



OzonAction

# OZONNEWS



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**Multilateral Fund**  
for the Implementation of the Montreal Protocol

A fortnightly electronic news update on ozone and climate protection and the implementation of the Montreal Protocol



## OzonAction Smartphone Application

# WhatGas?

Quickly search for the information you need



- Chemical name
- Chemical formula
- Chemical type
- ASHRAE designation
- Trade names
- HS code •
- CAS number
- UN number
- Montreal Protocol Annex and Control measures
- Ozone depleting potential (ODP)
- Global warming potential (GWP)
- Blend components
- Toxicity and flammability class
- Main uses

Now available for **free** in the Google Play and Apple IOS Store



Scan the QR code or search for “UNEP”, “OzonAction” or “WhatGas?”



## GWP-ODP Calculator SmartPhone Application



The application allow you to easily convert ODP, CO<sub>2</sub>-eq and metric quantities of refrigerants and other chemicals

- Helps in understanding and reporting under the Montreal Protocol (and future commitments under the Kigali Amendment)

- The calculator will automatically perform the conversion between metric tonnes, ODP tonnes and/or CO<sub>2</sub>-equivalent tonnes (or kg) and display the corresponding converted values
- The app includes both single component substances and refrigerant blends
- The components of a mixture and their relative proportions (metric, ODP, CO<sub>2</sub>-eq) are also displayed.

**Available for free from the [Apple IOS store](#) and [Google PlayStore](#)  
Search for “GWP ODP CALC” in the Playstore to install!**



## GLOBAL

### 1. Nations to Agree on Funding for Continued Protection of the Ozone Layer and Reduction of Climate-warming Gases

#### **Joint 11<sup>th</sup> Conference of the Parties to the Vienna Convention and 29<sup>th</sup> Meeting of the Parties to the Montreal Protocol**

**20 – 24 November 2017, ICAO Headquarters, Montreal, Quebec; Canada**

#### **23 & 24 November - High-Level Segment**

14 November 2017 –One year after they reached a landmark agreement (the Kigali Amendment) to phase down climate-warming hydrofluorocarbons (HFCs), the 197 parties to the Montreal Protocol on Substances that Deplete the Ozone Layer and the Vienna Convention for the Protection of the Ozone Layer will meet in Montreal, Canada, to enhance their efforts to protect the ozone layer and to mitigate climate change.

Among the issues the parties will consider are: the funding level for the replenishment of the Multilateral Fund for the Implementation of the Montreal Protocol for the 2018 to 2020 triennium to support developing countries in their efforts to continue the phase-out of ozone-depleting hydrochlorofluorocarbons (HCFCs) and to initiate enabling activities for the phase-down of HFCs.

The parties will also consider other critical issues such as the status of ratification of the Kigali Amendment, energy efficiency in the refrigeration, air conditioning and heat pump sectors, the safety standards relevant to low-global-warming-potential alternatives to ozone depleting substances, and research and systematic observations of the ozone layer, as it is through the observations that scientists can monitor the recovery of the ozone layer and the interaction between ozone and climate.

#### **Ministerial round table discussion**

Environment ministers from around the world will participate in a ministerial round table discussion on the theme “*Montreal Protocol at 30: Identifying future opportunities and priorities*” on 23 November, after the opening of the high-level segment of the meeting at 10:00 a.m.

Ministers Khachik Hakobyan (Armenia), Catherine McKenna (Canada), Meelis Münt (Estonia), Sydney Alexander Samuels Milson (Guatemala), Abdullah Ziyad (Maldives) and Vincent Biruta (Rwanda) will be joined by Head of UN Environment Erik Solheim in the round table discussion that will be moderated by Leyla Acaroglu, UN Environment Champion of the Earth for 2016.

#### **Science panel discussion**

On the same day, from 2:30 p.m. to 4:00 p.m., top scientists from various countries will hold a panel discussion on the theme “*The scientific foundation of the Montreal Protocol: past, present, and future*”.

The discussion will look at the effect of the changing atmospheric composition on the ozone layer; ozone depletion and climate change; and observations and monitoring needs for ozone layer protection and recovery.

### **Ozone Awards 2017**

Every 10 years, the Ozone Secretariat gives awards to individuals and organizations that have demonstrated extraordinary commitment and contribution to the progress and achievements of the Montreal Protocol. The 2017 Ozone Awards ceremony will take place from 6:30 p.m. on the same day.

As the world marks the 30<sup>th</sup> anniversary of the Protocol this year, there is a lot of good news to celebrate. The Protocol has led to the phase-out of more than 99 per cent of nearly 100 ozone-depleting chemicals and significantly contributed to climate change mitigation. As of today, the ozone layer is showing signs of healing and is set to recover by the middle of the century.

In addition, the Protocol has contributed significantly to the mitigation of climate change by averting more than 135 billion tonnes of carbon dioxide equivalent emissions (as some ozone-depleting substances are also powerful greenhouse gases) in the atmosphere from 1990 to 2010.

And as a result of ozone protection efforts under the Protocol, up to 2 million cases of skin cancer may be prevented globally each year by 2030.

- ▶ For more information please contact: [Dan Teng'o](#), Ozone Secretariat, UN Environment



## **2. 11<sup>th</sup> Meeting of the Conference of the Parties to the Vienna Convention for the Protection of the Ozone Layer (COP 11) and 29<sup>th</sup> Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer (MOP 29)**

**20-24 November 2017 | Headquarters of the International Civil Aviation Organization (ICAO), Montreal, Canada**

The eleventh meeting of the Conference of the Parties to the Vienna Convention (COP 11) and the twenty-ninth Meeting of the Parties to the Montreal Protocol (MOP 29), being held during the thirtieth anniversary of the Montreal Protocol, will meet from 20-24 November 2017 in Montreal, Canada.

The preparatory segment will be held from 20-22 November 2017 and the high-level segment will be held from 23-24 November 2017.

Combined issues to be considered during the preparatory segment include the financial reports and budgets of the trust funds as well as the extension of the trust funds for the Vienna Convention and the Montreal Protocol. The MOP will consider, *inter alia*: the Kigali Amendment to the Montreal Protocol to phase down hydrofluorocarbons (HFCs); the Multilateral Fund (MLF) replenishment; issues related to Article 2 of the Protocol; use of controlled substances as process agents; energy efficiency; and safety standards relevant to low global-warming-potential alternatives. The COP will consider the report of the tenth meeting of the ozone research managers of the parties to the Vienna Convention and the status of the general trust fund for financing activities on research and systematic observations relevant to the Vienna Convention.

The high-level segment includes presentations by the assessment panels on the status of their work, including latest developments, and by the Chair of the MLF Executive Committee on its work. There will also be a high-level roundtable on identifying future opportunities and priorities, as well as a science event entitled 'the science of ozone layer depletion and recovery: reflections on the past, present and future.'

The high-level segment will also address the report of the co-chairs of the preparatory segment and consideration of the decisions recommended for adoption by COP 11 of the Vienna Convention and MOP 29 of the Montreal Protocol.

### **COP 11/MOP 29 Resources**

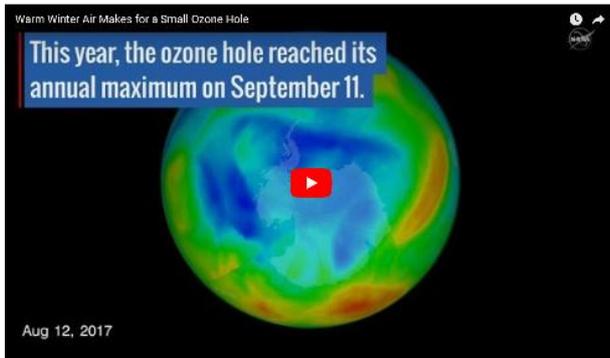
- [COP 11/MOP 29 Website](#)
- [COP 11/MOP 29 Provisional Agenda](#)

- [COP 11/MOP 29 Pre-Session Documents](#)
- [Draft Decisions for Consideration by COP 11 and MOP 29](#)
- [Ozone Secretariat Website](#)

▶ See what's happening during the COP11/MOP-29 keep abreast by following daily coverage by [IISD Reporting Services](#)

### 3. Warm Air Helped Make 2017 Ozone Hole Smallest Since 1988

Measurements from satellites this year showed the hole in Earth's ozone layer that forms over Antarctica each September was the smallest observed since 1988, scientists from NASA and NOAA announced today.



This year's ozone hole was similar in area to the hole in 1988, about 1 million miles smaller than in 2016. Although scientists predict the ozone hole will continue to shrink, this year's smaller ozone hole had more to do with weather conditions than human intervention.

*Credits: NASA's Goddard Space Flight Center/Kathryn Mersmann*

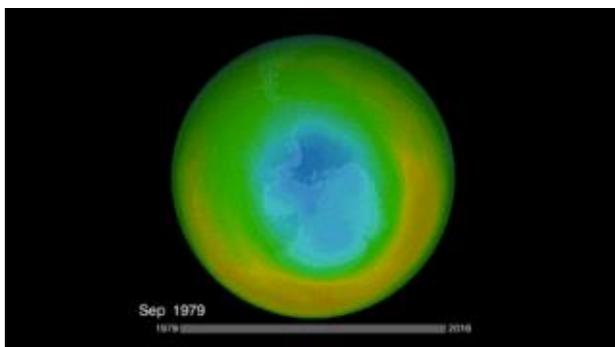
[Scientific Visualization Studio](#)

According to NASA, the ozone hole reached its peak extent on Sept. 11, covering an area about two and a half times the size of the United States – 7.6 million square miles in extent - and then declined through the remainder of September and into October.

NOAA ground- and balloon-based measurements also showed the least amount of ozone depletion above the continent during the peak of the ozone depletion cycle since 1988. NOAA and NASA collaborate to monitor the growth and recovery of the ozone hole every year.

“The Antarctic ozone hole was exceptionally weak this year,” said Paul A. Newman, chief scientist for Earth Sciences at NASA's Goddard Space Flight Center in Greenbelt, Maryland. “This is what we would expect to see given the weather conditions in the Antarctic stratosphere.”

The smaller ozone hole in 2017 was strongly influenced by an unstable and warmer Antarctic vortex – the stratospheric low pressure system that rotates clockwise in the atmosphere above Antarctica. This helped minimize polar stratospheric cloud formation in the lower stratosphere. The formation and persistence of these clouds are important first steps leading to the chlorine- and bromine-catalyzed reactions that destroy ozone, scientists said. These Antarctic conditions resemble those found in the Arctic, where ozone depletion is much less severe.



Ozone depletion occurs in cold temperatures, so the ozone hole reaches its annual maximum in September or October, at the end of winter in the Southern Hemisphere.

*Credits: NASA/NASA Ozone Watch/Katy Mersmann*

In 2016, warmer stratospheric temperatures also constrained the growth of the ozone hole. Last year, the ozone hole reached a maximum 8.9 million square miles, 2 million square miles less than in 2015. The average area of these daily ozone hole maximums observed since 1991 has been roughly 10 million square miles.

Although warmer-than-average stratospheric weather conditions have reduced ozone depletion during the past two years, the current ozone hole area is still large because levels of ozone-depleting substances like chlorine and bromine remain high enough to produce significant ozone loss.

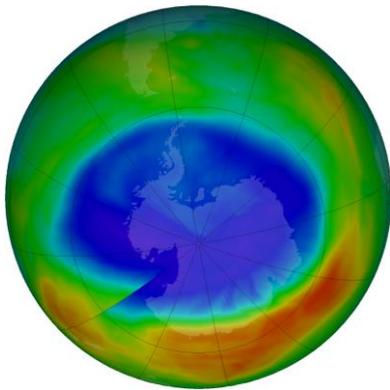
Scientists said the smaller ozone hole extent in 2016 and 2017 is due to natural variability and not a signal of rapid healing.

First detected in 1985, the Antarctic ozone hole forms during the Southern Hemisphere's late winter as the returning sun's rays catalyze reactions involving man-made, chemically active forms of chlorine and bromine. These reactions destroy ozone molecules.

Thirty years ago, the international community signed the Montreal Protocol on Substances that Deplete the Ozone Layer and began regulating ozone-depleting compounds. The ozone hole over Antarctica is expected to gradually become less severe as chlorofluorocarbons—chlorine-containing synthetic compounds once frequently used as refrigerants – continue to decline. Scientists expect the Antarctic ozone hole to recover back to 1980 levels around 2070.

Ozone is a molecule comprised of three oxygen atoms that occurs naturally in small amounts. In the stratosphere, roughly 7 to 25 miles above Earth's surface, the ozone layer acts like sunscreen, shielding the planet from potentially harmful ultraviolet radiation that can cause skin cancer and cataracts, suppress immune systems and also damage plants. Closer to the ground, ozone can also be created by photochemical reactions between the sun and pollution from vehicle emissions and other sources, forming harmful smog.

Although warmer-than-average stratospheric weather conditions have reduced ozone depletion during the past two years, the current ozone hole area is still large compared to the 1980s, when the depletion of the ozone layer above Antarctica was first detected. This is because levels of ozone-depleting substances like chlorine and bromine remain high enough to produce significant ozone loss.



At its peak on Sept. 11, 2017, the ozone hole extended across an area nearly two and a half times the size of the continental United States. The purple and blue colors are areas with the least ozone.

*Credits: NASA/NASA Ozone Watch/Katy Mersmann*

NASA and NOAA monitor the ozone hole via three complementary instrumental methods. Satellites, like NASA's Aura satellite and NASA-NOAA Suomi National Polar-orbiting Partnership satellite measure ozone from space. The Aura satellite's Microwave Limb Sounder also measures certain chlorine-containing gases, providing estimates of total chlorine levels.

NOAA scientists monitor the thickness of the ozone layer and its vertical distribution above the South Pole station by regularly releasing weather balloons carrying ozone-measuring "sondes" up to 21 miles in altitude, and with a ground-based instrument called a Dobson spectrophotometer.

The Dobson spectrophotometer measures the total amount of ozone in a column extending from Earth's surface to the edge of space in Dobson Units, defined as the number of ozone molecules that would be required to create a layer of pure ozone 0.01 millimeters thick at a temperature of 32 degrees Fahrenheit at an atmospheric pressure equivalent to Earth's surface.

This year, the ozone concentration reached a minimum over the South Pole of 136 Dobson Units on September 25— the highest minimum seen since 1988. During the 1960s, before the Antarctic ozone hole occurred, average ozone concentrations above the South Pole ranged from 250 to 350 Dobson units. Earth's ozone layer averages 300 to 500 Dobson units, which is equivalent to about 3 millimeters, or about the same as two pennies stacked one on top of the other.

"In the past, we've always seen ozone at some stratospheric altitudes go to zero by the end of September," said Bryan Johnson, NOAA atmospheric chemist. "This year our balloon measurements showed the ozone loss rate stalled by the middle of September and ozone levels never reached zero."

- ▶ Contact: Katy Mersmann, NASA's Earth Science News Team  
Theo Stein, NOAA Office of Oceanic and Atmospheric Research, Boulder, Co.
- ▶ [National Aeronautics and Space Administration](#), 3 November 2017



#### 4. SolarChill Refrigeration: An Offshoot of the Montreal Protocol

Over 1 billion people live in regions without reliable electrical supply. In those regions maintaining a secure “cold chain” for preserving vaccines, medicines and food supplies is extremely challenging. Lack of reliable refrigeration results in extensive food, medicine and vaccine spoilage.

Co-conceived by UN Environment, OzonAction and Greenpeace International during the 12<sup>th</sup> MOP in Ouagadougou, Burkina Faso, the SolarChill Project was launched in 2001 to develop and bring to market HCFC and HFC-free (i.e. ozone and climate friendly), solar powered and lead acid battery-free vaccine coolers and food refrigerators for off-grid regions. (see endnotes for current SolarChill Project Partners) <sup>[i]</sup>

SolarChill technology evolved in part from the Greenpeace developed hydrocarbon domestic refrigerators. Greenpeace developed the so called ‘Greenfreeze’ technology in 1993 to demonstrate that there were viable alternatives to fluorocarbons for refrigeration. Today there are close to 1 billion hydrocarbon refrigerators in the world and their numbers are rapidly growing.

SolarChill technology, with the technical expertise of the Danish Technological Institute, integrated hydrocarbon based refrigeration with solar direct drive (SDD) technology. SolarChill pioneered the storage of solar energy in ice instead of batteries.

In low-sun situations, or with power completely disrupted, the thick insulation of the cabinet and ice storage maintains acceptable temperatures for up to 5 days. The thickness of the insulation varies according to the ambient temperature for which the specific SolarChill units are designed.

SolarChill addresses four environmental challenges: (a) harnessing renewable solar energy to meet human needs; (b) eliminating ozone depleting and potent global warming substances; (c) eliminating reliance on fossil fuels such as kerosene; and (d) eliminating the use of toxic lead acid batteries.

Presently, there are between 15,000 to 20,000 SolarChill or SDD technology based vaccine coolers installed around the world. Variations of the technology are produced by 8 different companies in Europe, Asia and Africa.

The SDD vaccine coolers are proving to be more reliable and cost effective than other off-grid vaccine cooler technologies, and solar direct drive vaccine coolers are rapidly becoming the technology of choice of Ministries of Health. <sup>[iii]</sup>

The SolarChill food refrigerator, for domestic and small commercial refrigeration, is not yet on the market. It is expected to be tested and commercialized in 2018.

Funded by a 2011 Global Environment Facility (GEF) grant, the SolarChill Project is presently implementing demonstration and technology transfer projects in Kenya, Swaziland and Colombia, The Project aims to encourage manufacturers worldwide (particularly in developing countries) to take up the production and commercialization of SolarChill refrigerators.

SolarChill demonstrates that non-fluorocarbon and off the grid refrigeration is technically and commercially feasible. Furthermore, SolarChill offers expanded market opportunities for appliance manufacturers and thus provides added incentives for the conversion of existing plants from fluorocarbons to natural refrigerants.

Installation and maintenance of SolarChill units requires training of local technicians. The SolarChill Project thus enhances the development of a skilled cadre of technicians that can work with natural refrigerants and solar electricity.



SolarChill has additional potential. Some manufacturers are in the process of developing energy harvesting technologies to utilize the excess energy from the SDD units for other applications, such as charging of cell phones and lighting.

The SolarChill Project bridges health, development and environmental issues. SolarChill demonstrates that health, environment and poverty issues are inextricably interrelated and can be tackled together.

The SolarChill Project welcomes enquiries from interested agencies and companies.

▶ Please see [www.solarchill.org](http://www.solarchill.org) or contact Janos Maté, [jmate@telus.net](mailto:jmate@telus.net)

<sup>[1]</sup> The SolarChill Project partners today include: Danish Technological Institute (DTI), German Government Development Agency (GIZ) GmbH, Global Environment Facility (GEF), Greenpeace International, HEAT GmbH, Programs for Appropriate Technologies in Health (PATH), Swiss Resource Centre and Consultancies for Development (SKAT), United Nations Environment Programme (UNEP), United Nations Children's Fund (UNICEF) and the World Health Organization (WHO).

<sup>[1]</sup> [http://www.who.int/immunization/programmes\\_systems/supply\\_chain/optimize/direct\\_drive\\_solar\\_vaccine\\_refrigerator.pdf](http://www.who.int/immunization/programmes_systems/supply_chain/optimize/direct_drive_solar_vaccine_refrigerator.pdf)



## ASIA PACIFIC

### 5. Bhutan - Her Majesty The Gyaltsuen Commemorates the 30<sup>th</sup> Anniversary of the Montreal Protocol



6 November 2017 - Thimphu, Bhutan - Her Majesty The Gyaltsuen graced a celebration to commemorate the 30<sup>th</sup> anniversary of the signing of the Montreal Protocol- a United Nations treaty to take steps to protect the ozone layer. Dignitaries and senior officials from the government, UN and private sector also attended the event, which organized by National Environment Commission (NEC).

The Montreal Protocol has been the most successful environment treaty of the United Nations, and the only one to receive universal endorsement- where 197 member states unanimously came together to phasing out chemicals that were damaging the Ozone Layer. As a result, more than 99

percent of nearly 100 ozone-depleting chemicals have been phased out, and this has also significantly contributed to climate change mitigation.

Protecting the Ozone Layer remains an important endeavor, and these efforts have been bolstered by Her Majesty's support as the UNEP Ozone Ambassador. The lesson from the success Protocol is being used in efforts to achieve similar collective action for climate change today.

A Coffee Table book on 25 Years of Partnership for Environment Conservation, documenting the achievements of the last 25 years, was launched during the event. Refrigeration and Air Condition equipment (RAC) was also handed over to Ministry of Labour and Human Resources to assist the RAC curriculum.

In commemoration of the anniversary, The Motithang Park in Thimphu was declared an 'Ozone Park'. With the support from Thimphu Thromde, the park has been remodeled into an ozone advocacy park, providing information on ozone history and countries' initiatives for ozone layer protection ever since the ozone hole was discovered in early 1980s.

▶ Contact: [Atul Bagai](#), Senior Regional Network Coordinator, Asia and Pacific Office, UN Environment, Bangkok

### 6. The Maldives' second-largest economic sector, the fisheries industry, is now transitioning away from legacy HCFC systems to low-GWP alternatives, but challenges remain



*Kurumba Maldives resort.*

In an effort to transition the Maldives' fishing industry to using low-GWP alternative technologies, the government has begun implementing training and retrofit incentive programmes.

However, though the country is intent on shifting away from f-gases, there are significant challenges that need to be overcome.

*Ammonia21.com* spoke to Miruza Mohamed, director of environment management, at the Maldives Ministry of Environment and Energy to find out more.

### **Majority of industry still on R22**

“As of 2014, there are 22 operating fishing enterprises,” said Mohamed. “About 15-20% of the HCFCs imported are consumed in the fisheries sector. And HCFC usage across the enterprises is approximately 65%.”

Mohamed explained that R22 is currently the dominant refrigerant used in the industry. “As most of the seaborne vessels use R22 and there is no readily available alternative, it is going to be challenging for the sector.”

“We are in the process of finding a good alternative for retrofitting mother vessels under a demonstration project funded by Multilateral Fund for the Montreal Protocol.”

Fishing is the Maldives' second-largest economic sector after tourism. The industry accounts for about 10% of the country's GDP and employs around 20% of the workforce.

The largest portion of R22 use is on marine refrigerated seawater systems installed on fishing vessels. The rest of it is used in cold chain logistics facilities such as transport trucks and freezer containers, as well as blast freezers and cold stores.

Though some ammonia is used, Mohamed explained that the government is continuing to work with industry to shift away from R22.

“We have provided incentives for six fisheries companies to retrofit from R22 to low-GWP alternatives,” said Mohamed.

“If more funds become available we would continue to provide incentives to the fisheries sector.”

### **Technology and training challenges**

However, specific challenges remain for this industry.

Mohamed detailed their biggest concerns regarding alternative refrigerants and selection criteria for systems and technology.

Their biggest concerns when evaluating alternative refrigerants are “environmental impact, overall performance when the system is retrofitted or replaced, cost and availability of the refrigerant in the local market, compatibility with current equipment, and finally safety (flammability and toxicity).”

With respect to the main criteria they are looking for when evaluating new systems or technology, these are: “ease of operation and maintenance, familiarity of system with local technicians, equipment performance, and the cost of system components and repair.”

Regarding the future, Mohamed said the government was focused on training local technicians, with an emphasis on natural refrigerant technology alternatives.

“In addition to continuing our good practices in service trainings, we would like to introduce a certification programme whereby only certified technicians can do the servicing and installation,” said Mohamed.

“Our focus now is to provide training on natural refrigerants and focus on onsite training. This week five people from different sectors will be attending China to get training on natural refrigerants.”

▶ [Ammonia21](#), 9 November 2017, By: Devin Yoshimoto

**7. Training organisations in Australia and New Zealand are seeing increased demand for natural refrigerant system training in the Asia-Pacific**



Credit: Gauge Refrigeration Management Ltd.

In a sign of growing interest in natural refrigerants in the Asia-Pacific, training organisations in Australia and New Zealand are seeing increased demand for natural refrigerant system training from owners, operators, and technicians in the region.

New Zealand-based training organisation Gauge Refrigeration Management specialises in industrial refrigeration systems based on natural refrigerants such as ammonia.

"I think we are going to see ammonia become more popular, particularly low-charge ammonia systems," said Padraic Durham, managing director at Gauge Refrigeration Management.

"However, we must make sure that everyone is ready to handle it and prepared with proper training."

Earlier this year, the company received accreditation for the first-ever New Zealand Qualifications Framework (NZQA) ammonia safety specific training unit standard 30127, titled: *Demonstrate knowledge of anhydrous ammonia and safe practices for its use as a refrigerant*.

Additionally, in August, the company completed ammonia safety training in the south pacific island nation of Fiji, a country on the front lines of battling the environmental effects of climate change.

Durham said the country was pushing heavily for natural refrigerant use in local industry.

"We just completed a safety training in Fiji where we are seeing that they are pushing for CO<sub>2</sub> and ammonia systems as well," he said.

In Australia, whose HFC phase-down begins in January 2018, New South Wales-based training organization Superior Training Centre is continuing its push for increased training on ammonia and hydrocarbon refrigeration systems.

In partnership with local refrigerant wholesaler Totaline, the organisation recently held a hydrocarbon safety training on 29 October.

"We had a great turnout, and from all accounts, it was a great success," said Superior Training Centre Director Ben Peters.

Earlier in the year, it partnered with leading Australian commercial and industrial refrigeration contractor, Tri Tech Refrigeration, to hold its first 'Ammonia Safety Awareness and Training Forum'.

"The feedback which we had received at the event was all positive," said Peters. "We had 85% of the attendees who completed the course pass and receive their statements of attainment, which are nationally recognised."

▶ [Ammonia21](#), 7 November 2017, By Devin Yoshimoto



## LATIN AMERICA AND CARIBBEAN

### 8. Capa de ozono se tardará 10 años en recuperar: Mario Molina



A la ceremonia asistió el secretario del Medio Ambiente y Recursos Naturales, Rafael Pacchiano. Foto: Cuartoscuro / Archivo

El científico mexicano y premio Nobel de Química, Mario Molina, lamentó que ya se sientan los efectos del cambio climático en el planeta y que estos tengan repercusiones como la de retardar la recuperación de la capa de ozono destruida por las sustancias conocidas como clorofluorocarbonos.

***"Lo que estamos proyectando es que la recuperación de la capa de ozono va a tardar probablemente una década más de lo que teníamos anticipado por el cambio climático". Mario Molina, premio Nobel del Química***

Al participar en la cancelación del timbre postal con motivo del trigésimo aniversario del protocolo de Montreal firmado y ratificado en 1987 por 197 países y con el que se han combatido las sustancias que dañan la capa de ozono, confió en que los países logren un acuerdo similar para revertir los efectos del cambio climático.

***“De ahí la importancia enorme que tiene el protocolo de Montreal porque no hemos logrado algo parecido con el cambio climático que es un riesgo monumental para futuras generaciones”. Mario Molina, premio Nobel del Química***

Por último, dijo que pese a que el gobierno de Estados Unidos tiene posturas contrarias al combate del cambio climático, otros sectores del país estadounidense como el académico y empresarial, sí tienen en su agenda reducir las emisiones contaminantes.

▶ [Uno TV](#), 10 noviembre 2017, Agustín Velasco

## 9. México avanza en eliminar sustancias que dañan capa de ozono

México, 11 nov (PL) Al cumplirse 30 años del Protocolo de Montreal, México eliminó 99 por ciento de sustancias que estaban presentes en aerosoles, las cuales dañaban la capa de ozono, aseguró hoy Rafael Pacchiano, secretario de Medio Ambiente y Recursos Naturales (Semarnat).

Anticipó que con el cumplimiento de esta medida para el 2030 se habrán evitado más de dos millones de casos anuales de cáncer de piel, lesiones oculares y daños al sistema inmunológico.

Pacchiano argumentó que a México sólo le falta la supresión de estos compuestos en el sector de servicios, ejecutándose actualmente un programa de capacitación, en coordinación con la Secretaría de Educación Pública y el Instituto Politécnico Nacional.

En los últimos dos años, agregó, se han eliminado 113 toneladas de dichas sustancias, evitando así la emisión de 970 mil toneladas de CO<sub>2</sub>.

El objetivo principal de este Protocolo es la protección de la capa de ozono mediante la toma de medidas para controlar la producción y el consumo de sustancias que la agotan, a partir de los conocimientos científicos e información tecnológica.

Para los especialistas, si todos los países trabajaran de forma unidad y con la misma decisión que México se estarían dando pasos muy certeros para mejorar la calidad de la vida en el planeta.

▶ [Prensa Latina](#), 11 noviembre 2017



## NORTH AMERICA



### 10. Canada Ratifies Global Agreement to Reduce Powerful Greenhouse Gases and Heads to International Climate Change Conference to Urge Climate Action

Canada is now among the first countries to ratify the Kigali Amendment to the Montreal Protocol, which will phase down powerful greenhouse gases. This milestone demonstrates Canada's bold action to ensure a sustainable planet for future generations.

Found in air conditioners and aerosols, hydrofluorocarbons—or HFCs—are thousands of times more powerful drivers of climate change than carbon dioxide. Each year, HFC sources emit the carbon-dioxide equivalent released by 300 coal-fired power plants. If left unchecked, HFCs could account for 10 percent of global greenhouse gas emissions.

Canada was one of the first countries to ratify the Montreal Protocol in 1987, a historic international agreement that has eliminated over 99 percent of substances that were thinning the earth's protective ozone layer.

By reducing HFCs, we will reduce the future impacts of climate change such as sea-level rise, droughts, and floods. Further, by phasing out HFCs and shifting to cleaner alternatives, scientists believe we could avoid half-a-degree Celsius of warming by the end of the century.

To succeed in phasing down HFCs, Canada recently published regulations to reduce its HFC consumption by 85 percent, by 2036. This measure not only upholds our commitment to the Kigali Amendment but to our made-in-Canada climate plan as well.

This week, the Canadian delegation heads to the 23<sup>rd</sup> session of the Conference of the Parties, in Bonn, Germany, and Minister McKenna will join them from November 13 to 16. While in Bonn, the Minister and the delegation will work to advance the implementation of the Paris Agreement and urge more countries to ratify the Kigali Amendment. A Meeting of the Parties to the Montreal Protocol will be held November 20 to 24, in Montréal.

Canada continues to deliver on its commitment to working globally to advance the implementation of the Paris Agreement, taking action to build a clean economy and create more opportunities for middle-class Canadians.

► [Environment and Climate Change Canada](#), 7 November 2017, – Gatineau, Quebec

## 11. Carbon credits coordinated by EOS Climate incentivize HFC reclamation and R22/CFC destruction as well as the installation of natural refrigerant-based systems



Jeff Cohen, EOS Climate's co-founder and vice president.

Food retailers and others in North America can earn valuable carbon credits while transitioning from R22 and HFCs to natural refrigerants, thanks to programs created by San Francisco-based EOS Climate, which is now part of Xpansiv Data Systems.

For example, in August, a program developed by EOS Climate was approved by the American Carbon Registry (ACR) so that carbon credits for the destruction of R22 are now available to the industry as part of ACR's Ozone Depleting Substances (ODS) Destruction Methodology.

This updated ODS destruction methodology expands the opportunities companies have to obtain carbon credits. Since 2009 supermarkets in North America have been able to destroy CFC refrigerants for carbon credits. Beginning in 2015 – under another ACR methodology originated by EOS – stores became eligible for credits by reclaiming and re-using HFCs or deploying advanced commercial refrigeration systems that use natural refrigerants.

Currently, the carbon credits for CFC destruction can be applied in a cap-and-trade (compliance) market like California. In both compliance and voluntary markets, all of the refrigerant-based credits can be sold or applied to a company's greenhouse-gas reduction program.

"You've probably heard about carbon offsets [credits], or 'verified emission reductions,'" said EOS Climate's co-founder and vice president, Jeff Cohen, last June at an ATMOSphere America session titled "Refrigerants in Transition: Market Incentives."

"[Carbon credits] represent a reduction in business as usual of one metric ton of CO<sub>2</sub>," he continued, "so one carbon credit is an avoided or prevented emission of one metric ton of CO<sub>2</sub>—or the equivalent of it."

To date, Cohen said, the ODS destruction protocol that EOS Climate originated has generated nearly 11 million offset credits.

Cohen said the HFC reclamation and installation of advanced (natural refrigerant-based) systems are impactful environmental tools because they keep potent greenhouse gases from ever being produced.

► [R744](#), 3 November 2017, By Elise Herron

## 12. MACS reminds the aftermarket to be aware of changes to Section 609 requirements in 2018

November 6, 2017 (Lansdale, PA) - Technicians who service mobile A/C systems and distributors who sell refrigerant need to be aware of new regulations effective on January 1, 2018 concerning the requirement of technicians to be Section 609 certified.

- The final rule published November 2016 extends Section 608 requirements to HFCs. **Starting Jan. 1, 2018, sale of most refrigerants of two pounds or larger will be restricted to 608 and 609- certified technicians;** distributors must keep refrigerant sales records and verify purchasers are (or employ) 608 or 609-certified technicians.
- Small cans (2 pounds or less) of non-exempt refrigerants may continue to be manufactured or imported and sold after Jan. 1, 2018, if equipped with self-sealing valves.

- To learn more about Section 609 certification visit the MACS website at <http://www.macsw.org>. To view the new regulations on the U.S. EPA website, visit <https://www.epa.gov/section608/refrigerant-sales-restriction>

There is no mandatory re-certification, Section 609 certification once obtained is good for life. Technicians who have lost their MACS or IMACA certification may replace their credentials for \$10. by calling the MACS office at 215-631-7020 x 0 or following the directions listed on the Section 609 page of the MACS website at <https://goo.gl/PhRzEF>.

“The MACS staff has been busy answering questions for technicians and distributors who are confused or have been given wrong information about the new requirements. MACS wants everyone to understand that if you are Section 609 certified your credentials are good for life. If you have lost your credentials and are MACS or IMACA certified, MACS can issue a reprint of credentials for a \$10 processing fee,” explained Elvis L. Hoffpauir, MACS president and chief operating officer.

Technicians who are not certified can become certified by visiting the MACS website at [www.macsw.org](http://www.macsw.org). The newest Section 609 certification program which debuted in 2015 includes training on handling R-1234yf. Section 609 certification can be obtained through a written or online test for \$20. Group classes can also be arranged by contacting our training department at 215-631-7020 x 304 or email [marion@macsw.org](mailto:marion@macsw.org)

🔗 [Mobile Air Conditioning Society \(MACS\)](#) , 6 November 2017

### 13. Low GWP Fire Suppression Alternatives Spark Opportunity for Early Action on HFCs

Clean agent total flooding fire suppression systems are designed to protect high value assets from fire when water-based suppression cannot be used (e.g. computer rooms and data centers, control rooms, museums, etc.). The National Fire Protection Association (NFPA) 2001 Standard (2015 edition) is the industry standard that governs use of clean agents in most regions of the world and defines a clean agent as “an electrically nonconductive, volatile, or gaseous fire extinguishant that does not leave a residue upon evaporation.”

The attached table from NFPA 2001 illustrates the very high GWP of hydrofluorocarbons (HFCs) sold into clean agent fire suppression and the availability of multiple low GWP substitutes for HFCs.

Table A.1.6 Potential Environmental Impacts

| Agent        | GWP<br>(IPCC 2013) | ODP   |
|--------------|--------------------|-------|
| FIC-1311     | ≤1                 | 0*    |
| FK-5-1-12    | ≤1                 | 0     |
| HCFC Blend A | 1500               | 0.048 |
| HFC Blend B  | 1400               | 0     |
| HCFC-124     | 527                | 0.022 |
| HFC-125      | 3170               | 0     |
| HFC-227ea    | 3350               | 0     |
| HFC-23       | 12,400             | 0     |
| HFC-236fa    | 8060               | 0     |
| IG-01        | 0                  | 0     |
| IG-100       | 0                  | 0     |
| IG-541       | 0                  | 0     |
| IG-55        | 0                  | 0     |

Note: GWP is reported over a 100-year integrated time horizon.

Low GWP alternatives to HFCs include 3M™ Novec™ 1230 Fire Protection Fluid (FK-5-1-12), inert gas solutions and water mist technology. Transition to low GWP substitutes in fire suppression can result in >99% reduction in GWP impact compared to HFCs. FK-5-1-12 and inert gas systems are already very mature technologies with competitive costs and substantial market share. Inert gas solutions have been commercially available since the mid-1990s and FK-5-1-12 was approved by the U.S. EPA in 2002.

The total flooding fire suppression sector is similar to other HFC sectors in that emissions of HFCs will continue to grow as the installed base of systems continues to grow. The atmospheric concentrations of HFC-227ea provide a good illustration of industry emissions since HFC-227ea came into the market as a major replacement for halon (Laube, et.al. 2010).

Significant investment has gone into developing low GWP replacements for HFCs, and there has also been substantial investment in the systems that utilize low GWP agents. The low GWP substitutes for HFCs are available from the same industry leading system manufacturers that currently sell HFCs, are listed by the same approval bodies and included in the same standards as HFCs. In fact, some system manufacturers only sell low GWP substitutes for HFCs.

Low GWP substitutes can also provide a larger margin of safety in use. In its approval of FK-5-1-12, the U.S. EPA already recognized that FK-5-1-12 “provides an improvement over use of halon 1301, hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) in fire protection. We find that FK-5-1-12 is acceptable because it reduces overall risk to public health and the environment”

The Montreal Protocol Technology and Economic Assessment Panel (TEAP) has identified the limited, niche applications for which HFCs would continue to be needed in the fire sector, e.g., in some military, aviation or low temperature applications. These applications represent a minor percent of total clean agent use and, unlike refrigeration and air conditioning applications, high ambient temperatures do not represent a barrier to transition away from HFCs in fire suppression.

#### Summary

There are multiple low GWP alternatives available for clean agent fire suppression. Early action to restrict HFCs in fire suppression can immediately start minimizing the continued growth of the installed base of HFC systems, at costs comparable to HFC technology.

- ▶ Contact: [Kurt T. Werner](#), DABT, Government and Regulatory Affairs Manager, 3M Electronics Materials Solutions Division

## 14. Arctic Climate Research Lab Funding Renewed for Two More Years



Canada's high arctic research station is being given at least a two-year reprieve as the federal government steps up with new funding. A rock cairn marks a high point near the Polar Environmental Atmospheric Research Laboratory (PEARL) near the Eureka Weather Station, on Ellesmere Island, Nunavut, on Monday, July 24, 2006. THE CANADIAN PRESS/Jeff McIntosh

Canada's high Arctic research station is being given at least a two-year reprieve as the federal government steps up with new funding.

Science Minister Kirsty Duncan says \$1.6 million will be provided to keep the Polar Environmental Atmospheric Research Laboratory, or PEARL, running until the fall of 2019.

"PEARL is a unique facility," said Duncan. "It is most northern in Canada, and it looks at the atmosphere, it looks at climate change, ozone depletion and the interaction between the atmosphere, ice and ocean. So, today's a good day."

The station is on Ellesmere Island in Nunavut, about 1,100 kilometres from the North Pole and is used by scientists to research ozone depletion, pollution, and climate changes in the Arctic.

Global warming is happening much faster in the Arctic and PEARL is one of a handful of research stations in the world helping understand the changes. [...]

- ▶ [CTV News](#), 8 November 2017



## EUROPE & CENTRAL ASIA

### 15. Fin de vie des fluides : la France va faire école



Shamila Nair-Bedouelle, directrice du programme OzonAction

**Alors que le 30<sup>e</sup> anniversaire du Protocole de Montréal vient d'être fêté, la directrice du programme OzonAction pour l'Organisation des Nations unies pour l'environnement, fait le point sur les enjeux en matière d'utilisation des fluides.**

**Quel est votre avis concernant les récentes attaques suggérant que la couche d'ozone ne serait pas en train de se résorber, notamment à cause du dichlorométhane entrant dans la composition du R 32 ?**

Je pense que la couche d'ozone se répare, mais lentement. Les efforts doivent donc être poursuivis. Il ne faut pas oublier que les pays en voie de développement tendent à avoir la même croissance économique que les pays développés et que l'utilisation de la climatisation et la réfrigération constitue la pierre angulaire de ce développement. Il faut tout de même rappeler que les fluides de remplacement HFC, ont quand même un impact sur l'effet de serre. Et c'est pour cela que l'on a abouti à l'amendement de Kigali (2016), dont le défi principal reste sa mise en œuvre.

**30 ans après, quel bilan pouvez-vous faire du Protocole de Montréal ?**

Il est important de rappeler que jamais un protocole n'a eu autant de succès que celui de Montréal. 3,5 milliards de dollars ont déjà été investis dans la réduction du trou dans la couche d'ozone. Il présente cependant l'inconvénient de se focaliser uniquement sur les fluides frigorigènes. Or il faut voir le système dans sa globalité et prendre en compte les besoins des pays en voie de développement. La question est de savoir de quelle manière mettre les fluides à faible GWP à disposition de ces pays.

**Pensez-vous que le retrait des États-Unis de l'accord de Paris puisse remettre l'ensemble des avancées en cause ?**

Pour répondre à votre question, il est évident que les États-Unis jouent un rôle très important. Ce pays finance la protection de la couche d'ozone depuis les années 90. De leur côté, les industries américaines sont très en avance. Elles ont mis en place différents guides et ouvrages pour favoriser l'accès aux alternatives aux pays en développement. Et je pense que cela va continuer sur cette lancée.

**Le système de récupération de fluides salué en France va-t-il être repris par d'autres pays ?**

Il est prévu que la France et l'Allemagne collaborent étroitement avec 26 pays francophones qui nous ont sollicités pour le recyclage. Je pense que c'est le moment de le faire.

**La mise en place d'une éventuelle taxe en France peut-elle conduire à une intensification de la contrebande ?**

La question est trop sensible. Chaque pays a sa propre politique et un accès propre aux technologies.

**Quelles sont les missions d'OzonAction ?**

Nous gérons 9 réseaux régionaux de coordinateurs nationaux de l'ozone comprenant 147 États membres et conduisons actuellement plus de 500 projets en collaboration avec le bureau Ozone dans chaque pays. L'ensemble est financé par le fonds multilatéral, mis en place en 1990. En tant qu'agence de mise en œuvre de l'Organisation des Nations unies pour l'environnement, celle-ci a plusieurs responsabilités. Le mandat qui lui a été confié consiste à aider les pays membres à promouvoir l'élimination des substances qui appauvrissent la couche d'ozone, en étant en règle avec les obligations nationales. Nous les soutenons dans l'accès aux technologies alternatives comme les fluides à bas GWP et à l'information sur la maintenance. Le bureau Ozone travaille avec les techniciens frigoristes sur des sujets tels que le transport, l'utilisation des fluides à bas GWP dans le commerce, le secteur domestique, la climatisation, etc. En France, nous coopérons avec l'IIR pour utiliser l'outil qu'ils ont mis en place pour former les techniciens et ils nous aident dans la sensibilisation et la documentation. Le Cemafroid participe aussi à nos réunions afin de donner son avis sur les formations. Nous travaillons avec d'autres institutions françaises telles que l'Inserm et la Sécurité solaire afin de promouvoir la corrélation santé et ozone. Nous collaborons aussi avec les pays francophones africains ainsi qu'avec l'Area qui a déjà formé des techniciens en Afrique à Kigali, ainsi qu'avec l'EPEE.

**Quel message peut-on donner aux installateurs frigoristes quant à l'utilité de l'ONU Environnement ?**

L'une des préoccupations majeures consiste à promouvoir les technologies indispensables à la vie, respectueuses de l'environnement et en phase avec les impératifs économiques. Dans ce contexte, les techniciens frigoristes jouent un rôle primordial. Le secteur de la réfrigération est une pierre angulaire de la vie moderne. La santé et la sécurité alimentaires sont en jeu. Une différence de température de 0,5 °C peut avoir des conséquences considérables. 400 millions de tonnes de denrées alimentaires périssent chaque année à cause d'une mauvaise gestion de la chaîne du froid.

## La Chine est souvent perçue comme peu scrupuleuse vis-à-vis des réglementations environnementales. De nombreux experts soulignent toutefois que de gros progrès ont été constatés. Comment le percevez-vous ?

Nous sommes en relation avec la Chine depuis les années 90. Ce pays a fait énormément de progrès au niveau national pour éliminer ces substances. L'ONU Environnement y poursuit d'ailleurs plusieurs projets. Le plus important a été financé l'année dernière pour un montant de 19,7 millions de dollars pour le secteur tertiaire. La mise en place de normes est envisagée en concertation avec les ministères du travail, de la sécurité, de l'environnement et des technologies. L'industrie chinoise est très active dans la sensibilisation et œuvre conjointement avec le bureau Ozone dans les différentes provinces. Le pays a mis en place un système de formation qui peut réellement servir de modèle à d'autres pays. Il est prévu que 60 000 techniciens soient formés à la gestion des fluides dans les 3 ans à venir dans l'un des centres de Shanghai. Le pays en compte actuellement 19 en tout. Des normes plus strictes que les normes internationales en vigueur, ont d'ores et déjà été mises en place parce que la Chine l'a exigé.



▶ LaRPF, 20 octobre 2017, Interview par : Elise Kuntzelmann



## FEATURED

### OZONE SECRETARIAT

- ▶ Vienna Convention and Montreal Protocol Meetings: A Primer - [Read/Download](#)
- ▶ [29<sup>th</sup> Meeting of the Parties to the Montreal Protocol](#)
- ▶ [COP11-MOP29 : Issues for discussion by and information for the attention of the Conference of the Parties to the Vienna Convention at its eleventh meeting and the Twenty Ninth Meeting of the Parties to the Montreal Protocol - UNEP/OzL.Conv.11/2–UNEP/OzL.Pro.29/2 - Advance copy \( E \)](#)
- ▶ [28<sup>th</sup> Meeting of the Parties to the Montreal Protocol](#)
- ▶ Final text of the Kigali Amendment to the Montreal Protocol available in all the six official UN languages ([A](#) [C](#) [E](#) [F](#) [R](#) [S](#))
- ▶ OEWG 39: The 39<sup>th</sup> Session of the Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, preceded by the 58<sup>th</sup> meeting of the Implementation Committee under the Non-Compliance Procedure for the Montreal Protocol, held on 9 July and a workshop on safety standards relevant to the use of low-GWP alternatives to HFCs, held on 10 July 2017.
  - [Draft report of the thirty-ninth meeting of the Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer - Addendum](#)
  - [Draft report of the thirty-ninth meeting of the Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer](#)
- ▶ Click [here](#) for further information.

– Browse through the Ozone Secretariat “[In Focus](#)” to learn about latest updates.

– Click [here](#) for Montreal Protocol Meetings Dates and Venues

**The UN Environment Assessment Panels** have been the pillars of the ozone protection regime since the very beginning of the implementation of the Montreal Protocol. Through provision of independent technical and scientific assessments and information, the Panels have helped the Parties reach informed decisions that have made the Montreal Protocol a world-recognized success.

UNEP initiated the process of setting up the assessment panels in 1988, pursuant to Article 6 of the Montreal Protocol, to assess the scientific issues of ozone depletion, environmental effects of ozone depletion, and the status of alternative substances and technologies and their economic implications.

Four panels, namely the panels for Scientific, Environmental Effects, Technology, and Economic Assessments were formally established and approved at the First Meeting of the Parties to the Montreal Protocol in 1989 where their first set of Terms of Reference were adopted. Shortly after the Second Meeting of the Parties in 1990, the Panels for Technical Assessment and the Panel for Economic Assessment were merged into one Panel called the Technology and Economic Assessment Panel (TEAP), which together with the Scientific Assessment Panel (SAP) and the Environmental Effects Assessment Panel (EEAP) make up the three assessment panels active today.

In accordance with Article 6 of the Montreal Protocol and subsequent decisions of the Parties, the three panels carry out a periodic assessment at least every 4 years. The first assessment reports were published in 1989 and since then major periodic assessments have been published by all three panels in 1991, 1994, 1998, 2002, 2006 and 2010. For each periodic assessment, the key findings of the panels are synthesized into a short report. The full SAP assessment report for 2014 was published in December 2014, while the EEAP assessment report for 2014 was published in January 2015.

#### PROGRESS & QUADRENNIAL ASSESSMENT REPORTS

- [EEAP](#)
- [SAP](#)
- [TEAP](#)

[Assessment Panels List of Meetings](#)

#### SYNTHESIS REPORTS

- [2014 assessments](#)
- [2010 assessments](#)
- [2006 assessments](#)

## THE MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL

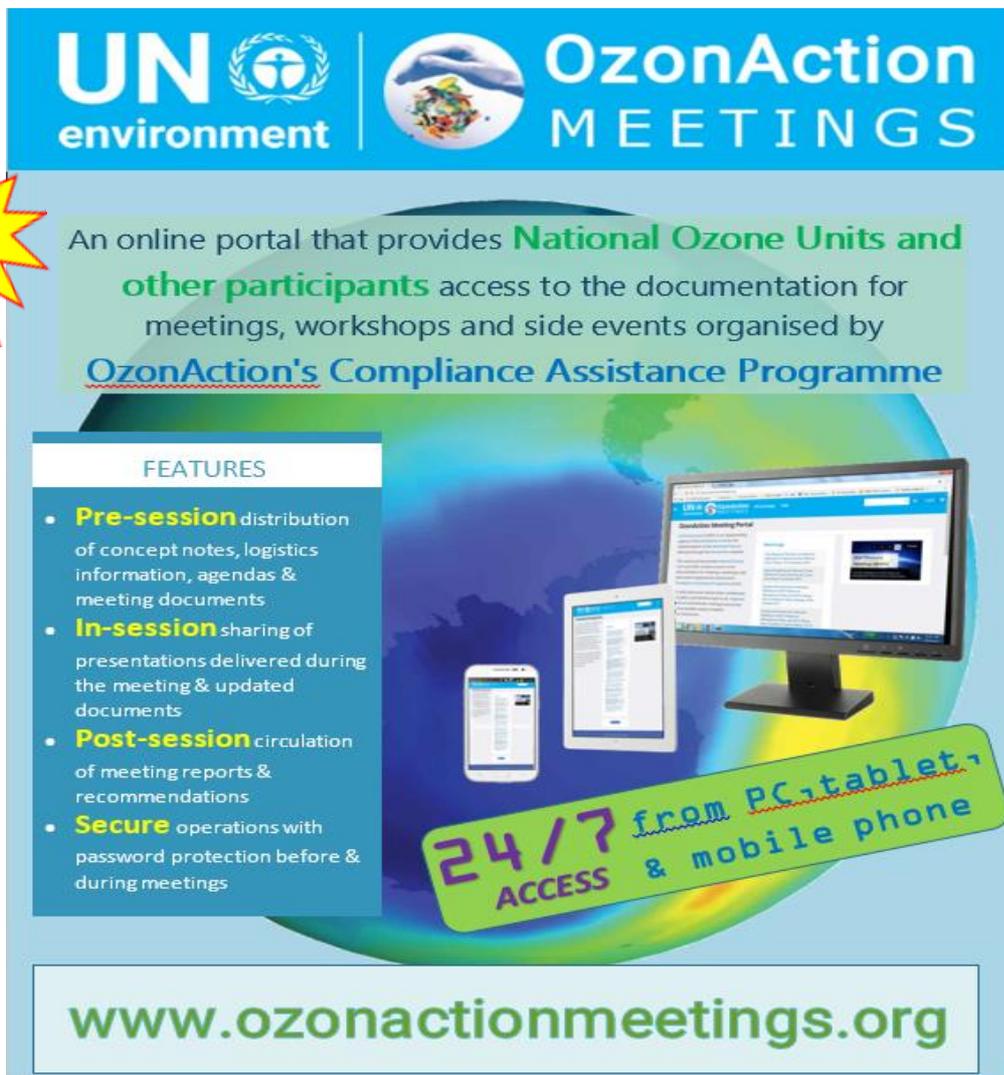


- [Documents for the 80<sup>th</sup> meeting of the Executive Committee](#)
- [Agenda for the 80<sup>th</sup> meeting of the Executive Committee](#)
- [Report of the 79<sup>th</sup> meeting of the Executive Committee](#)

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# OZONACTION

UN Environment, [OzonAction](#) highlights



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INTERNATIONAL OZONE DAY 2017

OZONE DAY ACTIVITIES AROUND THE WORLD

Please visit the [OzonAction Ozone Day website](#) for other interesting products. Also, in the right-hand column of this webpage you will find links to last year's Ozone Day webpage and other previous years; please feel free to browse through them for useful information and ideas.

We would also appreciate receiving your Ozone Day planned activities/reports for posting on the OzonAction website. You may send this information through your respective regional OzonAction CAP office or to Ms [Jo Chona](#).

[▶ OzonAction Ozone Day 2017 website](#)

## [The Kigali Amendment to the Montreal Protocol - Opportunities and Next Steps - OzonAction Video](#)

The Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer reached agreement at their 28<sup>th</sup> Meeting of the Parties on 15 October 2016 in Kigali, Rwanda to phase down hydrofluorocarbons (HFCs). The UN Environment,

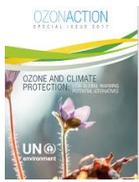


OzonAction developed a video to find out from renowned international scientific, health, technical, financial and national experts about background and significance of this Kigali amendment.

The amendment presents many opportunities: improving the environment, refrigeration and air-conditioning systems and especially energy efficiency. It also presents new challenges. It is absolutely critical now for industry, governmental bodies and civil society to work together to adopt greener technologies in each country of the world and fight global warming.



[OzonAction YouTube](#) | See also: [United Nations Treaty Collection](#)



## Ozone and Climate Protection: Low-Global Warming Potential Alternatives - OzonAction Special Issue 2017

### OzonAction Factsheets:



[HS codes for HCFCs and certain other Ozone Depleting Substances ODS](#) (post Kigali update)



[The Kigali Amendment to the Montreal Protocol: HFC Phase-down](#) - The phase-down of HFCs under the Montreal Protocol on Substances that Deplete the Ozone Layer has been under negotiation by the Parties since 2009 and the successful agreement on the Kigali Amendment at the 28<sup>th</sup> Meeting of the Parties on 15 October 2016 in Kigali, Rwanda to phase-down hydrofluorocarbons (HFCs) continues the historic legacy of the Montreal Protocol. This factsheet summarises and highlights the main elements of the Amendment of particular interest to countries operating under Article 5 of the Protocol (Article 5 Parties).



**OzonAction Factsheet:** [Refrigerant Blends: Calculating Global Warming Potentials](#) (post-Kigali update)



**OzonAction Factsheet:** [Global Warming Potential \(GWP\) of Refrigerants: Why are Particular Values Used?](#) (post-Kigali update).



**OzonAction Factsheet:** [Tools Commonly used by Refrigeration and Air-Conditioning Technicians](#)

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Watch our short instructional videos on refrigeration & air-conditioning techniques, safety and best practices on your mobile device

Available in English, French, Spanish, and German

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**OzonAction Multimedia Video Application: Refrigeration and Air-conditioning Technician Video Series** - OzonAction has launched an exciting new application which hosts series of short instructional videos on techniques, safety and best practice for refrigeration and air-conditioning technicians. This application, consisting of short instructional videos on techniques, safety and best practice, serves as a complementary training tool for refrigeration and air-conditioning (RAC) sector servicing technicians to help them revise and retain the skills they have acquired during hands-on training. Additional videos will be added regularly.

Please share with your RAC associations, technicians and other interested stakeholders... **Over 11, 200 installations to date!**

Now available in the [Android Play Store](#) and Apple Store/iTunes.



(Just search for 'OzonAction' or scan this QR Code)





**OzonApp eDocs+** launched in Android Play Store and Apple Store. This new application launched by OzonAction on February 12, includes publications, videos, fact sheets and other awareness materials to help National Ozone Units (NOUs) and other stakeholders to build their capacity to implement the Montreal Protocol in a sustainable manner and at the same time to derive climate benefits. Now available in the [Android Play Store](#) and Apple Store/iTunes.



*(Just search for “OzonAction”, or scan this QR code)*

**OzonAction News Drops** - UNEP OzonAction is presenting a series of short video “News Drops” which focus on ozone layer protection, climate change and the importance of continuing ozone observations.



**Regional News Drops**

The Regional Networks of National Ozone Units (NOUs) under the Multilateral Fund are a path-breaking mechanism for North-South and South-South cooperation. Networking provides a platform for NOUs from Article 5 countries to exchange experiences, develop their skills and tap the expertise of their peers in both developing and developed countries. Conducted at the regional level, the Networking activity builds the Ozone Officers' skills for implementing and managing their national ODS phase-out activities. During 2016 these videos were filmed at the regional network meetings around the world.

The NOUs were asked about their success stories, alternative refrigerants selected and their personal messages for national ozone celebrations...

Click [here](#) to access the News Drops

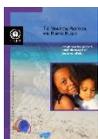
**OzonAction Recent Publications:**



**Lower-GWP Alternatives in Commercial and Transport Refrigeration: An expanded compilation of propane, CO<sub>2</sub>, ammonia and HFO case studies** - This booklet presents an expanded compilation of case studies on lower-GWP alternatives in commercial and transport refrigeration and provides an update to the first set of case studies which was published in 2014 by UNEP DTIE OzonAction/CCAC (Low GWP Alternatives in Commercial Refrigeration: Propane, CO<sub>2</sub> and HFO Case Studies).



**NATIONAL CERTIFICATION SCHEMES FOR RAC SERVICING TECHNICIANS** - This publication aims to provide introductory information for institutions in developing countries to better understand the issue of certification in the field of refrigeration and air conditioning, to assist in the creation of such certification and training schemes and to demonstrate to service technicians and enterprises why it is in their interest to participate.



**THE MONTREAL PROTOCOL AND HUMAN HEALTH** - This booklet summarizes how the successful implementation of the Montreal Protocol has protected human health. It describes how ozone depletion would have led to increases in UV radiation and, based on current understanding of the mechanisms by which UV affects biological processes, how that would have led to a dramatic increase in skin cancers, cataracts and affected human health in other ways. It also covers recent progress in understanding the ‘World Avoided’ – that is the world we would have lived in without a successful Montreal Protocol.



**FINANCING THE CLIMATE CO-BENEFITS OF THE HCFC PHASE-OUT** - A guide for Low Volume Consuming Countries - Hydrochlorofluorocarbons (HCFCs) are being phased out worldwide under the Montreal Protocol on Substances that Deplete the Ozone Layer. The Parties to this treaty encouraged countries to promote the selection of alternatives to HCFCs that minimise environmental impacts, in particular impacts on climate. The Protocol’s Multilateral Fund encourages developing countries to explore potential financial incentives and opportunities for additional resources to maximise the environmental benefits from HCFC Phase out Management Plans (HPMPs). This booklet explains how Ozone Officers in low volume consuming countries can explore such opportunities for climate co-benefits. [English](#) | [French](#) | [Spanish](#)



### **SAFE USE OF HCFC ALTERNATIVES IN REFRIGERATION AND AIR CONDITIONING** - An

Overview for Developing Countries - Many of the alternative refrigerants to hydrochlorofluorocarbons (HCFCs) have particular characteristics in terms of toxicity, flammability and high pressure which are different from those used previously. It is therefore important that the refrigeration and air-conditioning industry adapts to both the technical and safety issues concerning these refrigerants. This publication provides an overview of the alternatives, their general characteristics and their application in the context of the safety issues. It provides guidance for National Ozone Units (NOUs) and other interested parties in developing countries on how they can advise and assist their national stakeholders in the selection and implementation of alternative refrigerants.



### **PHASING-OUT HCFCs IN SMALL AND MEDIUM-SIZED ENTERPRISES** - This booklet aims to

assist foam enterprises, especially SMEs, to better understand policies on HCFC phase-out, access to assistance from the Multilateral Fund for the Implementation of the Montreal Protocol and access alternative technologies in different foam applications taking into account challenges in converting to alternative technology. It also discusses some tips on how to identify enterprises that may use HCFCs and verify the HCFCs consumption of enterprises.



### **INTERNATIONAL STANDARDS IN REFRIGERATION AND AIR-CONDITIONING** - This guide

provides an introduction and simple overview of the issues related to international standards in the refrigeration and air-conditioning sector and how they can be useful in the context of the phase-out of hydrochlorofluorocarbons (HCFCs) in developing countries as required by the Montreal Protocol on Substances that Deplete the Ozone Layer.



## EVENTS

**2017**

**EUREKA<sup>2017</sup>**

**EUREKA 2017: Heating, Cooling & Ventilation: Sustainable technologies for a better life,**  
11-12 December 2017, Berlin, Germany

**2018**



**The HVAC & Refrigeration Show,** 23 - 25 January 2018, London, United Kingdom

*A/Ccess* is the theme of the MACS 2018 Training Event and Trade Show to be held 14-18 February 2018, at the Caribe Royale Hotel and Convention Center, USA



**AIRAH Refrigeration 2018,** 26 – 27 March 2018, Sydney, Australia



**2nd IIR International Conference on the Application of HFO Refrigerants**  
2nd - 5th September 2018

**1st IIR International Conference on the Application of HFO Refrigerants.**  
2-5 September 2018, Austin Court Conference Centre, Birmingham, United Kingdom



## READING



[Twenty Questions and Answers About the Ozone Layer](#), presents complex science in a straightforward manner. It complements the [2014 Scientific Assessment Report of Ozone Depletion](#) by WMO and the U.N. Environment Programme.



[UNEP and USEPA: Promoting ozone and climate-friendly technologies in public procurement - a scoping study of Asia Pacific](#)



[WMO Antarctic Ozone 2016 Bulletin](#) - Containing information on the state of the ozone layer in the Antarctic at roughly two week intervals from August to November. The bulletins are based on data provided by WMO Members which operate ozone monitoring stations in the southern hemisphere and satellites to observe ozone globally.



The [EU F-Gas Regulation Handbook](#), Keeping Ahead of the Curve as Europe Phases Down HFCs - a free online resource for climate media and other concerned parties, published by the London-based Environmental Investigation Agency (EIA).



[Alternative Refrigerant Evaluation for High-Ambient-Temperature Environments: R-22 and R-410A Alternatives for Mini-Split Air Conditioners](#)



[AREA Guidance on minimum requirements for contractors' training & certification on low GWP Refrigerants](#) - AREA has updated its Guidance on minimum requirements for contractors' training & certification on low GWP Refrigerants.



[Free guide to F-gas changes](#) The European contractors association AREA has produced a timely guide to the F-gas regulations which clarifies the new rules, their impact and their practical application...[Read more](#)



The recent [Alternatives to HCFCs/HFCs in developing countries](#) with a focus on high ambient temperatures" study carried out by Öko-Recherche for the European Commission stresses that the refrigerant and blowing agent demand is expected to triple by 2030 in developing countries as a result of economic growth. A sector by sector analysis shows that a climate-friendly replacement for current and future of HCFCs and high GWP HFCs is possible in most applications ...



[Primer on Hydrofluorocarbons](#), Fast action under the Montreal Protocol can limit growth of HFCs, prevent up to 100 billion tonnes of CO<sub>2</sub>-eq emissions by 2050, and avoid up to 0.5°C of warming by 2100. IGSD, January 2014, Lead authors: Durwood Zaelke, Nathan Borgford-Parnell, and Danielle Fest Grabiell. Contributing authors: Stephen O. Andersen, Xiaopu Sun, Dennis Clare, Yuzhe Peng Ling, and Alex Milgroom.



[Flammable Refrigerants Safety Guide](#), AIRAH - Many of the refrigerants traditionally used in refrigeration and air conditioning systems in Australia have been non-flammable, non-toxic, synthetic greenhouse gases (SGGs) that have a high global warming potential (GWP). These were typically synthetic refrigerants including CFCs, HCFCs and HFCs. Due to the growing national and international concern regarding the resulting atmospheric effects of SGGs, the use of alternative low GWP refrigerants is increasing. ...



[Recent Trends in Global Emissions of Hydrochlorofluorocarbons and Hydrofluorocarbons: Reflecting on the 2007 Adjustments to the Montreal Protocol](#). S. A. Montzka \*†, M. McFarland ‡, S. O. Andersen §, B. R. Miller †||, D. W. Fahey †, B. D. Hall †, L. Hu †||, C. Siso †||, and J. W. Elkins †† Earth System Research Laboratory, National Oceanic and Atmospheric Administration, Boulder, Colorado 80305, United States ‡ DuPont Chemicals & Fluoroproducts, Wilmington, Delaware 19805, United States § Institute for Governance &

Sustainable Development, Washington, D.C. 20007, United States|| Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, United States.

## [Geothermal Heating and Cooling: Design of Ground-Source Heat Pump Systems](#)- ASHRAE

A first edition, the IIR guide “[CO<sub>2</sub> as a Refrigerant](#)” highlights the application of carbon dioxide in supermarkets, industrial freezers, refrigerated transport, and cold stores as well as ice rinks, chillers, air conditioning systems, data centers and heat pumps. This guide is for design and development engineers needing instruction and inspiration as well as non-technical experts seeking background information on a specific topic. Publication, IIR Technical Guide, 2014.

FREE [HVAC Optimisation Guide released](#) by AIRAH and the NSW Office of Environment & Heritage outlines 20 HVAC optimisation strategies and how they can be applied to the vast majority of commercial systems, both in older and modern buildings...

## [Latin America Industrial Refrigeration Equipment Market Benefits from Region Flourishing Food and Beverage Production and Processing Market](#) – Trends and forecast 2013-2019.

## [Solvents & Bio Solvents Market Outlook - Global Trends, Forecast, and Opportunity Assessment \(2014-2022\)](#)

## [Chlorofluorocarbon Market: Global Industry Analysis and Forecast 2015 to 2021](#)

[Getting The World Off the Chemical Treadmill: A per capita convergence framework for an ambitious phase-down of HFCs under the Montreal Protocol](#), By: Umang Jalan, Research Associate, Climate Change Programme, Centre for Science and Environment

[The Importance of Ambition in the 2016 HFC Phase-Down Agreement](#). Download the full report from EIA, [here](#)

[Update on the Illegal Trade in Ozone-Depleting Substances](#) – The Environmental Investigation Agency (EIA) briefing to the 38<sup>th</sup> meeting of the Open-Ended Working Group of Parties to the Montreal Protocol, in Vienna, Austria, from July 18-21, 2016.

[F-Gas Regulation shaking up the HVAC&R industry](#). Commissioned by the Greens in the European Parliament, the study provides qualitative and quantitative analysis of the early impacts of the EU F-Gas Regulation on the European industry and evaluates its influences on other countries and regions in designing their own policies to curb HFCs.

"[The Road to Competence in Future Green Technologies](#)", the International Special Issue 2016-2017 of Centro Studi Galileo. Read/Download [pdf version](#) | [E-book](#)

The [2016 editions of ASHRAE's major refrigerants-related standards](#) have been published as a package with 30 new refrigerants and refrigerant blends added.

[Quest for climate-friendly refrigerants finds complicated choices](#), National Institute of Standards and Technology (NIST), 17 February 2017, Summary: Researchers have just completed a multiyear study to identify the 'best' candidates for future use as air conditioning refrigerants that will have the lowest impact on the climate.



Industrial Refrigeration Equipment Market (Refrigeration systems, Coil and Condensers, Thermal panels and Parts) - Latin America Industry Analysis, Size, Share, Growth, Trends and Forecast 2013 - 2019





The second issue of [The Natural Voice magazine](#), entitled ‘Mainstreaming Natural Refrigerants’ showcases examples of installations using natural refrigerants around the world, including in the Gambia, Jordan, South Africa, China, Thailand, Tanzania and Saudi Arabia.



[Industria & Formazione, no. 2/17](#), Preview of the journal Industry & Training in refrigeration and air conditioning, technical refrigeration and air-conditioning, Centro Studi di Galileo # 406 Technological innovations in cooling and air conditioning with special focus on the F-Gas new regulations, new refrigerants, components and systems, food storage and cold sector. Vol. XLI - No. 2-2017.



Refrigeration: An increasingly strategic issue for data centres - [Cooling data centres: A major economic challenge](#) Today, data centres play a key role in many businesses as information technology is becoming an increasingly strategic factor. Cooling can present a major economic challenge for data centres. If cooling is implemented incorrectly or is inadequate, the amount of energy required to cool a data centre can equal or exceed that used to operate the equipment. Larger data centres can use a staggering amount of energy just to ensure the day-to-day running of electronic equipment. As a result, these data centres can produce a great deal of heat, which require large-scale cooling systems in order to maintain efficient and continual operation... Browse through a selection of [articles and papers](#), by [iifir](#)



[shecco](#) GUIDE to Natural Refrigerants Training in Europe shows that training is readily available. [Read on r744](#)



[40 Years of Global Environmental Assessments: A Retrospective Analysis](#), J. Jabbour and C. Flachsland. Environmental Science & Policy



FactSheet - [Hazards during the Repair and Maintenance of Refrigeration Systems on Vessels](#).



[High-performance insulation materials market](#), June 2017



[EIA Applauds Bipartisan Effort to Tackle Super Pollutants, Including HFCs](#). Environmental Investigation Agency, 8 June 2017



[The Environmental Investigation Agency \(EIA\)](#), recently launched report: [Chilling Facts VII](#) , [Chilling Facts I-VI](#) reports available [here](#)



ASHRAE Releases New Edition of [Principles of Heating, Ventilating and Air Conditioning](#). - Eighth edition of textbook updated based on the 2017 ASHRAE Handbook - The textbook is ASHRAE’s recommended text for HVAC instruction and presents the fundamental concepts for HVAC systems and design.



[The Australian Institute of Refrigeration, Air Conditioning and Heating outlines the Future of HVAC in a Net-Zero World](#)



“[Absorption Chillers Market: Global Industry Analysis and Forecast, 2017-2025](#),”... The demand for thermally-driven chillers in multiple industrial verticals is poised to grow in the immediate future. Considering the rising demand for electrical chillers in commercial, residential as well as industrial settings, the adoption of absorption chillers will gain traction at considerable rate. By consuming lesser energy than conventional electrical chillers, absorption chillers will also garner surplus demand for not using ozone-depleting chlorofluorocarbons (CFC) for chilling purposes. Persistence Market Research’s latest report delivers key insights for the future of global [absorption chillers market](#), excerpts from which highlight that by the end of 2025, more than US\$ 2 Bn worth of absorption chillers will be sold throughout the globe...



[Thousands of scientists issue bleak ‘second notice’ to humanity](#), The Washington Post, Speaking of Science, 13 November 2017, By: Sarah Kaplan



## MISCELLANEOUS

### Announcement!

The UN Environment, OzonAction, in collaboration with Marco Gonzalez and Stephen O. Andersen are updating and expanding the Montreal Protocol Who’s Who” as part of the celebration of the 30<sup>th</sup> Anniversary of the Montreal Protocol - which was agreed as 16 September 1987.



**The new website will be launched during the upcoming Meeting of the Parties to the Montreal Protocol, Montreal, Canada, 20-24 November 2017.**

We are pleased to invite you to submit your nomination\*, and/or nominate an Ozone Layer Champion(s). The short profile should reflect the nominee’s valuable work related to the Montreal Protocol and ozone layer protection.

**Please notify and nominate worthy candidates through the [on-line form](#)**

Looking forward to receiving the nomination(s), and please feel free to contact our team for any further assistance concerning your nomination.

**Take this opportunity to raise the profile of men and women who made important contribution to the Montreal Protocol success and ozone layer protection.**

▶ Contact : [Samira Korban-de Gobert](#), UN Environnement, OzonAction

*\* If you are already nominated, no need to resubmit your profile*



[UN knowledge platform launches live-tracking tools to review progress towards SDGs](#), UN Environment’s dynamic online platform designed for sharing contextualized data...



New **International Journal of Refrigeration** service for IIR members - As of January 2017, not only will IIR members continue to receive the hard copy of the journal but IIR membership will now also give members access to the complete archives of the *International Journal of Refrigeration (IJR)* online. Designed with IIR members in mind, this new and practical electronic subscription gives members substantial advantages:

- Immediate and permanent access to the latest research and to IJR archive
- Access the latest articles as soon as they become available online.
- Browse, search and read each one of the nearly 4,500 papers since Volume 1, Issue 1.
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**International Observers - New AREA membership category** - Due to the significant worldwide interest in European legislative developments and the increase in competence of personnel who handle new refrigerants, AREA is pleased to introduce its brand new "International Observer" membership category. This provides a fantastic opportunity for non-European RACHP installer bodies the world, to benefit from the expertise and discussions within Europe through access to AREA. Contact: [info@area-eur.be](mailto:info@area-eur.be)



The Mobile Air Conditioning Society (MACS) Worldwide has released the **MACS Mobile A/C Diagnostics app** powered by Shiftmobility® for use on all mobile devices. The MACS app includes comprehensive mobile A/C and engine cooling system specifications for cars and light duty trucks from 1960-present; A library of heavy duty vehicle specifications donated by MACS member companies; access to MACS training calendar and website, archived MACS **ACTION™** magazines and **Service Reports**, MACS mobile A/C diagnostic checklists and a MACS member supplier directory. The MACS app is available only to MACS members in good standing. Each membership will receive one free download; and additional member downloads are \$60 each annually. The MACS app can be downloaded from the Google play or iTunes store



US GreenChill Webinar: **Supermarket Experiences Managing Refrigeration Systems in Small-Format Stores**

Date: Tuesday, December 5, 2017 | Time: 2:00 pm to 3:00pm (Eastern time)

Description: Amber Hardy and Brad Birchfield from Aldi will discuss Aldi's experiences with natural refrigerants and what factors led the company to its current portfolio. They will also discuss Aldi's strategy for natural refrigerants, as well as the benefits and the obstacles. Ed Stanek, of ABC Refrigeration & Air Conditioning, and Jason Babin, of Hillphoenix, will also join as technical experts.

**To join the webinar:** 1. Visit the webinar access page: [Supermarket Experiences Managing Refrigeration Systems in Small-Format Stores](#). 2. Select "Enter as a Guest". It is important that you select the option to enter as a guest. 3. Enter your name. 4. Click "Enter Room". 5. Click "OK".

**For audio:** 1. Call the toll free call-in number: 1-866-299-3188 (706-758-1822 from outside the U.S.) 2. Use Conference Code: 202 343 9185#

### **Vatican Pontifical Academy of Sciences Proposes Practical Solutions to Prevent Catastrophic Climate Change**

*New Declaration from Vatican's Scientific Body Finds Climate Change Is Existential Threat to Humans and the Earth Unless We Act Fast*

Vatican City, Vatican, 9 November 2017 – Scalable and practical solutions exist to help preserve the quality of life of future generations in the face of accelerating climate impacts, and with perhaps a decade left to put these into place, the time for climate change action is now. These are the conclusions of the *Declaration* issued last week by the Vatican's Pontifical Academy of Sciences, entitled "[Our Planet, Our Health, Our Responsibility](#)".

Noting with concern that "climate change caused by fossil fuels and other human activities poses an existential threat to *Homo sapiens* and contributes to mass extinction of species," the Pontifical Academy of Sciences and the seven climate change experts leading a key workshop that produced the *Declaration* called on governments, faith leaders, civic society and other stakeholders to urgently undertake the scalable and practical solutions available to mitigate climate change.

The twelve solutions – which include rapid reductions of short-lived climate pollutants and the development of carbon dioxide removal technologies – are based on a three-lever cooling strategy outlined in the recently published matched pair of reports the [\*Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change\*](#), authored by a team of 33 prominent scientists and policy experts co-chaired by Professor V. Ramanathan of the Scripps Institution, Nobel Laureate Mario Molina, and IGSD President Durwood Zaelke, and the peer-reviewed companion paper by Xu & Ramanathan, [\*Well Below 2°C: Mitigation strategies for avoiding dangerous to catastrophic climate changes\*](#) in the *Proceedings of the National Academy of Science*.

The strategy elaborated in the two *Under 2°C* reports and echoed in the *Declaration* demonstrate how the bending the emissions curves of climate pollutants and successfully limiting global temperature to less than 2°C above pre-industrial levels – as global leaders have pledged through the Paris Agreement – can be achieved by pulling three levers:

- Decarbonizing the global energy system by mid-century;
- Drastically reducing emissions of short-lived super climate pollutants like hydrofluorocarbons, methane, and black carbon by 2020;
- Undertaking atmospheric carbon extraction, which will be needed if CO<sub>2</sub> emissions do not peak by 2020.

“The world has cumulatively emitted about 2.2 trillion tons of CO<sub>2</sub> to date, and there is a 1 in 20 chance that emission beyond this rate presents catastrophic and perhaps even an existential risk” said Professor V. Ramanathan, lead co-author of the *Declaration* and both *Under 2°C* reports. “To put in perspective, how many of us would choose to buckle our grandchildren to an airplane seat if we knew there was as much as a 1 in 20 chance of the plane crashing? With climate change that can pose existential threats, we have already put them in that plane. The good news from our findings is that there is still time to avoid these catastrophic changes.”

“The feasibility of achieving this aggressive three-lever mitigation strategy implemented through the twelve solutions is backed up by numerous living laboratories ranging from cities such as Stockholm to large states like California, the sixth largest economy in the world, that have already embarked on mitigation actions such as 40% reductions in CO<sub>2</sub> emissions by 2030 and 50% to 80% reductions in short-lived climate pollutants” said Zaelke. “The multitude of examples in our recent past—further expanded upon in the reports — provide hopeful cases of humanity’s ability to mobilize to achieve our collective environmental objectives” he added.

The workshop of top scientists, speakers, and observers from around the globe, held from November 2-4, helped remind the world that climate change is an urgent problem requiring urgent solutions.

*Declaration: Our Planet, Our Health, Our Responsibility* is [here](#).

*Health of People, Health of Planet and Our Responsibility Climate Change, Air Pollution and Health*, information is [here](#).

*Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change* is [here](#).

*Well Below 2°C: Mitigation strategies for avoiding dangerous to catastrophic climate changes* is [here](#).

[Institute for Governance & Sustainable Development \(IGSD\)](#), 9 November 2017



**The Montreal Protocol Who's who**  
*See the latest nominations /*

Nominate Ozone Layer Protection Champion  
From Your Country /Region >>

<http://www.unep.fr/ozonaction/montrealprotocolwhoswho>

MONTREAL PROTOCOL  
WHO'S WHO

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<sup>[i]</sup> The SolarChill Project partners today include: Danish Technological Institute (DTI), German Government Development Agency (GIZ) GmbH, Global Environment Facility (GEF), Greenpeace International, HEAT GmbH, Programs for Appropriate Technologies in Health (PATH), Swiss Resource Centre and Consultancies for Development (SKAT), United Nations Environment Programme (UNEP), United Nations Children's Fund (UNICEF) and the World Health Organization (WHO).

<sup>[ii]</sup> [http://www.who.int/immunization/programmes\\_systems/supply\\_chain/optimize/direct\\_drive\\_solar\\_vaccine\\_refrigerator.pdf](http://www.who.int/immunization/programmes_systems/supply_chain/optimize/direct_drive_solar_vaccine_refrigerator.pdf)