World Refrigeration Day
26 June 2019

Refrigerants for Life

How refrigerants affect modern life

WEBINAR
BY ASHRAE, UN ENVIRONMENT OZON ACTION AND WRD SECRETARIAT
Sheila J. Hayter
ASHRAE Presidential Member
World Refrigeration Day
26 June 2019

Refrigerants for Life

How refrigerants affect modern life

WEBINAR
BY ASHRAE, UN ENVIRONMENT OZON ACTION ANDWRD SECRETARIAT
James S. Curlin
Acting Head of OzonAction,
UN Environment
James S. Curlin
Acting Head of OzonAction, UN Environment

UNEP’s Remarks

Refrigerants for Life;
How Refrigerants Affect Modern Life
UN Environment OzonAction, (ASHRAE), and the World Refrigeration Day Secretariat are campaigning for the first World Refrigeration Day (WRD), on 26 June 2019 with the theme of:

REFRIGERANTS FOR LIFE
### The Montreal Protocol and Dynamics of Technology

**Non-Article 5 parties**
- **Baseline formula**
- Average HFC consumption for 2011-2013 + 15% of HCFC baseline
  - 2019: 10%
  - 2024: 40%
  - 2029: 70%
  - 2034: 80%
  - 2036: 85%

**A5 parties – “Group 1”**
- **Baseline formula**
- Average HFC consumption for 2020-2022 + 65% of hydrochlorofluorocarbon (HCFC) baseline
  - 2024: Freeze 10%, 30%
  - 2029: Freeze 10%, 30%
  - 2035: Freeze 10%, 30%
  - 2040: Freeze 10%, 30%
  - 2045: Freeze 10%, 30%

**A5 parties – “Group 2”**
- **Baseline formula**
- Average HFC consumption for 2024-2026 + 65% of HCFC baseline
  - 2028: Freeze 10%, 30%
  - 2032: Freeze 10%, 30%
  - 2037: Freeze 10%, 30%
  - 2042: Freeze 10%, 30%
  - 2047: Freeze 10%, 30%
The Bigger Picture; How HVAC&R contributes to SDGs?

Technology Selection (7 Goals)
- Health, Food Cold Chain, Cities, Renewables, Climate Action, Sustainable Production & Consumption and Innovation

Research, Education and Career (3 Goals)
- Quality of Education, Jobs & Economic Growth and Innovation

Welfare and Quality of Life (7 Goals)
- Food Security, Health, Education, Clean Water, Jobs & Economics, Cities and Innovation & Infrastructure

Brazil, China, India, Mexico, Korea RO, Saudi Arabia, Thailand

Afghanistan, Algeria, Argentina, Bahrain, Bangladesh, Benin, Burkina Faso, Cameroon, Chile, Colombia, Côte d’Ivoire, Congo DR, Dominican Republic, Egypt, Gabon, Ghana, Indonesia, Iran, Iraq, Jordan, Kenya, Korea DPR, Korea Rep, Kuwait, Lebanon, Libya, Madagascar, Malaysia, Morocco, Niger, Nigeria, Oman, Pakistan, Panama, Peru, Philippines, Qatar, Senegal, Singapore, Somalia, South Africa, Sudan, Syria, Trinidad and Tobago, Tunisia, Turkey, United Arab Emirates, Uruguay, Venezuela, Viet Nam, Yemen

Very large volume consuming countries

Medium volume consuming countries

LVCs

Same needs but different capacities
## Diverse range of stakeholders to engage with

<table>
<thead>
<tr>
<th>A. Institutional (Public Sectors)</th>
<th>A. Technical (Private, Non-Governmental)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. NOUs (Environmental Authorities)</td>
<td>1. Servicing workshops, companies and technicians</td>
</tr>
<tr>
<td>2. Energy / Climate</td>
<td>2. Refrigerants’ importers, wholesalers and distributors</td>
</tr>
<tr>
<td>3. Customs, Enforcement, Boarder controls</td>
<td>3. Training Institutes and Centers</td>
</tr>
<tr>
<td>4. Standardization Authorities</td>
<td>4. Engineers, plants/facility managers and operators</td>
</tr>
<tr>
<td>5. Industry Authorities</td>
<td>5. Consultants and consulting firms</td>
</tr>
<tr>
<td>7. Research Institutes &amp; Universities</td>
<td>7. Research Institutes &amp; Universities</td>
</tr>
<tr>
<td>8. Housing and Buildings Authorities</td>
<td>8. Engineering groups</td>
</tr>
<tr>
<td>10. Marine/Fisheries/Agriculture/Ports, Others</td>
<td></td>
</tr>
<tr>
<td>11. Chambers of Trade and Industry</td>
<td></td>
</tr>
</tbody>
</table>
# OzonAction Partnerships

<table>
<thead>
<tr>
<th>AHRI</th>
<th>Refrigerant Driving License (RDL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E-Learning, Award, Events, Guides and more</td>
</tr>
<tr>
<td></td>
<td>Model for Cold Chain Database</td>
</tr>
<tr>
<td></td>
<td>Technology Awareness for Cold Chain Sectors</td>
</tr>
<tr>
<td></td>
<td>Risk Assessment Model for flammable Refrigerants</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Universal Training Kit</th>
</tr>
</thead>
<tbody>
<tr>
<td>on Sound Management of Refrigerants</td>
</tr>
<tr>
<td><em>(In cooperation with AREA)</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EPEE</th>
<th>HFCs Outlook</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scenario Model for A5 countries</td>
</tr>
<tr>
<td></td>
<td><em>(In cooperation with EPEE)</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ATF</th>
<th>National Certification Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>based on F0Gas Certification</td>
</tr>
<tr>
<td></td>
<td><em>(In cooperation with ATF)</em></td>
</tr>
</tbody>
</table>
WEBINAR
9:00 - 10:30 EDT
Wednesday 26 June 2019

Refrigerants for Life:
How Refrigerants affect Modern Life

https://www.unenvironment.org/ozonaction/refrigerants-life
World Refrigeration Day
26 June 2019

Refrigerants for Life

How refrigerants affect modern life

WEBINAR
BY ASHRAE, UN ENVIRONMENT OZON ACTION AND WRD SECRETARIAT
Stephen Gill
World Refrigeration Day Secretariat
World Refrigeration Day
26 June 2019

Refrigerants for Life

How refrigerants affect modern life

WEBINAR

BY ASHRAE, UN ENVIRONMENT OZONACTION AND WRD SECRETARIAT
World Refrigeration Day
26 June 2019

Refrigerants for Life

Sheila Hayter
ASHRAE President

James S. Curlin
Acting Head of OzonAction
UN Environment

Stephen Gill
World Refrigeration Day
Secretariat

Didier Coulomb

Ray Gluckman

Andy Pearson

Andrea Voigt

Rajan Rajendran
World Refrigeration Day
26 June 2019

Refrigerants for Life

WEBINAR

HOW REFRIGERANTS AFFECT MODERN LIFE

DIDIER COULOMB, DIRECTOR GENERAL
INTERNATIONAL INSTITUTE OF REFRIGERATION (IIR)
WWW.IIFIIR.ORG
1. **Cooling:**
   (1) Removal of heat, usually resulting in a lower temperature and/or phase change.
   (2) Lowering temperature.

2. **Refrigeration:**
   (1) Cooling of a space, substance or system to lower and/or maintain its temperature below the ambient one (removed heat is rejected at a higher temperature).
   (2) Artificial cooling

3. **Chilling:**
   Cooling of a substance without freezing it.

4. **Freezing:**
   Solidification phase change of a liquid or the liquid content of a substance, usually due to cooling.

5. **Cold Chain:**
   Series of actions and equipment applied to maintain a product within a specified low-temperature range from harvest/production to consumption.
A few figures (IIR informatory note):

- 5 billion systems worldwide, including 2.6 billion air-conditioning units (1.1 billion residential; 1 billion mobile; 0.5 billion commercial), 2 billion domestic refrigerators and freezers (+0.12 billion commercial refrigeration...)
- 0.22 billion heat pumps
- Annual sales: 500 billion USD
- Already 20% of the overall electricity used worldwide
- 7.8% of global GHG emissions, 63% due to indirect emissions
Figures are constantly increasing and will continue to increase dramatically, particularly because of two sectors:

- **Food and health products**
  - Food losses are huge due to a lack of a cold chain: about 20% of the global food supply

  Ex:  India
  
  22% fruits and vegetables, 34% meat → cold chain / Europe 95%

  The number of heat-sensitive healthcare products increased by 45% from 2011 to 2017; one out of 2 medicines on the market is now heat-sensitive.
Figures are constantly increasing and will continue to increase dramatically, particularly because of two sectors:

- **Air conditioning**
  - AC-ownership rate:
    - 4% in India
    - 60% in China
    - 10% in Europe
    - 90% in the USA and Japan
    - 100% in some Middle East countries

According to the IEA, global energy needs for space cooling would triple by 2050 (baseline scenario-business as usual).
Vital needs

Health is vital, and cooling is health, including air conditioning.

Ex: US

“The mortality impact of days with a mean temperature exceeding 27°C has declined by about 75% over the course of the 20th century”

Development is necessary
Population is dramatically increasing in the less developed countries (Africa, South Asia)
Ageing population is increasing all over the world.
Consequences

Demand for cooling will continue to increase dramatically and global warming will further accentuate this trend.

→ Need for more people
   Ex: In the US, employment of mechanics and installers in HVACR is projected to grow by 15% from 2016 to 2026 (average for all occupations: 7%)

→ Need to reduce the environmental impact
   The Kigali amendment,
   Use of renewable energy, energy efficiency.
Solutions exist

- Certifications
- Training
- Development of alternative refrigerants
- Development of solar energy
- Integrated systems (buildings, districts, etc.) but not enough focused on cooling
- Energy efficiency margins: ex, the average efficiency of ACs sold today is less than half what is typically available and one third of best available technology.

But Need for information, particularly for SMEs
Promoting cooling in schools (to attract future technicians, engineers, etc.) and in the direction of public authorities is essential
Initiatives

- World Refrigeration day
- Congresses and conferences
- Informatory notes, briefs, statements
- Databases
- Working groups
- Research and innovation
THANK YOU

d.coulomb@iifiir.org
World Refrigeration Day
26 June 2019

Refrigerants for Life

How refrigerants affect modern life

WEBINAR
BY ASHRAE, UN ENVIRONMENT OZONACTION AND WRD SECRETARIAT
World Refrigeration Day
26 June 2019

Refrigerants for Life

SNAPSHOT OF REFRIGERANTS MARKET AND DEVELOPMENT

RAY GLUCKMAN
GLUCKMAN CONSULTING, UK
Drivers for selecting new refrigerants

• **global HFC phase-down**
  • Kigali Amendment
  • leading to 85% cut in GWP-weighted HFC use
  • but, relatively slow start – especially for Article 5 countries

• **national and regional regulations**
  • e.g. EU Regulation creates fastest HFC phase-down
    • 2018: 44% cut in HFCs that can be sold
    • 2021: 60% cut

• **international “pull-through”**
  • influence of major equipment suppliers in all countries
  • innovation (e.g. efficiency) targeted to newer refrigerants
What does “lower” GWP mean?

• **ideal solution: “ultra-low” GWP**
  - e.g. GWP <10: pure HFOs, ammonia, CO₂, HCs
  - but, available ultra-low options don’t suit all RACHP applications

• **consider GWP compared to “traditional” HFC option**
  - R-404A (GWP 3922)
    - R-448A and R-449A (GWP ~1400): 65% lower
  - HFC-134a (GWP 1430)
    - a GWP of 1400 is not “lower”!
    - R-450A and R-513A (GWP ~600): 50% lower
Achieving HFC phase-down in non-A5 countries

• **start point (in non-Article 5 countries)**
  • dominant HFCs: R-404A, R-410A, HFC-134a
  • average GWP of all HFCs used ~2000

• **target after 85% cut**
  • average GWP ~300 (assuming equal market size)

• **early stages of phase-down**
  • using refrigerants with GWP of 1400 to replace R-404A is a reasonable strategy

• **later stages of phase-down**
  • only limited use of GWP 1400 refrigerants will be possible
Achieving HFC phase-down in A5 countries

• **start point (in Article 5 countries)**
  • dominant refrigerant: HCFC-22
  • HCFC phase-out only just started
  • HFC phase-down starts with freeze (2024 or 2028)

• **possible route**
  • adopt “the usual” HFCs to replace R-22
  • i.e. R-404A, R-410A, R-134a
  • then switch to lower GWP refrigerants in 5 to 10 years

• **better route: jump directly to lower GWP gases**
  • switch to lower GWP technologies as part of HCFC phase-out process
Menu of refrigerants

• **high GWP HFC menu** - only a small number of relevant refrigerants
  • 3 dominant: R-404A, R-410A, HFC-134a
  • plus a few others e.g. R-407C
  • patents expired on almost all products

• **lower GWP menu** - much more complex
  • ammonia, CO₂, propane, iso-butane
  • various pure HFOs including 1234yf, 1234ze, 1233zd
  • lower GWP pure HFCs including HFC-32, HFC-152a
  • numerous new blends – at least 20 under consideration
# Examples of New Blends

<table>
<thead>
<tr>
<th>GWP</th>
<th>Example Blends</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>R-514A</td>
</tr>
<tr>
<td>10 – 150</td>
<td>R-454C, R-455A, R-459B</td>
</tr>
<tr>
<td>750 – 1400</td>
<td>R-448A, R-449A, R-449C</td>
</tr>
<tr>
<td>1400 - 2200</td>
<td>R-452A, R-407F, R-407H</td>
</tr>
</tbody>
</table>
Observations on the changing refrigerant menu

1. Historically 4 refrigerants did most jobs. All flammability class 1 (non-flammable).
2. New menu is still growing, reflecting an immature market.
3. Very likely that the menu will get smaller over time.
4. Many new options are flammability class 2L or 3 (lower or higher flammability)
5. Patents on many lower GWP refrigerants may affect price and availability
7. Retrofit of class 1 refrigerant with a flammable fluid is risky: should be avoided
Some markets with clear trends to ultra-low GWP

<table>
<thead>
<tr>
<th>Market Sector</th>
<th>Refrigerants Being Adopted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic refrigerators</td>
<td>HC-600a</td>
</tr>
<tr>
<td>Mobile air-conditioning</td>
<td>HFO-1234yf</td>
</tr>
<tr>
<td>Stand-alone retail refrigeration</td>
<td>HC-290</td>
</tr>
<tr>
<td>Air-conditioning / process chillers</td>
<td>HFO-1234ze; HFO-1233zd; R-514A; R-717; R-290</td>
</tr>
<tr>
<td>Large supermarket refrigeration</td>
<td>R-744; R-290 integrals + water loop</td>
</tr>
<tr>
<td>Large industrial refrigeration</td>
<td>R-717; R-744</td>
</tr>
</tbody>
</table>
### Some markets making slower progress

<table>
<thead>
<tr>
<th>Market Sector</th>
<th>Refrigerants Being Adopted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small split air-conditioning</td>
<td>Good progress to HFC-32 in parts of market (GWP 675)</td>
</tr>
<tr>
<td></td>
<td>• safety standards restrict use; ultra-low GWP a big challenge</td>
</tr>
<tr>
<td>Multi-split and VRF air-conditioning</td>
<td>Charge size makes 2L options challenging</td>
</tr>
<tr>
<td></td>
<td>• some progress e.g. using HFC-32 + risk mitigation measures</td>
</tr>
<tr>
<td>Medium sized retail refrigeration</td>
<td>Easy to avoid R-404A with HFO/HFC A1 blends (GWP 1400)</td>
</tr>
<tr>
<td></td>
<td>• A2L alternatives (GWP ~150) beginning to make progress</td>
</tr>
<tr>
<td></td>
<td>• small R-744 becoming more cost effective</td>
</tr>
</tbody>
</table>
Concluding Remarks

- the popular high GWP HFCs can all be avoided in new equipment
- ultra-low GWP options commercially available in several important sectors
- moderate GWP options can make important contribution
  - especially in early years of phase-down process
- end users likely to be confused by so many options
  - this may get worse before market gets rationalised!
- developing countries can jump directly to lower GWP refrigerants
  - avoiding the route taken in most developed countries
World Refrigeration Day
26 June 2019

Refrigerants for Life

How refrigerants affect modern life

WEBINAR

By ASHRAE, UN Environment OzonAction and WRD Secretariat
World Refrigeration Day
26 June 2019

Refrigerants for Life

MODERN REFRIGERATION RESEARCH

DR ANDY PEARSON,
STAR REFRIGERATION LTD
Refrigerant Development

- Ether
- Air
- Absorption
- CO₂
- Hydrocarbons
- Ammonia
- SO₂
- Methyl Chloride

Timeline:
- 1825
- 1850
- 1875
- 1900
- 1925
- 1950
- 1975
- 2000
- 2025

Key Phases:
- Reinvent
- Reposition
- Recognize
- Revolutionize
Modern Refrigeration Research

Coping with the removal of CFC refrigerants...... and HCFC refrigerants

Achieved by:

- Rediscovering old fluids
- Developing new fluids
- Inventing new cycles and systems
  - Thermoacoustic
  - Magneto-caloric
  - Solid adsorption

Improving energy efficiency

Inventing new types of food and food processing
This has been a great time
More money on R&D than ever before
This has been a great time, but

More money on R&D than ever before

Not addressing real world benefits

(running ever harder just to stand still)
Hot areas for research

- Compressor development
- Expander Development
- System configuration
- New working fluids
- New lubricants
Neglected areas

- System modelling
- Digital twin
- Performance prediction
- Internet of Things
- Non-cooling alternatives
World Refrigeration Day
26 June 2019

Refrigerants for Life

How refrigerants affect modern life

WEBINAR

BY ASHRAE, UN ENVIRONMENT OZONE ACTION AND WRD SECRETARIAT
World Refrigeration Day
26 June 2019

Refrigerants for Life

REFRIGERANTS AND THEIR RESPONSIBLE USE

RAJAN RAJENDRAN
REFRIGERATION COMMITTEE, ASHRAE
EMERSON’S VICE PRESIDENT

Reference: ASHRAE Position Document on Refrigerants and Their Responsible Use, ASHRAE, 2018
Overview

HVAC&R essential for human comfort and preservation of food/other products

Refrigerants – working fluids in HVAC&R systems

Fluorinated Fluids
  ◦ CFCs and HCFCs phased out by Montreal Protocol (1987) for ozone depletion effects
  ◦ HFCs being phased down by the Kigali Amendment (2016) for direct global warming effects
  ◦ HFOs and blends of low global warming potential (GWP) fluids now being introduced

Non Fluorinated Fluids
  ◦ Ammonia, CO2, hydrocarbons have low direct global warming impact

Energy consumed by HVAC&R systems often has greater climate impact than refrigerant emissions

Even more important – continuous maintenance and refrigerant management

Responsible use of refrigerants is a holistic task, requiring attention throughout the life of equipment
Selection of Refrigerants

ASHRAE Positions on selection of refrigerants:

- Based on complete analysis: energy efficiency, performance attributes, environmental impact, safety, economics
- Selection should not be based on single factor
- Different applications will necessitate wide variety of refrigerants

Holistic Approach To Selection & Design
Use of Refrigerants

Life Cycle Climate Performance (LCCP)

ASHRAE positions on minimizing climate impact of refrigerants:

Limit both direct and indirect emissions

Key to success: Research, education, improved design, manufacturing, commissioning, maintenance, decommissioning, enforcement of standards and regulations

Equally important: Safe recovery at end of life, reuse, recycle, reclaim, safe destruction, refrigerant management program to track use

Research & Development Recommendations

Promote R&D to investigate and adopt lower GWP refrigerants for better LCCP

Evaluate flammable refrigerants to understand safety, develop safe-use standards and training

Support development and adoption of standards and guidelines to facilitate deployment of lower GWP refrigerants

Balance safety, system energy efficiency, cost and environmental impacts of refrigerants when selecting and designing new lower GWP systems

Advance R&D of new systems that enable reduction of refrigerant charge and emissions

Develop tools, equipment, methodologies and practices to minimize or prevent refrigerant loss during install, operation, maintenance, and decommissioning of systems
Education & Policy Recommendations

Develop and enact certification programs and set benchmarks and competencies of good practices

Introduce training programs about lower GWP refrigerants and their responsible use

Develop and promotes a comprehensive refrigerant management program including refrigerant recovery, recycling (reuse), reclamation, safe disposal and end of life

Promote corporate social responsibility policies and programs

Work with UNEP and others to enable sustainable procurement policies promoting the deployment of energy efficient and lower GWP technologies in HVAC&R
ASHRAE Commitments

In order to promote responsible use of refrigerants and practices that minimize refrigerants’ impacts on environment while enhancing performance, cost effectiveness and safety,

ASHRAE commits to, in a timely manner:

Supporting research to develop and advance HVAC&R technologies and practices

Developing and revising guidelines and standards

Supporting responsible refrigerant use through education, information dissemination and training

Collaborating with societies, universities, private industry, government agencies, and international organizations
World Refrigeration Day
26 June 2019

Refrigerants for Life

How refrigerants affect modern life

WEBINAR
BY ASHRAE, UN ENVIRONMENT OZONACTION AND WRD SECRETARIAT
Refrigerants for Life

REGULATING REFRIGERANTS:
THE ROLE OF GOVERNMENTS AND ASSOCIATIONS

ANDREA VOIGT
DIRECTOR GENERAL EPEE
Who is EPEE?

Founded in 2000, headquartered in Brussels

Currently 48 members from three continents:
• OEMs: heat pumps, a/c, refrigeration
• Component manufacturers
• Gas producers
• Installers
• National & international associations
The demand for cooling is set to grow

- **Warming climate**
- **Ageing / growing population**
- **Urbanisation**
- **Scarcity of resources**
- **Health & Well-being**
- **Digitalisation**
Energy & Refrigerants are in the spotlight

• **Indirect** emissions are related to energy type and consumption and typically represent > 80% of total emissions

• **Direct** emissions are related to refrigerants and represent a far smaller share of the total emissions

→ **Both are interrelated and both need to be addressed to reduce emissions**
Refrigerants are a small but an important part of the puzzle

Minimise the cooling load

Systems

Products

Building Design

Shading

Insulation Glazing

Renewable Energies
Thermal Storage
Heat Recovery
Demand side flexibility
Operation and maintenance
Controls

Product efficiency
Sizing
Materials and Recycling
Refrigerants GWP

Materials and Recycling
They can and have to be addressed in many ways:

- Stop using high GWP refrigerants
- Move to lower GWP refrigerants
- Reduce refrigerant charge sizes
- Design for leak-tightness
- Reduce leakages, maintain, service
- Recover, recycle, reclaim
- Get ready for flammables
The role of governments: provide regulatory certainty

**Solid data**
Policy measures should be based on solid data reflecting industrial and market reality. Reaching out to all stakeholders is key.

**Anticipation**
Policy measures should not be introduced "last minute" but should leave the market sufficient time to adapt. Building codes and standards need to be ready.

**Communication**
Experience with the phase-down in Europe has shown that communication is key to ensure the market is aware and understands how the phase-down works.

**Flexibility**
Policy measures should allow for some flexibility to adapt to the market situation.

**Technology Neutrality**
Policy measures should be technology neutral to give industry the freedom to innovate.

**Cooperation**
Governments should not work in silos and reach out to all stakeholders.
The role of industry associations: engage and prepare

Inform
Communicate
Cooperate
Innovate
Some examples – communicating and informing
Innovative HFC Outlook to model HFC phase-down scenarios
Some examples – educating & raising awareness

- Side events at MOP / OEWG meetings to inform about global policies
- Reaching out to new audiences to raise awareness on cooling
- Discussing out of the box on future of heating and cooling at EUREKA conferences
- Organising roundtables to inform about latest developments
- Participating in roadshows to inform about EU experiences
## Current major EU Trends – triggered by the F-Gas Regulation

<table>
<thead>
<tr>
<th>New Equipment A/C</th>
<th>New Equipment Supermarkets</th>
<th>Existing Equipment Supermarkets</th>
<th>Recovery / Recycling / Reclaim</th>
</tr>
</thead>
</table>
| **Small splits <3kg:**
  large proportion uses R-32 <br> **DX A/C 3kg – 12 kg:**
  rapidly moving to R—32 <br> **A/C water chillers:**
  many models with HFOs available | **No new equipment with R-404A** <br> **Large equipment:**
  lots of CO2 <br> **Small plug-in equipment:**
  hydrocarbons | **Many have invested in leak reduction** <br> **Many have begun retrofit programs** <br> **Big companies become self-sufficient:**
  recovered R-404A for top-ups | **Rapid growth** in reclaim infrastructure <br> **High price of R-404A provides incentive for recovery/reclaim** |

Sources: Gluckman Consulting, 11/2018 and EPEE Gapometer
Conclusion: We can do it!
The success story of the Montreal Protocol

One of the most successful international treaties ever, addressing specific ozone-depleting and greenhouse gases:

- Scientific evidence shows that the ozone layer is healing and is expected to recover by 2050.
- Recently agreed additional measures – the Kigali Amendment – could avoid up to 0.5°C of global warming by 2100.
Thank you for your attention

Contact:

EPEE
46 Avenue des Arts
1000 Brussels, Belgium

secretariat@epeeglobal.org
a.voigt@epeeglobal.org
www.epeeglobal.org
@EPEESecretariat