditioning equipment holding two or more lbs of refrigerant. The plan also proposes a ban on production of refrigerants with a GWP of 2,500 or greater, and, by 2024, refrigerants with a GWP of 1,500 or greater.

CARB will hold public workshops and stakeholder meetings on the SLCP Strategy measures through summer 2018, with a potential effective date for regulations around mid-2019.

In order to meet the state's 2030 HFC target, CARB is relying on, not only state, but also national and international HFC-reduction policies. The last refers to the Kigali Amendment to the Montreal Protocol – which recently passed the 20-party ratification threshold needed to enter into effect January 1, 2019.



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Glenn Gallagher, air
pollution specialist, CARB

▶ On a national level, California was depending on the Environmental Protection Agency's HFC delisting rules under its Significant New Alternatives Policy (SNAP). However, last August a federal appeals court ruling invalidated those rules. (The rules are still in effect pending appeals.) In response, CARB began the process of adopting similar measures as state law. (See ["CARB Launches Rulemaking for EPA SNAP Rules, Accelerate America, October 2017."](#))

CARB also recognizes that "regulatory monitoring, reporting, verification and implementation methodology" will be necessary in order to enforce the prohibitions on high-GWP HFCs and implementation of the EPA's SNAP program.

When it comes to the long-term timeline for the SLCP Strategy and reduction of GHGs, the Scoping Plan notes that, "once GHGs are emitted into the atmosphere, they can have long lifetimes that contribute to global warming for decades. Policies that reduce both cumulative GHG emissions and achieve the single-year 2030 target provide the most effective path to reducing climate change impacts. A cumulative construct provides a more complete way to evaluate the effectiveness of any measure over time, instead of just considering a snapshot for a single year."

CAP-AND-TRADE PROGRAM EFFECTIVENESS

An effective tool that California has employed to decrease GHG emissions has been its cap-and-trade program.

The five-year-old program puts a limit on total allowable emissions and allows non-polluting businesses to sell credits earned for low-emissions to businesses that exceed allowable emissions. The credits are under consideration for use in an incentives program that would fund environmentally friendly initiatives in disadvantaged communities.

"Continuing the cap-and-trade program through 2030 will provide the most secure, reliable, and feasible clean energy future for California – one that will continue to deliver crucial investments to improve the quality of life and the environment in disadvantaged communities," the Scoping Plan said.

Recently, the Canadian provinces of Quebec and Ontario linked up with California's cap-and-trade program. The linkage is the first of what CARB hopes could support more national and international partnerships.

High compliance rates with the cap-and-trade program also demonstrate that "the infrastructure and implementation features of the program are effective and understood by the regulated community," the Scoping Plan said.



INCREASING ENERGY-EFFICIENCY

Another pillar of California's Scoping Plan is the push to increase energy efficiency and renewable energy across sectors.

According to the Scoping Plan, California's climate policies and programs have already delivered emissions reductions resulting from cleaner, more fuel-efficient cars and zero emission vehicles (ZEVs), low carbon fuels, increased renewable energy, and improved energy efficiency of homes and businesses.

The state plans to move to 50% renewable electricity, set annual targets for statewide energy-efficiency savings and demand reduction that will achieve a cumulative doubling of statewide energy efficiency savings in electricity and natural gas end uses by 2030.

The Scoping Plan estimates a nearly 64-MMTCO₂e emissions reduction via regulations that address energy-efficiency in residential, commercial and industrial agriculture sectors.

"Emissions from the electricity sector are currently approximately 20% below 1990 levels and are well on their way to achieving deeper emissions cuts by 2030," the plan reads.

Utilities companies in California, such as the Sacramento Municipal Utility District (SMUD), have been offering incentives for energy-efficient programs for decades – something the Scoping Plan recognizes as an important factor in reducing GHG emissions in the electricity sector.

The Scoping Plan also called for expanding the state's Low-Income Weatherization Program (LIWP) "to continue to improve energy efficiency and weatherize existing residential buildings, particularly for low-income individuals and households."

The plan noted that further workshops and stakeholder meetings will likely take place in order to explore the potential of technologies like "high efficiency air conditioners, light-emitting diode (LED) lamps, and efficiency improvements in industrial process cooling and refrigeration." ■ EH

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UNIDO HELPS MEXICO DESTROY ODS

The country was able to eliminate stockpiles of ozone-depleting and climate-warming gases for the first time

— By Michael Garry



The United Nations Industrial Development Organization (UNIDO) has collaborated with the governments of Mexico and France to implement a demonstration project for the destruction of ozone-depleting substances (ODS) such as CFCs and HCFCs.

The program, supported by \$1.4 million from the Multilateral Fund for the Implementation of the Montreal Protocol, was described in an article last November by Danilo De Oliveira Pereira on UNIDO's website, unido.org. The stockpiling of ODS is a result of the phase-out orchestrated by the Montreal Protocol beginning in 1987.

The project "encouraged the first Mexican facilities to obtain the necessary authorizations to destroy ODS, allowing the substances to be destroyed in the country for the first time," wrote De Oliveira Pereira. It resulted in the destruction of 113 metric tons of ODS, the equivalent to the CO₂ emissions generated by 140,000 vehicles in one year.

He quoted Riccardo Savigliano, industrial development officer at UNIDO as saying that "The project proved that with solid technical assistance and access to the necessary funding, developing countries can develop the technology to destroy ODS."

To comply with national and international standards, UNIDO identified a list of requirements for transporting ODS, and trained technicians in the ODS collection and transportation process. The organization also instructed customs and other officials on dealing with the illegal trade of ODS.

A CHALLENGE FOR DEVELOPING COUNTRIES

De Oliveira Pereira pointed out that the process of phasing out ODS "can represent a challenge for many developing countries

which may not have the technical capacities necessary to safely collect, transport and destroy these substances."

As a result, "extremely large amounts of [ODS] gases," which also have a high GWP, remain improperly stored in several countries. Often countries holding large amounts of ODS banks "have to send these gases to developed countries where they can be destroyed," he said.

This was the situation in Mexico, where "unwanted ODS banks have been stockpiled for a long time." De Oliveira Pereira quoted Agustín Sánchez Guevara, coordinator of Mexico's Ozone Unit, as saying that some owners of contaminated ODS in Mexico "shipped them to the United States for destruction under a voluntary carbon market scheme."

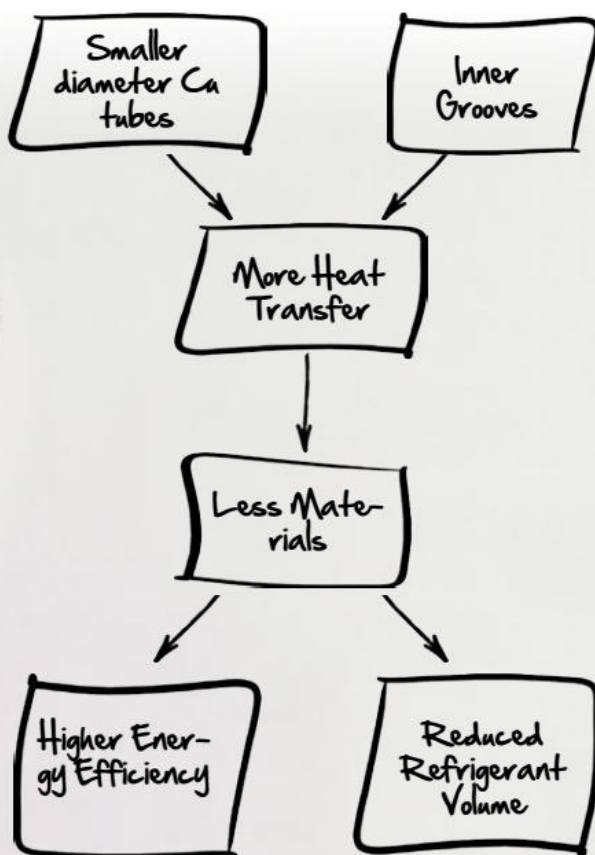
But exporting ODS to the U.S. is complicated. Classified in Mexico as hazardous wastes, ODS have to be consolidated, transported and handled by fully certified companies. Most importantly, collecting, transporting and destroying ODS "is a difficult and dangerous process," said De Oliveira Pereira. "Gases can leak from storage containers and equipment during transport or destruction." This underscores the importance of the successful UNIDO project to destroy ODS in Mexico.

Following the project's success, UNIDO organized a series of events "in order to share project outcomes and lessons learned, and to transfer results, including a study tour with representatives from several Latin American countries."

Latin American countries will now have an opportunity to export ODS to Mexico and reduce their costs in dealing with the substances, as well as "attempt to reproduce the efforts made in Mexico and start destroying ODS," said Savigliano.

■ MG

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HOT WATER, COURTESY OF CO₂

Natural refrigerants enter the North American domestic market as apartment buildings in Seattle and elsewhere install Sanden's CO₂ heat pump water heater

— By Michael Garry



Charlie Rogers,
City of Seattle's Office of
Housing, with a Sanden CO₂
heat pump water heater

Photography by
David Ryder

Over the past decade, as natural refrigerants – CO₂, ammonia and hydrocarbons – have emerged in North America, they have been increasingly used in commercial and industrial applications like supermarket display cases, vending machines and cold storage warehouses.

On the other hand, household appliances – refrigerators, air conditioners and heat pumps – have largely not yet made the transition to naturals in North America, though they have elsewhere in the world.

But that scenario appears to be changing.

For example, The Association of Home Appliance Manufacturers (AHAM) is expecting a transition in domestic refrigerators and air conditioners to hydrocarbon refrigerants. (See [“Are Home Fridges in U.S. Turning Toward Hydrocarbons?” Accelerate America, November-December 2017.](#))

And change is coming now to the heat pump water heater market. Sanden, a major Japanese manufacturer, is marketing its CO₂-based SANCO₂ domestic heat pump water heater, which extracts heat from the outside air, in the North American market. The system has been widely adopted in Japan as well as in Europe and Australia.

Introduced in North America in August 2016, the SANCO₂ units have been approved by ETL (Electrical Testing Laboratories). The Environmental Protection Agency allows CO₂ to be used in heat pumps designed for heating water (but not space heating).

The original CO₂ heat pump water heater – dubbed the Eco Cute – debuted in Japan around 2001. Today several companies, including Sanden, Mitsubishi, Fujitsu, Panasonic and Daikin, market a similar product in Japan, selling about 500,000 units annually, out of a total of three million domestic water heaters (including 2.3 million gas-driven units), according to John Miles, general manager for Eco Systems, Sanden International (USA), based in Plymouth, Mich.

In the U.S., he added, 8 million water heaters are sold annually, including 3.9 million electric-resistance and 4.1 million gas units. The market also includes 70,000 to 80,000 heat pump water heaters, using mostly R134A.

In North America, the Sanden CO₂ unit faces some headwinds. The first cost of the unit is higher than that of electric-resistance, gas and HFC refrigerant heat pump water heaters. Operating costs for gas water heaters may be tough to compete against because of low gas prices (though not all areas receive gas distribution). And the water heater market in the U.S. is a traditional one, so it's hard for a new product like Sanden's to penetrate, noted Miles. “The [first] cost and the uniqueness of the product make it difficult.”

But the CO₂ unit is a climate-friendly system, and Sanden is positioning it as a more efficient – and less costly to operate – alternative, particularly in the “green early adopter market,” said Miles. Among its early adopters are grant-supported low-income housing developers.

With its much-greater efficiency, the Sanden CO₂ units “could replace electric water heaters in the U.S.,” said Miles. He puts a three-to-four-year payback on the cost premium of a Sanden unit that replaces an electric unit at

FOCUS ON ENERGY COSTS

In the U.S., the Sanden unit caught the eye of Charlie Rogers, property rehabilitation specialist for the HomeWise Weatherization Program, part of the City of Seattle's Office of Housing.

HomeWise, which receives funding from local, state and federal sources (including the U.S. Department of Energy and the Bonneville Power Administration), focuses on reducing the energy burden and utility costs for low-income households.

Rogers and his team collaborate with the nonprofit owners of these housing developments to make upgrades. “We go to sites and conduct energy audits,” said Rogers. The audits include an assessment of mechanical systems like space heating, lighting, and water heating, followed by recommendations for energy-efficiency improvements.

Using energy-modeling software, HomeWise calculates grants for low-income housing providers to cover the cost of the enhancements. “Our grants are a function of cost effectiveness and energy savings,” said Rogers. “The more energy saved, the larger the grant.” He requires a “savings-to-investment ratio” of one or more for any grant to be awarded.

The nonprofits regard the HomeWise agreement “as a way to help pay for rehabilitation costs, [maintain] their properties, and reduce the energy burden on their clients,” Rogers said. 

▶ Rogers, who has been with the City of Seattle for two years, previously ran his own consulting firm doing third-party home comfort and energy inspections for eight years. So he finds the work he is doing now – designing energy efficient solutions for low-income housing developments – personally fulfilling.

He noted that grant programs for low-income-housing energy improvements exist in municipalities throughout the U.S. He suggested that contractors or building owners look for funding at the city or county level. “A lot of times it’s a non-profit that administers the grant funds,” he said. “We’re a little unique in that we’re housed in a city [agency].”

HomeWise determined that 24 low-rise town homes in six buildings at the Kingway Apartments in Seattle, owned by Bellwether, were a good fit for the Sanden heat pump water heaters, with a savings-to-investment ration determined to be 1.05.

Each of the homes comprises large households, averaging six people, and requires a large amount of hot water. The Sanden system mixes cold water with the hot water to bring the temperature down from one of three settings – 130°F, 150°F or 170°F – to “a safe 120°F, which is what the tenant sees,” said Rogers.

HomeWise thought Sanden was a good technology in part because of its high heat-recovery rate – much higher than that of a heat pump using R410A, said Rogers. The unit has a first-hour rating of 97.8 and a water-heating rate of 0.31 gallons/min, 50°F in, 150°F out.

“It refills the tank with hot water very quickly, and I wanted something that without question would provide hot water when the occupants needed it,” Rogers said.

According to Miles, the Sanden unit’s first hour rating “is the highest for all heat pump water heaters because of the ability of CO₂ refrigerant to lift the water temperature.”

After learning about the Sanden CO₂ heat pump water heater, Rogers realized that “none of our contractors had installed it.” So he organized a training session and “invited everyone we could.” Miles, who was brought in as the trainer, was able to “get our contractors comfortable and knowledgeable on how to do installations.” He selected Resicon, Tacoma, Wash., as the contractor for Kingway.

Craig Christensen, the owner of Resicon, said the installation of the Sanden units was more challenging than typical heat pump water heaters because of the need to install two separate components, water lines and a mixing valve. He also put a Sanden unit in his own home. “It is working quite well, even through freezing weather,” he said.

Previously, each of the 24 apartments at Kingway Apartments used a dedicated electric-resistance water heater, which was replaced by a Sanden unit. The Sanden installations began last summer and were completed in December. Fewer Sanden units could have been used, but “there was no easy way to do that because of the way the previous unit were metered,” said Rogers.

In addition to the heat pump water heaters, Resicon installed ductless heat pumps (using an R410A refrigerant) for space heating and added upgrades to lighting, insulation and air sealing; all equipment costs were covered by the program.

Bellwether Housing, the owner of Kingway Apartments, “has always looked for opportunities to upgrade our systems to be more energy efficient and better performing,” said Martin Gleaves, senior facilities manager for Bellwether. ▶



Town homes at Kingway Apartments, Seattle

Seattle location of the
installation of CO₂ heat
pump water heaters





1 /

► Its partnership with HomeWise offered an opportunity to “remove inefficient [water heater] equipment prior to failure and replace it with the best option based on energy usage and maintenance savings.”

Given that water heaters tend to only get noticed when they don’t work well, “Sanden’s must be working great because to date I have not heard a word from our tenants,” he added.

OTHER BENEFITS

The Sanden unit’s split configuration – the heat pump is located outside and connected to a 43-gallon water tank inside in a small closet underneath a staircase – also suited it to the design of the Kingway town homes.

A traditional HFC-based heat pump water heater positions the compressor on top of the tank inside the building, requiring a certain volume of surrounding air to operate effectively. A small closet would have to be fitted with a duct or passive grill to bring more air

in. “It gets complicated,” said Rogers. “It’s doable but not easy.” In addition, the compressor makes noise while the evaporator generates cold air that would need to be ducted to the outside. Moreover, an inside installation could result in increased energy use from the interaction between the heat pump water heater and space heating equipment.

Ultimately, the biggest benefit of the Sanden unit is its energy efficiency compared to the previous equipment. Rogers calculated that the 24 heat pump water heaters at the Kingway Apartments would save 81,500 kWh per year compared to the previous electric resistance water heaters. “That equates to about \$300 per year in avoided electric bill costs for each family,” said Rogers, though some of the families had already cut their utility costs through a program administered by Seattle City Light.

All the energy-cost savings is accrued by the tenants. “The owner isn’t seeing that but is getting lower maintenance

costs,” Rogers said.

He applied an energy factor (EF) of 2.9 for the Sanden unit, compared to an EF of 1.0 for an electric-resistance unit. “So Sanden should be using about one-third as much energy, a huge savings,” he noted.

Rogers derived the 2.9 EF from a study done by the Bonneville Power Administration and Washington State University Energy Extension showing that the Sanden heat pump water heater provides an average EF of 2.9 in Seattle’s climate. According to the Northwest Energy Efficiency Alliance’s qualified product list, Sanden’s models range from 2.9 to 3.3, which are comparable to HFC heat pump water heaters.

Sanden rates its heat pump water heater to a maximum of 3.84 EF, compared to 3.0 for an HFC heat pump, 0.95 for an electric-resistance water heater, 0.95 for a tankless gas water heater and 0.67 for a gas storage model. (Miles noted that the Sanden unit has a slightly lower EF at lower ambient temperatures and



2 /

3 /



1 / & 2 / Sanden CO₂ heat pump water heater

3 / Charlie Rogers at Kingway Apartments, Seattle

with the smaller, 43-gallon tank.) The Sanden unit has a maximum COP of 5.2. "The more hot water used, the more efficient [the Sanden unit] becomes," said Miles.

Rogers noted that with above-average hot-water use, "it's possible that the [HFC] R410 system EF would drop significantly, given that those systems have lower [heat] recovery rates and begin to use electric resistance heat when the compressor can't keep up with demand."

By contrast, the Sanden unit "has very high recovery rates and doesn't even have electric-resistant back-up heat, so we can feel more certain about its performance."

Rogers pointed out other aspects of the Sanden unit that motivated him to install it. For example, all of its heat pump equipment is contained in the outdoor equipment, which results in much less risk of installer error.

In addition, the Sanden unit is factory-built, so "the chances for refrigerant

leaks [due to faulty installation] are much lower," he said. Cleaning the system would only be necessary if got clogged by outside vegetation.

Another advantage of the Sanden unit, he said, is the durability of its tank, which is made of glass-lined stainless steel. "There's not as much corrosion so the tanks should last a long time," he said.

"I think the system should be much more durable and have less maintenance issues" than other water heaters, he said, noting that there is no need to change out electric-resistance elements. "And water is the only thing flowing besides electricity. That's really nice."

One challenge associated with the Sanden system, Rogers acknowledged, is its higher cost. The price of a Sanden unit was about \$3,000 (\$5,500 with everything included), about twice that of a standard water heater, he said. "But in this application, with very large family sizes, so much hot water use and much

greater energy savings, we were able to justify the cost." Part of what drove up the cost, he noted, is the need for both plumbing and electrical work in the installation.

NEW PROJECTS

Rogers is working on two new Sanden water heater installations, both at low-rise, low-income Seattle apartment dwellings with large family sizes, similar to Kingway Apartments. One is at Croft Place, a 21-unit, mostly duplex, building, owned by Delridge Neighborhoods Development Association; the other, Cedarvale Village, a 24-unit structure owned by the Seattle Housing Authority (which is separate from the city).

As at Kingway, the Sanden heat pump water heaters will replace electric resistance water heaters in both communities. Rogers estimates a May 2018 completion date for the Croft Place project while he is hoping to finish the Cedarvale work by September 2018. HomeWise grants will pay the full cost of both projects.

System Specs

SANDEN SANCO₂ HEAT PUMP WATER HEATER

- ▶ Capacity of outdoor heat pump: 4.5 kW (15.4 KBTU/hr)
- ▶ Heats water up to 175°F
- ▶ Ambient air operating temperature range: -20°F to 110°F
- ▶ Indoor water tank: 43 or 83 gallons
- ▶ Maximum COP: 5.2
- ▶ First-hour rating: 97.8
- ▶ Heating rate: 0.31 gallons/min, 50°F in, 150°F out

▶ “For our program, that’s the niche for these systems,” Rogers said, adding that neither large apartment buildings, nor small-family single homes would be as cost-effective.

HomeWise has also looked into replacing gas-driven water heaters in an apartment building with the Sanden unit, but found the energy argument less persuasive. That’s because mid- to high-rise apartment buildings require recirculation pumps to continually push warm water throughout the building to ensure that no one will need to wait after turning on a hot-water faucet. And “Sanden doesn’t like to see warm water come back to it; the efficiency drops,” said Rogers. “It really wants to see cold water and have temperature stratification in the tank.” However, he expects that this issue can be “worked around.”

In fact, Mercy Housing, a Denver, Colo.-based non-profit housing developer, last year installed multiple Sanden units as a replacement for gas-powered hot water heaters in six California buildings, as part of an overall efficiency upgrade. The buildings use recirculation pumps, which reduces the COP of the Sanden units to about three, similar to that of a gas water heater, said Caitlin Rood, Mercy Housing’s environmental sustainability director. So rather than efficiency, the switch from gas to the electric heat pumps was driven by grants based on reducing greenhouse gas (GHG) emissions produced by natural gas.

While replacing a gas-based water heater with a CO₂-based heat pump results in a major reduction in GHG generation, the HomeWise program only counts energy savings. “The CO₂ [refrigerant] was the cherry on top,” Rogers said. “I personally really like it. But in terms of how our program views it, there’s no incentive for [GHG saving].”

Rogers is working on getting solar panels installed in some projects using grant funds from the state of Washington. However, he does not consider the Sanden installations a good candidate because they lack sufficient roof space, but he doesn’t rule it out.

“We have no plans for solar on any buildings with Sanden units, but if the opportunity presents itself where there are buildings that are a good candidate for both, I would propose that,” he said. HomeWise would fund about one-third of the cost of solar panels. ■ MG

Sanden’s 43-gallon hot water tank, located inside a town home



DEREK'S NEW CO₂ WATER HEATER

Derek Hamilton, *Accelerate America's* vice president of business development and technical editor, is installing a Sanden SANCO₂ heat pump water heater in his home in Portland, Ore. The installation will be part of a contractor training video being produced by the Northwest Energy Efficiency Alliance (NEEA). Both Hamilton and NEEA hope that his home installation will inspire others to follow suit. Here's what he had to say about his decision to install the CO₂-based heat pump water heater.

Accelerate America: Why are you installing the SANCO₂ heat pump?

Derek Hamilton: I've been making some improvements to my house and at the moment the water heater is an electric resistance model, so I wanted to upgrade to a more energy-efficient alternative. When I did some research I realized that the CO₂ system was the most efficient on the market.

AA: When do you think it will be installed?

DH: We're looking at installing it in January sometime.

AA: What is the difference in energy-efficiency when you compare the old electric water heater with the new, CO₂-based heat pump?

DH: In broad terms, with an electric water heater you pay something in the region of \$1 per 100 gallons of hot water that you produce. When I move to the Sanden unit, I'll be paying something like \$0.70 per 100 gallons – so it's a really big reduction in water heating costs. The heat pump will more than pay for itself over its lifetime.

Sanden has a very clever, yet simple, design and control system, which ensures that the heat pump always runs at peak efficiency. And, aside from the low running costs, it also makes sense from an environmental perspective. Using a heat pump avoids any direct fossil fuel use (such as burning natural gas), and the fact that the heat pump uses CO₂ as its working fluid means I can avoid an HFC-based system.

AA: You met with NEEA to talk about the installation video they are going to film at your house. Why is NEEA interested in the heat pump?

DH: NEEA is interested in promoting energy-efficient products so they have been working with Sanden and looking at ways to promote the water heating system. NEEA is supporting Sanden because it's such an efficient system. There are many water heaters in the region, and one unit is a relatively small energy-consumer, but if you start talking about the millions of units that are out there it can make a measurable difference to overall carbon emissions from electricity production.

– Elise Herron

REASSURING CONTRACTORS

One of the key hurdles to introducing a new technology to the North American market is training contractors on its installation and maintenance.

Thus, the Japanese manufacturer Sanden has focused on training contractors – its main distribution conduit – on installing and maintaining its SANCO₂ CO₂-based heat pumps water heaters.

At a December 4 training for contractors at Gensco in Vancouver, Wash., local contractors raised some concerns about the CO₂-based Sanden systems, including whether, given their higher pressures, they were safe to install and service, and what the warranty terms for the new equipment would be.

John Miles, general manager for Eco Systems, Sanden International (USA), assured the group that the factory-sealed SANCO₂ heat pumps don't require any prior experience with CO₂ to install; the only connection to consider is the water line.

"You don't need to know anything about CO₂ other than it's a great fluid for doing the job that it does," Miles said.

Sanden gives contractors a three-year labor, 10-year parts and 15-year tank warranty. "If it develops a problem in the refrigeration circuit, we replace the system," said Miles, adding that most contractors "want to install it and move on."

The units' upfront cost was the biggest barrier to uptake recognized by contractors at the training, though they acknowledge that there would be substantial energy savings in the long run. Most agreed that an incentives program could be key for the technology to take root in the Pacific Northwest.

In Oregon, Gensco's outside sales representative, Stew Mercer, has been pushing the utility company Portland General Electric to incentivize installation of the SANCO₂ units.

Portland-based Northwest Energy Efficiency Alliance (NEEA), a nonprofit working to accelerate the adoption of energy-efficient technology, is planning to produce an installation training video to educate contractors on Sanden's SANCO₂ heat pumps.

"We recognize that water heat pumps represent a significant savings opportunity with regards to energy," said Kyle Stuart, NEEA's marketing manager.

One hundred and forty utility companies in four Northwest states fund NEEA, which helps connect consumers with rebates and incentives. It's too early to tell if the SANCO₂ unit will be incentivized by any of those utilities companies; meanwhile, NEEA is focused on educating and familiarizing contractors with the new technology.

– Elise Herron



AHR EXPO PREVIEW

Here's what some key companies will be exhibiting at the AHR Expo

— By Elise Herron and Michael Garry

The 2018 AHR Expo (short for International Air Conditioning, Heating, Refrigerating Exposition) — to be held Jan. 22-24, 2018 at McCormick Place, Chicago, concurrently with ASHRAE's Winter Conference — is one of the largest HVAC&R trade shows in the world.

Now in its 88th year, the AHR Expo, co-sponsored by ASHRAE and AHRI, will encompass 2,000+ exhibitors, including many that market natural refrigerant systems. It will feature 100+ seminar and product presentations, including a number relating to natural refrigerants. And it will attract more than 65,000 attendees, including contractors, engineers, facility managers, distributors, OEMs and other HVACR industry professionals.

Here's a look at what some companies involved with natural refrigerants will be showcasing at the Expo.

Embraco, booth 2524

At this year's expo, the Brazil-based manufacturer will be showcasing two hydrocarbon compressors and a "Plug n' Cool" R290 reach-in freezer and refrigerator solution.

The FMFT Bivolt is an R290-based compressor that employs variable-speed technology and is engineered for light commercial applications. The FMX compressor, alternatively, utilizes a new Fullmotion Inverter (variable-speed) technology. The FMX, which utilizes R600a (isobutane), is compact, low-noise, provides a wide voltage range and is built for freezers with built-in energy-efficiency cooling systems.

The R290-based Plug n' Cool is a self-contained condensing unit marketed for grocery and convenient stores and commercial kitchens. The cooler meets Environmental Protection Agency (EPA) and

Department of Energy (DOE) regulations and is also compliant with the EPA GreenChill program.

Munters, booth 6900

Texas-based Munters plans to display its DryCool EVR-Focus, a dedicated outdoor air system (DOAS). The DOAS combines desiccant dehumidification with energy recovery; the features new to this design include: a smaller footprint, easier maintenance, a higher dew-point option with greater controls strategy, and upgraded efficiency features.

Dorin, booth 4649

At AHR Expo this year the Italian-based manufacturer is planning to bring its inaugural compressor for transcritical applications, Series CD500. The CO₂ semi-hermetic compressor is one of the largest compressors on the market for transcritical use.

Sanden, booth 7565

Japan-based company Sanden will be displaying its SANCO₂, CO₂-based heat pump water heaters, which have recently been introduced to the U.S. market. The units are ETL (Electrical Testing Laboratories)-approved. According to Sanden, they are up to four times more energy-efficient than electric water heaters, and more efficient than conventional heat pump water heaters — which typically run on either R410A or R134a.

KeepRite, booth 3118

This year the manufacturer will be unveiling new KEP Extended Profile Evaporators. The KEP Extended Profile line features internally enhanced tubing and SmartSpeed technology. They're also compatible with low-GWP refrigerants, have high-efficiency and high-strength fan guards, ample electrical and header compartments, and are UL-certified.

1 / Embraco's Plug n' Cool R290 condensing unit

2 / ebm-papst AxiBlade axial fan



1 /

2 /



Emerson, booth 5310

At AHRI 2018, St. Louis-based Emerson's refrigeration and cold chain teams will feature the refrigeration, controls, monitoring and service solutions available through its distribution network and supported by trained contractors for use in grocery retail, convenience stores, foodservice, distribution and transportation applications. The primary areas of focus will be:

- ▶ Copeland low- and medium-temperature refrigeration systems, plus compact condensing units for foodservice applications.
- ▶ Copeland natural refrigeration systems optimized for grocery and food processing facilities.
- ▶ Emerson supervisory control systems engineered to support efficient refrigeration and facility management in grocery, foodservice and other retail applications.
- ▶ Emerson ProAct apps, insights and management services that help operators improve results across their enterprises.
- ▶ Transformative Wave rooftop unit controls, which help improve energy efficiency.
- ▶ In-booth Emerson E360 educational sessions exploring IoT in facility management and the latest in energy and refrigerant regulations.

In the cooling category, Emerson won an Innovation Award for its Copeland Scroll two-stage compressor, covering from one to 10 TR. The compressor is a third-generation technology that was redesigned for more performance and reliability in residential and commercial air conditioning systems. The Copeland Scroll offers up to 5% greater full-load and part-load performance.

ebm-papst, booth 2119

Farmington, Conn.-based ebm-papst will be highlighting the following products aimed for the use in the refrigeration market at the AHR Expo:

– BUS-enabled EC fan assemblies for use in display case and bottle cooler applications, which take full advantage of the "Internet of Things" with BUS communication for

evaporator and condenser fans. BUS communication provides control of fan operation and can enhance energy savings and refrigeration performance and limit downtime. In addition, these fan assemblies are compatible with hydrocarbon refrigerants.

▶ Refrigeration controls. ebm-papst is able to now provide controls for refrigeration equipment.

▶ AxiBlade rooftop condenser fans. ebm-papst's new fan design significantly reduces energy consumption and at the same time lowers operating noise. The AxiBlade line is backward compatible to the existing AC and EC product line.

▶ Evaporator fan assemblies. The AxiCool product line-up is designed for the needs of walk-in cooler freezers and cold storage room applications.



▶ The S1G305 series fan for the most common 12-inch-diameter walk-in cooler and freezer evaporators. The fan assembly is designed for quick installation, and the EC motor makes it eligible for local utility company rebates.

Carel, booth 5377

Italian component maker Carel offers a number of products supporting natural refrigerants, such as its EmJ modulating ejector that improves the efficiency of transcritical CO₂ systems. "This solution makes CO₂ efficient in warmer climates," said Lisa Murray, Carel's head of sales North America, Refrigerated Retail.

The continuous modulation ensured by the ejector allows the system to "continuously adapt to the typical variations in operating conditions," said Carel on its website.

The use of modulating ejectors, in concert with Carel's pRack pR300T compressor rack controller, allows integrated and synchronized management of all the transcritical rack's components.

Carel will also showcase the Heos water-loop system, which can accommodate CO₂ and propane. This includes a controller that manages individual display cases, a DC technology compressor, an electronic expansion valve and dashboards. ■ EH & MG

AHR EXPO BY THE NUMBERS

- 88th year
- 2,000+ exhibitors
- 100+ seminar and product presentations
- 65,000 attendees

RELEVANT SESSIONS

Among the AHR Expo seminars relating to natural refrigerants are the following:

▶ New ASHRAE-Classified Refrigerants to Meet Society's Changing Needs; speaker, Thomas Leck, ASHRAE; Sunday, January 21, 3:30 pm – 6:30 pm; S105D

▶ Global Trends in HVAC; speakers, Raphael Chalogany, Krystyna Dawson, Julia Evans, Lone Hansen and Anette Meyer Holley, all of BSRIA; Monday and Tuesday, January 22 and 23, 8:00 am – 10 am; S102BC

▶ Hydrocarbons as Refrigerants and Alternatives to HFCs; speaker, Arthur Miller, KAM Associates; Monday, January 22, 8 am – 12:00 pm; S103D

▶ Low-GWP Alternative Refrigerants for Cooling Applications – Skills, Needs, Gaps and Solutions; speakers, Marco Buoni, AREA Association of European Contractors and ATF Training; Graeme Maidment, London South Bank University and IOR; and Miriam Rodway, IOR; Monday, January 22, 10:00 am – 12:00 pm; S102A

▶ Some Low-GWP Next-Generation Refrigerant will be Flammable: What does it mean to be Flammable?; speakers, Matt Guernsey, Navigant; Stephen Kujak, Trane,

Ingersoll Rand; Gregory Linteris, National Institute of Standards and Technology; and Xudong Wang, AHRI; Monday, January 22, 1:00 pm – 2:30 pm; S101B

▶ Transcritical CO₂ Condensing Unit, Driven by DC Inverter Technology; speaker, Brandon Marshall, Carel Industries; Monday, January 22, 3:55 pm – 4:15 pm; Theater C

▶ Cooling Tower Fundamentals; speaker, Kent Marten, SPX Cooling Technologies; Monday, January 22, 2:00 pm – 3:00 pm; S104A

▶ Using Artificial Intelligence to Help Contractors "Get Savvy" in Their Service Business; speaker, Tom D'Amico, Coolfront Technologies

▶ Danfoss Oil-Free Application Solutions; speaker, Drew Turner, Danfoss; Monday, January 22, 3:45 pm – 4:05 pm; Theater B

▶ Closing the Loop – Which Method is Best for Your Heat Rejection System?; speaker, Benjamin Cohen, Baltimore Air Coil; Tuesday, January 23, 8:30 am – 9:30 am; S103D

▶ Danfoss Turbocor High Lift Compressors for Optimized Chiller Applications; Tuesday, January 23, 10:45 am – 11:05 am, Theater A

▶ Bridging the Gap: Protecting a Supermarket's Fresh Food During a Power Outage; speaker, Scott Wehun, Econofrost Night Covers; Tuesday, January 23, 2:05 pm – 2:25 pm; Theater C

▶ Mechanical Equipment Room Safety: MSA Chillgard 5000 Refrigerant Leak Detection; speaker, Natalie Silva, MSA – The Safety Company; Tuesday, January 23, 2:45 pm – 3:05 pm; Theater B

▶ Use and Benefits of a Good Filter Drier in an ACR System; speaker, Vikash Sekhani, Dry All; Tuesday, January 23, 3:05 pm – 3:25 pm; Theater C

▶ Remove the Scavenger Hunt from HVAC/R Service Appointments; speaker, Billy Marshall, ServiceTrade; Tuesday, January 23, 3:35 pm – 3:55 pm; Theater C

▶ Utilizing Variable Frequency Drives; speaker Tom Lowery, Schneider Electric; Tuesday, January 23, 4:00 pm – 5:00 pm; S101B

▶ Wireless Monitoring of Refrigerant Pressure & Temperature – Technical Breakthrough; speaker, Chris Gamm, Transducers Direct; Tuesday, January 23, 4:05 pm – 4:25 pm; Theater C

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AN ANGIE'S LIST FOR NATREF CONTRACTORS

NASRC has devised an online network to connect end users and contractors with natural refrigerant experience

– By Elise Herron



Danielle Wright, NASRC

Natural refrigerant-based technology is gaining traction in North America, but for some end users it's still difficult to find qualified contractors and technicians for installation, start-up and maintenance.

To address that challenge, the North American Sustainable Refrigeration Council (NASRC), Mill Valley, Calif., has created the Natural Refrigerants Service Network – a free online directory where end users can find contractors with natural refrigerants know-how, and contractors can post their experience.

The network website (www.NASRC-Network.org) was launched to a small group of contractors for beta testing in September and is now fully launched for public use. NASRC is currently building out the network by recruiting qualified contractors.

The idea for the network came about when beverage giant Red Bull approached NASRC in search of technicians that had experience in servicing hydrocarbon equipment.

"We heard from end users that finding qualified service contractors is a major concern in choosing natural refrigerant-based equipment and systems," said Danielle Wright, executive director for NASRC. "The perception is they won't be able to find someone to maintain or repair the system when it goes down, and this prevents them from even piloting natural refrigerant technologies in the first place. We realized a platform was needed to connect end users searching for natural refrigerant service and contractors with the expertise."

Red Bull's request provided the inspiration NASRC needed to launch the service

network website, and Wright says Red Bull has remained a key advisor throughout the website creation process.

HOW IT WORKS

The network offers end users free access to a directory, where they can search for a contractor by location and natural refrigerant type. Contractor profiles will include refrigerant specialties, qualifications and examples of natural refrigerant projects.

"It's easy and free for contractors to create a profile," Wright explained. "They select their areas of expertise with CO₂, ammonia and hydrocarbons, and have the option to list their service areas by county, state, ZIP code and city. That becomes a searchable database for end users or others looking for expertise in natural refrigerants."

So far around a dozen contractors have obtained listings, including Source Refrigeration, Key Mechanical, and Professional HVAC/R Services. Wright said that NASRC plans to expand the site beyond the directory to include natural refrigerant events, a resource center, and a place for contractors to post job opportunities.

"The first stage is to populate the site with contractors that have experience with natural refrigerants," she said. "Then we will focus on filling the service gaps across North America."

"Ultimately, we hope the site will serve not only as a comprehensive network of skilled contractors but also as a platform for natural refrigerant resources and training opportunities that will drive an increase in the number of experienced contractors."

■ EH

ARF TAPS MILITARY FOR TECHNICIAN APPRENTICESHIPS

Vets and military personnel often have the skill set for ammonia technician jobs

— By Elise Herron and Michael Garry



Lois O'Connor, ARF

Here's one solution to the pervasive shortage of technicians in the HVAC&R industry: recruit from the military.

In addition to being "the right thing to do," hiring current or former military personnel makes business sense because "they have similar skill sets for mechanical work," said Lois O'Connor, executive director of the Ammonia Refrigeration Foundation (ARF), a 12-year-old nonprofit research and training association for the natural refrigeration industry, based in an Alexandria, Va.

Indeed, people from the military are already making their mark in industrial refrigeration. "As I looked around and met people it dawned on me that a lot of people come straight out of the military and into the industry," she noted.

The recruitment of military personnel and veterans has become an important part of an ammonia industry apprenticeship program for refrigeration technicians, launched by ARF last November after being approved by the Department of Labor's Office of Apprenticeship. "[The apprenticeship program] is a win-win for end users, it's what contractors need, and it's good for the industry as a whole," said O'Connor. One company looking for technician recruitment help is Nestlé, which needs to fill 100 refrigeration technician positions, she said. "[Nestlé] had no idea how to tackle that feat and is working with ARF to hire."

The ammonia industry apprenticeship program is tied to national standards for refrigeration industry apprenticeships, which the DOL also approved last November. The standards were developed by ARF in conjunction with International Institute for Ammonia Refrigeration (IIAR), the Refrigerating Engineers Technicians Association (RETA), the Global Cold Chain Alliance (GCCA), Lanier Technical College and Fastport Inc., an employment-software company focused on veterans and those affiliated with the military.

The new standards will provide a basic

structure for an apprenticeship, which participating companies can modify depending on their individual needs. The standards cover everything from administration and qualifications to apprentice responsibilities and wages.

SCHOLARSHIP FUND

As part of its focus on the military, ARF has been building up a scholarship fund and working with the federal government to train transitioning military personnel on their bases. The on-base training is designed to make the transition into appropriate technician apprenticeships seamless.

"We are currently in discussions with several facilities across the USA, and anticipate training programs to begin soon," said O'Connor. "Financial support is key to this effort — it will cost roughly \$5,000 per trainee."

Apprentices with military backgrounds may qualify for additional benefits under the GI Bill and qualify for an additional monthly stipend paid by the Department of Veteran Affairs.

Fastport also helps by partnering with employers willing to recruit military personnel. O'Connor said Fastport is the de-facto "subject matter expert" when it comes to implementing apprenticeships that follow DOL guidelines.

Technician apprentices, she noted, "don't have to be in the military. You can be right out of high school."

ARF held a webinar last year on the apprenticeship program that drew 70 attendees. Based on that interest, O'Connor predicts the program will become a popular and important staple in the ammonia refrigeration industry.

The apprenticeship program's "driving principle," she said, is "helping solve a national crisis in [the shortage of] trained and qualified labor for our industry's membership, while assisting our veterans in transitioning into the civilian workforce in a growing market." ■ EH



Eric Berman of Hillphoenix (right) with AAA Refrigeration Service technicians

TLC FOR TECHS

Gordon Food Service's maintenance manager explains why investing in technicians is the best way to attract and retain them

— By Elise Herron

The technician shortage in the HVAC&R industry is well known. That's why Gordon Food Service, a Grand Rapids, Mich.-based foodservice distributor, is investing heavily in its technicians.

The value of this approach is reflected in a story about the professional growth of a technician shared by Jim Reid, Gordon's maintenance manager, at the RETA conference in Hershey, Pa., September 26-29.

In a whitepaper titled, "Grow, Support & Retain Your Refrigeration Operators: Including Workload Planning," Reid wrote that the young maintenance technician, who was new to the field and did not have much formal training, didn't know he wanted to be a refrigeration technician, but excelled at his job and was looking to expand his knowledge.

"This led him to train with our RETA CIRO-level refrigeration technician and he again started to excel," Reid wrote. "He continued training while also fulfilling his maintenance technician responsibilities, got involved with some of our action teams and completed some electrical training courses provided by our company. Once the opportunity to become a full-time refrigeration technician presented itself, he jumped at the chance and we further supported his development by enrolling him in an ammonia refrigeration school."

This technician has since accepted a position as a second-shift refrigeration operator, trains with others to continue to advance his knowledge and has initiated a few valuable energy-saving ideas for the company's refrigeration systems.

Reid used the story of this young technician to exemplify the many ways in which managers can support and retain their technicians.

"This support can come in many forms, and with the proper planning can be a vital way to ultimately retain your technicians."

He advised "knowing your team members and understanding what challenges, motivates, and excites them. Once you figure out these key components, then you can start laying the groundwork to move the relationship forward."

One avenue is to allow team members to participate in action teams such as a hazmat, safety, emergency response, or energy management. A place on a team can allow a technician to help with the direction of the team. "By allowing them to participate on these teams they can also grow their knowledge base," he said.

Growth can also happen through peer- and cross-training. "A person who is just allowed to take readings on the system might just be the next superstar if they are encouraged and allowed to train and develop with a more experienced and trained operator," he said.

BUDGET FOR REPAIRS AND TRAINING

A key investment a company can make is in the resources needed for repairs. "One way to support our operators is to budget properly to ensure they have the ability to make correct and complete repairs in a timely manner," said Reid.

This budgeting isn't exclusive to repair expenses; it also includes capital planning for equipment additions or replacements.

When funds aren't available for technicians to ensure accurate repairs, Reid writes, they lose the ability to take pride in and ownership over the results that they are producing.

"The band-aid approach only creates doubt in the operator's mind about the safety and integrity of their system," he said.

Another way to avoid "band-aid approaches" is to invest in the ongoing training of technicians. Reid pointed out that there are many contractors and vendors in the industry who are willing to provide training to technicians, and managers who do their homework can find good training at no, or very minimal, cost.

Other training opportunities exist in the form of RETA chapter meetings and conferences and online/home study training programs.

"There are also opportunities to partner with schools who will provide a free seat if you allow them to host a training at your facility," Reid added. "These require minimal investment but the training provided and the networking opportunities are valuable to the technician and the company."

Another way to foster a sense of agency within technicians, is to encourage them to make advancements in energy management.

"Energy management is an area that allows a technician to make an impact on the company as a whole and show what an asset a skilled technician can be to the company," Reid wrote. "When a technician improves the efficiency of the system, the savings can quickly pay off the investment dollars, if any are needed, and keeps giving back from that point on."

Examples of energy management Reid provided include: system adjustments, system upgrades and proper preventative maintenance techniques.

WAGES AND WORKLOAD PLANNING

Fair compensation for jobs performed is another key ingredient for retention. He encourages human resource departments to do a wage survey to ensure that the company's compensation is competitive with the market.

"This information can be used when you have to justify to a general manager why a pay increase might be necessary or be used as a tool to recruit other talent."

When it comes to workload planning, Reid says managers should strive to match equipment availability with required tasks, and assign maintenance work to those whose schedules are best suited to do the work.



And, of course, technician safety must be a major priority. Safety measures include supplying items like personal ammonia monitors, neoprene gloves, full-face respirators, quantitative proper fit testing, and hearing protection.

Also important is making sure that techs have a manager's support when it comes to safety – for example, by creating a buddy system during line openings and repairs.

He pointed out technology that can make the technician's job safer and easier, such as mobile technology that provides on-demand access to critical documents and standard operating procedures for specific pieces of equipment.

"Ultimately we are trying to retain the team members we invest so much into," Reid said. He recognized the unique demands on technicians – odd hours, being on call, traveling, working from home – and argued that providing competitive wages, being flexible about scheduling and investing in team members in various ways is the best way to retain qualified technicians.

"When a team member has the trust and support of management, this can create a work environment that allows a technician to reach their full potential and might make some of the demands of the job a little more tolerable, allowing you to retain the best possible talent." ■ EH

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Silvia Scaldaferrì
silvia.scaldaferrì@shecco.com
 +39 331 961 395

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Michael Garry
michael.garry@shecco.com
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