INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Welcome to the IDEA Webinar Series

- ❑ **The webinar will start promptly at 1:00pm EST (Boston time) and is scheduled to last one (1) hour. We may extend additional time if there are many questions.**
- ❑ **Please mute your phone during the webinar. All lines are muted.**
- ❑ **If you are having problems with video or audio, please send a note via the Chat Box function on the right side. Click the Chat box and choose – "Chat privately to Cheryl Jacques (host)". Or call IDEA at +1-508-366-9339.**
- ❑ **Questions to Presenters: Please enter your Questions in the Q&A box at the lower right of the screen during the presentation. These questions will be moderated and addressed at the conclusion of the presentation and as time allows. We may extend the webinar if many questions remain to be answered.**
- ❑ **Survey: Please complete the brief on-line survey following the webinar.**
- ❑ **Webinar Download or Streaming: Webinar will be recorded and a link will be sent to all registered attendees. It will be available via download or streaming. Slides will be made available in pdf format. Please visit www.districtenergy.org.**

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Refrigerant Update

THE NEXT TRANSITION HAS BEGUN

Ryan Geister
Intelligent Systems Leader
Trane, An Ingersoll-Rand Company

Mike Thompson
Refrigerant Director
Ingersoll-Rand Company

Learning Objectives

After viewing the presentation, attendees will be able to:

- Discuss the science behind why & how HVAC refrigerants are evolving.
- Summarize the drivers behind the new regulations & legislation for HVAC refrigerants.
- Discuss the actions being taken both globally (via the Kigali Amendment to the Montreal Protocol) & domestically (via the U.S. EPA).
- Compare & contrast current & next-generation refrigerant options, in terms of environmental impact, efficiency & safety.

Understand the facts today; plan for tomorrow

World Motivation Driving Actions

Montreal Protocol targets new global agreements on greenhouse gases (GHGs)

http://www.achrnews.com/articles/131056-montreal-protocol-sets-global-hfc-phasedown

Montreal Protocol Se
Global HFC Phasedo

BY RON RAJECKI
THE NEWS STAFF

The end is near for hydrofluorocarbons (HFCs).

The 197 Parties to the Montreal Protocol agreed to begin work on an amendment that will reduce the global production and consumption of HFCs at the 27th Meeting of the Parties (MOP), held Nov. 1-5 in Dubai, United Arab Emirates. The amendment, deemed the "Dubai Pathway," is expected to be completed in 2016 and puts to rest an

Primer on Hydrofluorocarbons

Fast action under the Montreal Protocol can limit growth of HFCs, [illegible] impact that are more severe, and to 100 [illegible] action [illegible] required to reduce climate pollutants.[1] This *Primer* describes how the Montreal Protocol can be used to quickly reduce one climate pollutant, hydrofluorocarbons (HFCs), with further support from national and regional laws and institutions. HFCs are the fastest growing greenhouse gases in much of the world, increasing at a rate of 10-15% per year. They are factory-made gases used in air conditioning, refrigeration, foam insulation, and other specialized sectors. World leaders recognized the threat posed by the growth of HFCs in the outcome document of the Rio +20 Summit in 2012 and called for the gradual phase-down of their production and consumption. Six countries, with the support of more than 100 others, have submitted proposals to undertake such a phase-down under the Montreal Protocol. Support for this approach is growing rapidly, including most recently from the [illegible]

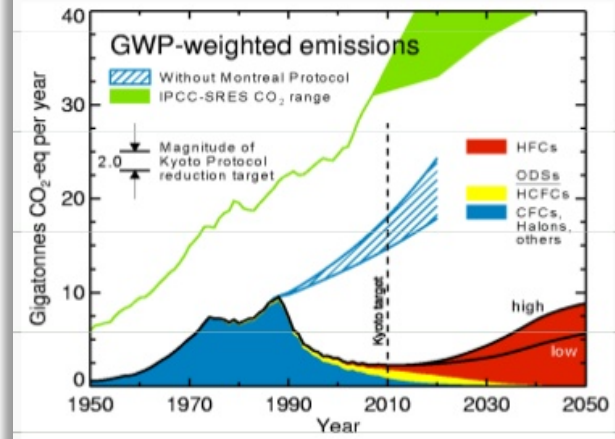
IGSD

Global agreement targeting GHGs, including HFCs in global phase-down
Montreal Protocol: October 2016 at Rwanda, Africa

What is Driving Action in the USA?

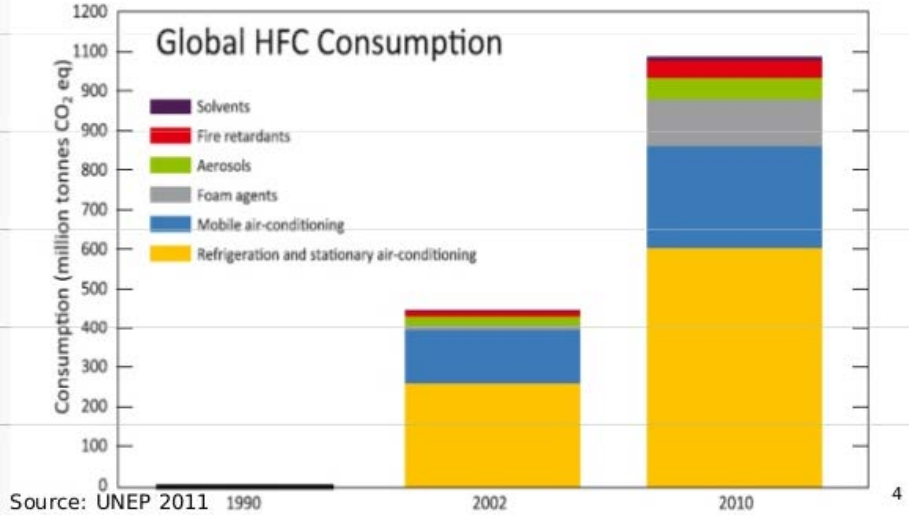
Dramatic global growth of high-GWP HFCs

HFCs: Potential Growth If Unmitigated



- HFC growth directly linked to Montreal Protocol's ODS phaseout and expanding availability of refrigeration & air conditioning
- HFC emissions could reach 19% of projected global CO_2 emissions by 2050 if left unchecked

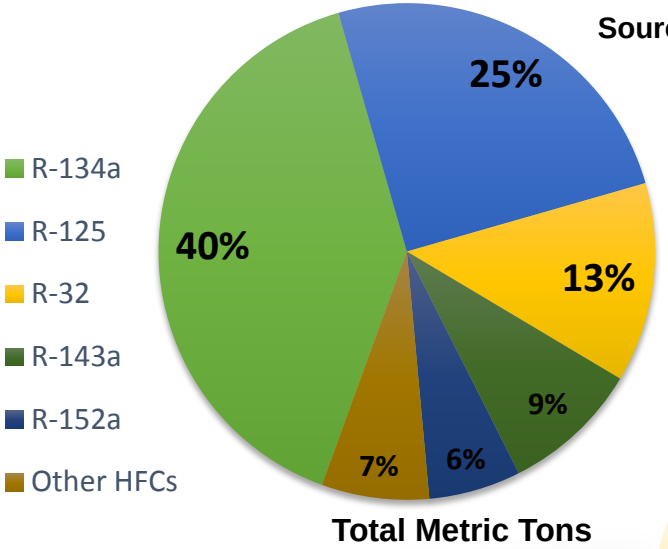
Recent HFC Growth Dramatic and Increasing



Source: UNEP 2011

Alignment with support to sign Montreal Protocol Amendment

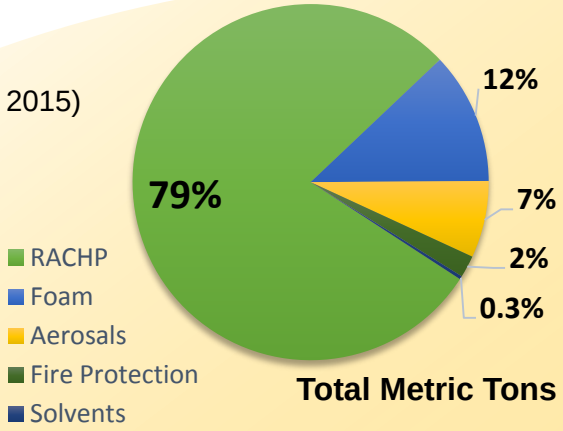
Global Consumption of HFCs



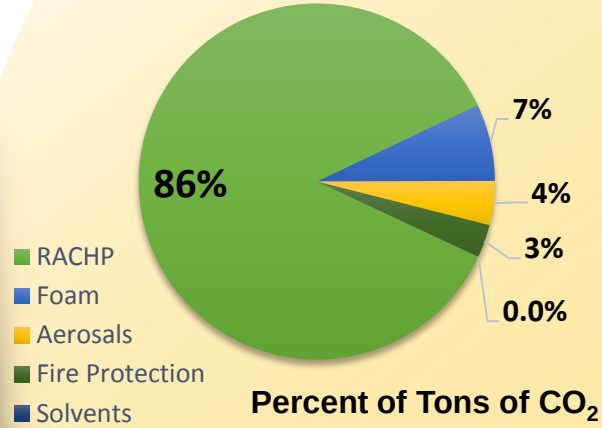
Total Metric Tons

Source: UNEP Ozone Secretariat Fact Sheet 2
"Overview of HFC Market Sectors" (Oct 2015)

Markets Using HFCs



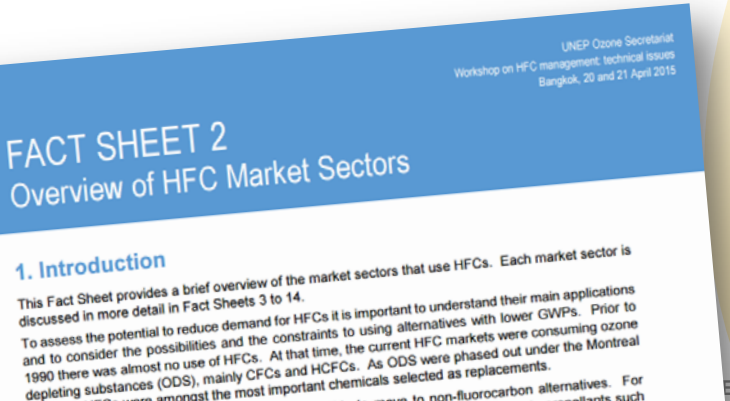
Total Metric Tons



Percent of Tons of CO_2

Market	Key HFCs	GWP
RACHP	R-404A	3922
	R-410A	2088
	R-407C	1774
	HFC-134a	1430
Aerosols	HFC-134a	1430
	HFC-152a	124
	HFC-227ea	3220
Foams	HFC-134a	1430
	HFC-245fa	1030
	HFC-365mfc / HFC-227ea	960 - 1100
Fire protection	HFC-227ea	3220
	HFC-125	3500
	HFC-23	14800
Solvents	HFC-4310mee	1640

RACHP: Refrigeration, Air-Conditioning, Heat-Pumps



UNEP Ozone Secretariat
Workshop on HFC management: technical issues
Bangkok, 20 and 21 April 2015

FACT SHEET 2
Overview of HFC Market Sectors

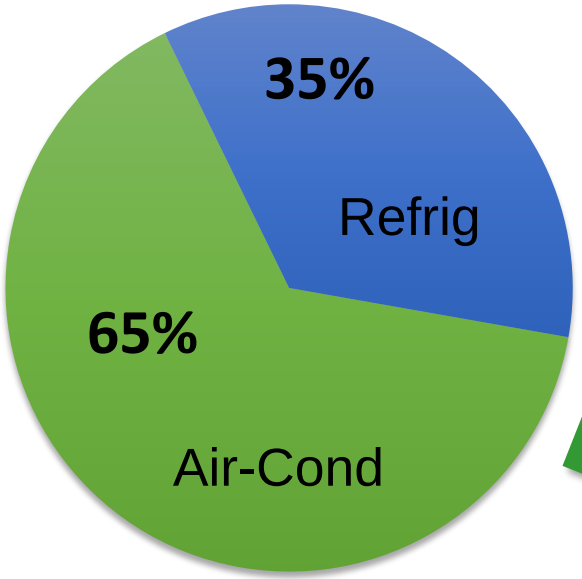
1. Introduction

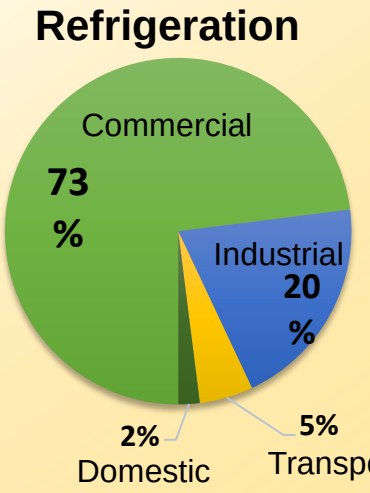
This Fact Sheet provides a brief overview of the market sectors that use HFCs. Each market sector is discussed in more detail in Fact Sheets 3 to 14.

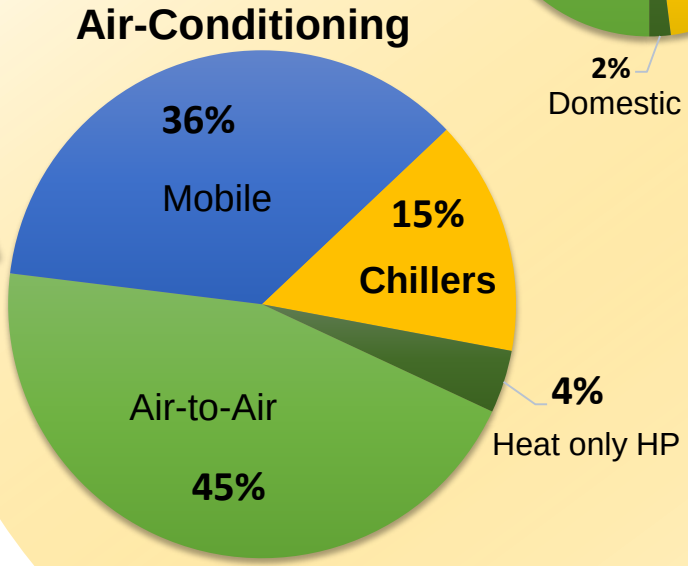
To assess the potential to reduce demand for HFCs it is important to understand their main applications and to consider the possibilities and the constraints to using alternatives with lower GWPs. Prior to 1990 there was almost no use of HFCs. At that time, the current HFC markets were consuming ozone depleting substances (ODS), mainly CFCs and HCFCs. As ODS were phased out under the Montreal

Global HFC use of Refrigerants in RACHP

Refrigeration, Air-Conditioning, Heat Pump







Source: UNEP Ozone Secretariat Fact Sheet 2
"Overview of HFC Market Sectors" (Oct 2015)

Where were we and where are we going?

Past (CFCs)
R-12, R-11, R-113 more…

17 35,453 Cl CHLORINE

⇨ **ODP**

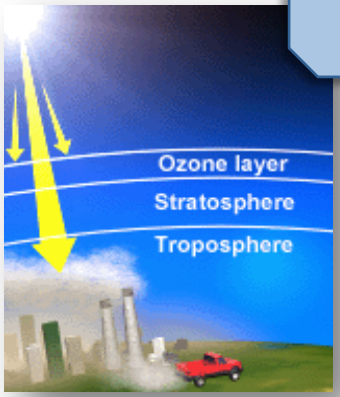
Low-ODP
or no ODP

Present (HCFCs & HFCs)
R-22, R-134a, R-410A, R-407C
R-123, R-404A R-245fa more…

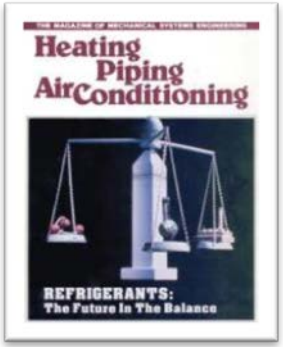
9 18,998 F FLUORINE

⇨ **GWP**

Reduced
GWP & De Minimis ODP



Future (HFO & Blends)
R-1234yf, R-1234ze, R-1233zd, R-513A,
R-1336mzz, R-514A, R-452B, more…



Trane discussed ozone depletion, global warming, and energy efficiency as all being equally important.

As stated in 1991 Trane Article
for HPAC Magazine.

Balanced approach minimizes overall environmental impact:

- Ozone depletion
- Energy efficiency
- Refrigerant emissions
- Global warming
- Atmospheric life

Refrigerant selection focused on minimizing overall impacts

R

What Actions Have Been Taken Already

European Environment Agency

European Union F-Gas Regulations

1-1-2013 de facto ban on R-134a in new model vehicles per Directive 2006/40/EC for Mobile AC

SAE finds R1234yf is "safe and effective"

Published: 23 April 2013

United States Environmental Protection Agency

Corporate Average Fuel Economy (CAFE)

The 2012-2016 Standards offered credits for using low-GWP refrigerants instead of R-134a, with ban in 2021:

- ~ 3-4 MPG for changing refrigerant
- ~ 5 MPG for overall system changes

Vehicles using R-1234yf refrigerant (United States)

- ✓ **BMW** I3, I8
- ✓ **Cadillac** XTS
- ✓ **Chevrolet** Spark EV, Malibu, Trax
- ✓ **Chrysler** 200, 300
- ✓ **Dodge** Challenger, Charger, Dart
- ✓ **Ford** Transit
- ✓ **Honda** Fit EV
- ✓ **Hyundai** Santa Fe, i30
- ✓ **Infinity** Q50
- ✓ **Jeep** Cherokee
- ✓ **Kia** Sorento, Optima, Carenz
- ✓ **Mazda** CX-5
- ✓ **Mitsubishi** Mirage
- ✓ **Range Rover** Sport
- ✓ **Subaru** BRZ, Forrester, Impreza
- ✓ **Tesla** Model S

AHRI's Yurek says global momentum building to phase down HFCs

OnPoint: Wednesday, June 8, 2016

http://www.eenews.net/videos/2138?platform=hootsuite

During this, Interview, Stephen Yurek, president of AHRI, discusses new research collaboration with the USA DOE and the international momentum for aggressive timelines to phase-down HFCs along with how will industry work to comply in phasing-out of HFCs.

Auto industry began transition in 2006; HVAC industry is next

World Motivation Shaped Action

Montreal Protocol Targets New Global Agreement on Greenhouse Gases

November 6, 2015

"Pleased with the progress made, Stephen Yurek, president and CEO of the US Air Conditioning, Heating, and Refrigeration Institute (AHRI), said "AHRI's member companies – including refrigerant producers and original equipment manufacturers – have proactively been researching potential alternative refrigerants to ensure that the world's air conditioning and refrigeration equipment manufacturers will have access to appropriate refrigerants."

http://www.coolingpost.com/world-news/world-could-agree-hfc-phase-down-in-2016/

World could agree HFC phase-down in 2016

Posted on Friday, November 6, 2015 · Leave a Comment

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DUBAI: With HFCs now to be included within the Montreal Protocol, this week's meeting in Dubai ended with real prospects of a global HFC phase-down agreement next year.

In the face of four amendments on the table from the Island Nations, India, the EU and North America, objections to forming an HFC contact group to begin negotiating an amendment were finally dropped.

US secretary of state John Kerry, in a US party of more than 20 led by Environmental Protection Agency administrator Gina McCarthy, hailed the negotiations as a major accomplishment that shows "that the world is ready for a new chapter in the fight against climate change."

Pleased with the progress made, Stephen Yurek, president and CEO of the US Air Conditioning, Heating, and Refrigeration Institute (AHRI), said "AHRI's member companies and original equipment manufacturers

Global agreement to include HFCs in Montreal Protocol

World Taking Action!

Montreal Protocol Agreement Made

October 15, 2016

BBC

NEWS

Climate change: 'Monumental' deal to cut HFCs, fastest growing greenhouse gases

By Matt McGrath
Environment correspondent

15 October 2016 | Science & Environment

THE WALL STREET JOURNAL. Monday, October 17, 2016 | B1

Cooling Industry to Adjust

Chemical firms, appliance makers had anticipated global decision to phase out hydrofluorocarbons

By Andrew Tangel And Ted Mann

A global pact to limit planet-warming emissions is

thaorocarbons from cooling appliances beginning in 2019. Meeting in Rwanda, major emitters including the U.S., China and India agreed to aim for an 80% reduction in their

use in the U.S. Some are flammable. Manufacturers will have to convince regulators the new compounds are safe before retooling production.

"It's not going to be easy, but we're committed to doing it," said Stephen Yurek, chief executive of the Air-Conditioning, Heating, and Refrigeration Institute, a trade group.

alternatives, Mr. Yurek said, adding that his group supported a global framework for coolant regulations.

The U.S. Environmental Protection Agency recently set deadlines to phase out HFCs in new appliances such as refrigerators by 2021 and in chillers by 2024. Industry groups have said those targets would hurt

Alternative coolants exist to pow

U.S. and China lead the way to preventing half-a-degree Celsius

By Jean Chemnick, ClimateWire on October 17, 2016

Credit: U.S. DEPARTMENT

A new global agreemer
highly warming chemic
a check next to the last n
diplomacy bucket list.

CNN World » Nations agree landr

We did it!

The world has passed the Kigali Amendment to the Montreal Protocol – a historic step in protecting our climate for generations to come.

DALLASNEWS

CLIMATE CHANGE

Deal phases out harmful AC coolant

the outcome could have an equal or even greater impact

Global agreement made!

Montreal Protocol HFC Amendment Agreement!

Kigali Amendment drives global transitions based on GWP

October 15, 2016

	A5 Group 1 (Developing Countries)	*A5 Group 2 (Developing Countries)*	Non-A5 *(Developed Countries)*
Baseline	2020-2022	2024-2026	2011-2013
Formula	Average HFC consumption	Average HFC consumption	Average HFC consumption
HCFC	65% baseline	65% baseline	15% baseline*
Freeze	2024	2028	-
1st step	2029 – 10%	2032 – 10%	2019 – 10%
2nd step	2035 – 30%	2037 – 20%	**2024 – 45%**
3rd step	**2040 – 50%**	**2042 – 30%**	**2029 – 70%**
4th step			2034 – 80%
Plateau	2045 – 85%	2047 – 85%	2036 – 85%

*** For Belarus, Russian Federation, Kazakhstan, Tajikistan, Uzbekistan 25% HCFC component of baseline and different initial two steps – (1) 5% reduction in 2020 and (2) 35% reduction in 2025**

Notes:

1. **Group 1: Article 5 parties not part of Group 2**
2. **Group 2: GCC, India, Iran, Iraq, Pakistan**
3. **Technology review in 2022 and every 5 years**
4. **Technology review 4-5 years before 2028 to consider the compliance deferral of 2 years from the freeze of 2028 of Article 5 Group 2 to address growth in relevant sectors above certain threshold.**

UNEP

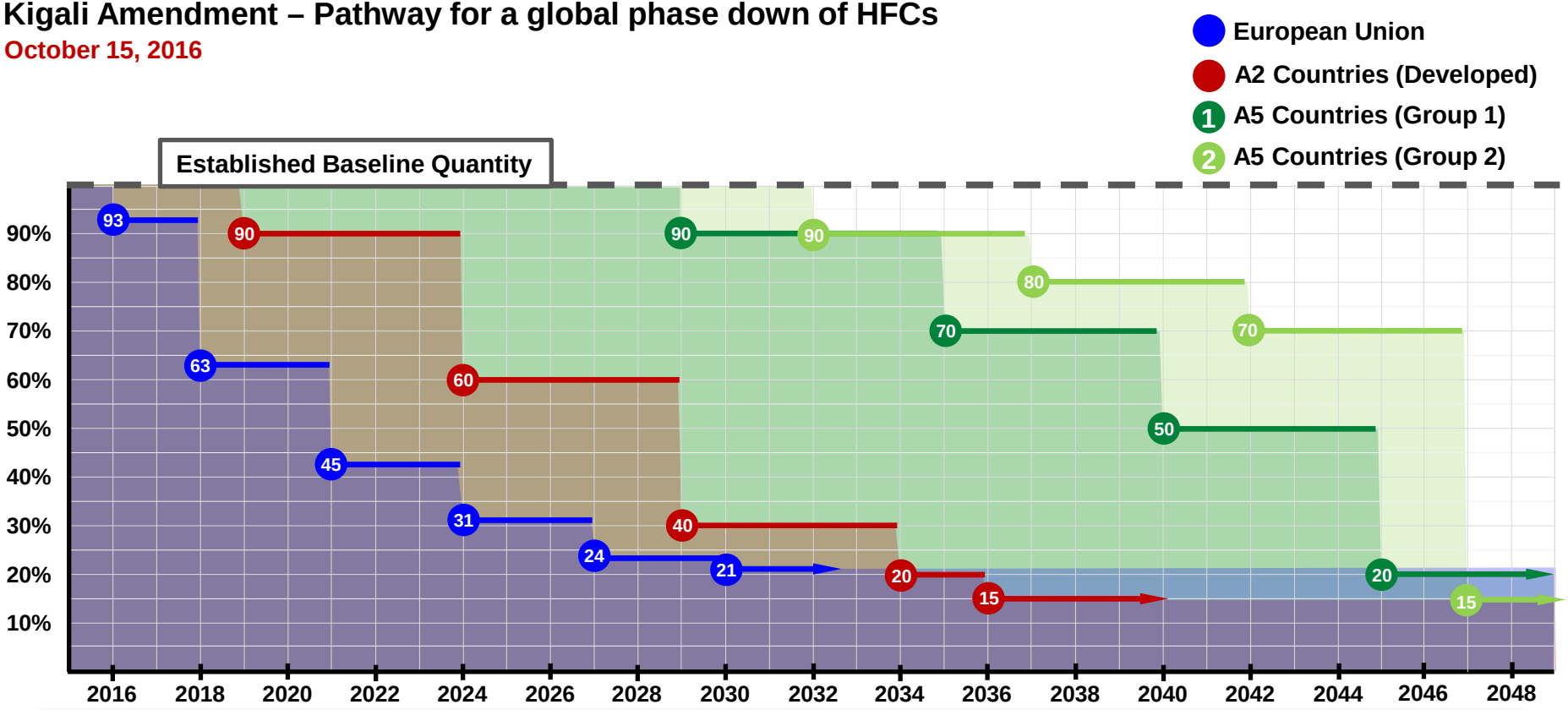
* http://www.unep.org/NewsCentre/default.aspx?DocumentID=27086&ArticleID=36286

Agreement goes into effect 1/1/19 if ratified by at least 20 countries*

Montreal Protocol HFC Amendment

Kigali Amendment – Pathway for a global phase down of HFCs

October 15, 2016



Cap and phase down of HFCs starting in 2019 for developed nations

Proposed Changes to HFC Acceptability

Environment and Climate Change Canada

March 23, 2016

"…prohibit the manufacture and import of certain refrigeration and air conditioning products that contain HFCs with a global warming potential (GWP) greater than a specified value…"

- ***Stand-alone Med Temp Commercial Refrigeration***
  (Jan 1, 2020 – GWP > 650)
- ***Stand-alone Low Temp Commercial Refrigeration***
  (Jan 1, 2020 – GWP >1500)
- ***Centralized Refrigeration***
  (Jan 1, 2020 – GWP >1500)
- ***Chillers - Centrifugal & Positive Displacement***
  (Jan 1, 2025 – GWP >700)
- ***Domestic Refrigeration***
  (Jan 1, 2025 – GWP > 150)
- ***Mobile Refrigeration***
  (Jan 1, 2025 – GWP > 2200)

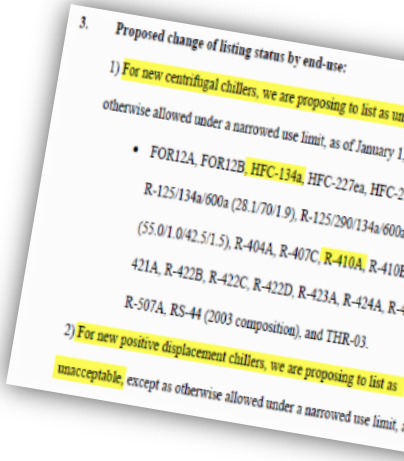
https://www.ec.gc.ca/ozone/default.asp?lang=En&n=77A94123-1

SNAP

March 29, 2016

"…this action proposes to list a number of substances as acceptable, subject to use conditions; to list several substances as unacceptable…" changes status to "unacceptable" for certain HFC refrigerants:

- ***Centrifugal Chillers*** *(Jan 1, 2024)*
  R-134a, R-410A, R-407C, R-245fa…
- ***Positive Displacement Chillers*** *(Jan 1, 2024)*
  R-134a, R-410A, R-407C, R-245fa…
- ***Cold Storage Warehouses*** *(Jan 1, 2023)*
- ***Retail Food Refrigeration*** *(Jan 1, 2021)*
- ***Household Refrigerators/Freezers*** *(Jan 1, 2021)*


3. Proposed change of listing status by end-use:

1) For new centrifugal chillers, we are proposing to list as un
otherwise allowed under a narrowed use limit, as of January 1,
• FOR12A, FOR12B, HFC-134a, HFC-227ea, HFC-2
R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a
(55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410
421A, R-422B, R-422C, R-422D, R-423A, R-424A, R-
R-507A, RS-44 (2003 composition), and THR-03.
2) For new positive displacement chillers, we are proposing to list as
unacceptable, except as otherwise allowed under a narrowed use limit,

https://www.epa.gov/snap/snap-regulations

California EPA

- ***All HVAC Refrigerants >750 GWP*** *(Jan 1, 2021)*
  - *Effectively phasing out R-134a, R-410A*

http://www.arb.ca.gov/cc/shortlived/shortlived.htm

US Final Rule pending; Canada & California still out for public review

Final Rule 21: Protection of Stratospheric Ozone:

SNAP: Significant New Alternatives Policy

EPA Proposed Rule

Proposed Rule

What is EPA proposing?

- List as acceptable subject to use conditions, list as unacceptable, and change the status of several substances
- Exempt propane from the CAA's section 608 venting prohibition
- Clarify status of acceptable fire suppression alternative

Which industrial sectors are included?

- Refrigeration & Air Conditioning
- Fire Suppression & Explosion Protection
- Foam Blowing

Who is affected?

- Chemical producers, some manufacturers, and some end-users of equipment and products using refrigerants, fire suppressants, and foam blowing agents

When?

- Starting 30 days after publication of a final rule; see table for dates

FOR IMMEDIATE RELEASE:
March 29, 2016

www.epa.gov/snap

FACT SHEET

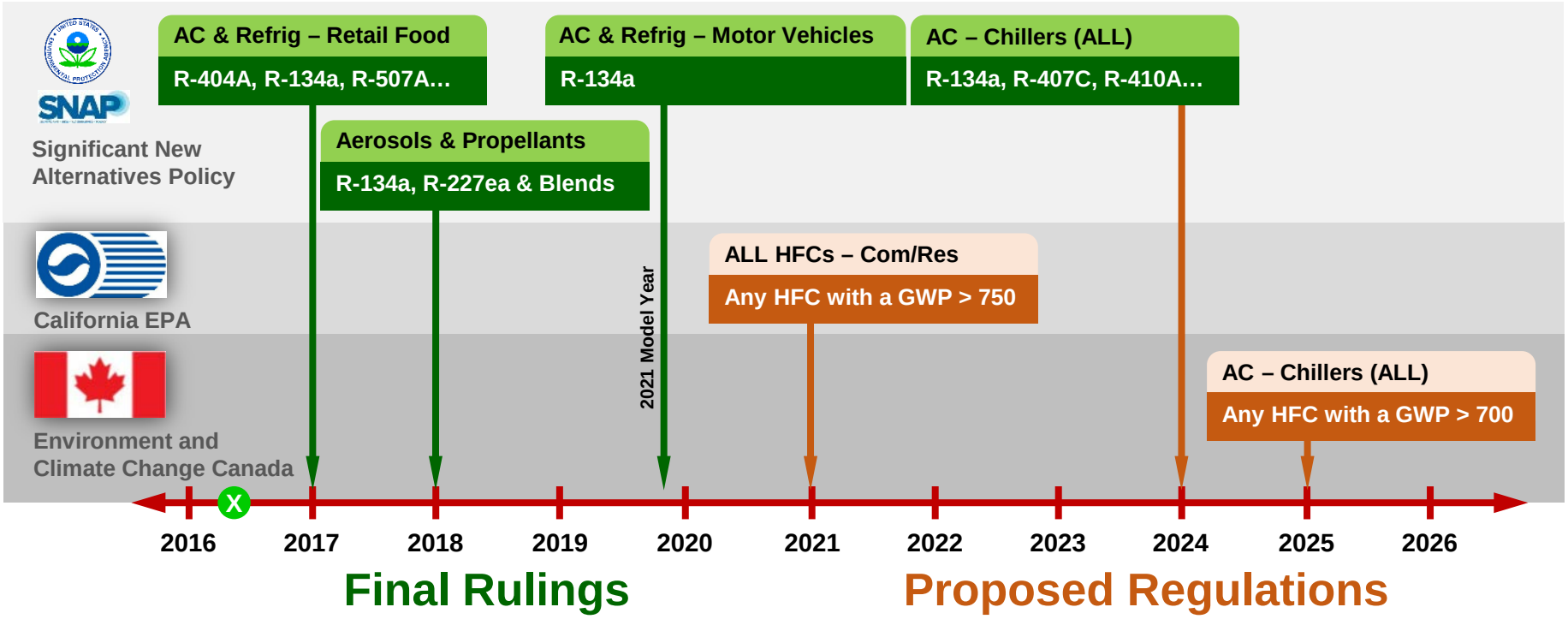
PROPOSED CHANGE OF LISTING STATUS

End-Uses	Substitutes	Proposed Effective Date
Air Conditioning		
Centrifugal chillers (new)	FOR12A, FOR12B, HFC-134a, HFC-227ea, HFC-236fa, HFC-245fa, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-423A, R-424A, R-434A, R-438A, R-507A, RS-44 (2003 composition), and THR-03	Unacceptable, except as otherwise allowed under a narrowed use limit, as of January 1, 2024
Positive displacement chillers (new)	FOR12A, FOR12B, HFC-134a, HFC-227ea, KDD6, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-424A, R-434A, R-437A, R-438A, R-507A, RS-44 (2003 composition), SP34E, and THR-03	Unacceptable, except as otherwise allowed under a narrowed use limit, as of January 1, 2024

EPA mechanism for managing regulations

Review of Current and Pending Regulations

Ban on shipment of new equipment with HFCs



HFC phase-out dates for high-GWP refrigerants in US & Canada

US EPA to Tighten HFC Regulations

Changes to Section 608 Refrigerant Management Regulations of the Federal Clean Air Act

Overview of Changes	Current Requirement	EPA Final Ruling *(changes indicated in red)*
Refrigerants Covered	CFCs and HCFCs	CFCs, HCFCs, HFCs and all other replacement refrigerants (HFOs, HFO blends, etc.)
Allowable Leak Rates (*50+ lbs. of refrigerant*) Industrial Process Refrigeration Commercial Refrigeration Comfort Cooling Equipment	 35% 35% 15%	 30% 20% 10%
Leak Inspections	None Required	If allowable leak rate is exceeded, then: 50-500 lbs.: annual inspections 500+ lbs.: quarterly inspections
Recordkeeping Requirement	50+ lbs.	5+ lbs. for disposal 50+ lbs. for service/repair
Chronic Leaks	None Required (“*should be repaired*”)	If leaks ≥ 125% of charge in a calendar year, must submit detailed reports of efforts to identify leaks and repair equipment

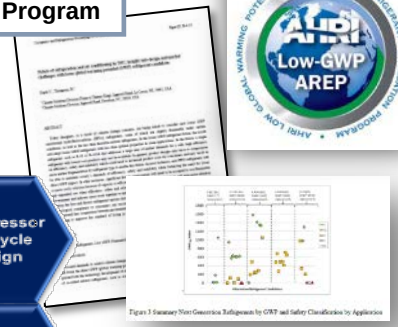
https://www.epa.gov/section608/revised-section-608-refrigerant-management-regulations

Leak-tight machines gaining advantage – enhancing hermetic appeal

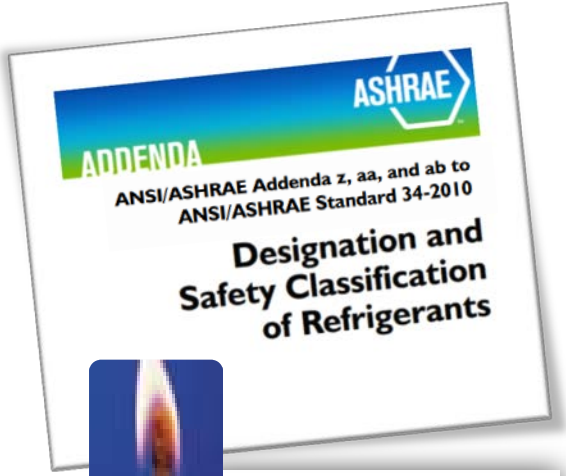
Next-Generation Refrigerants

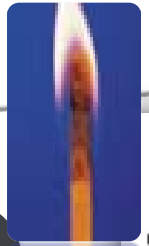
More variables; balancing offers challenges

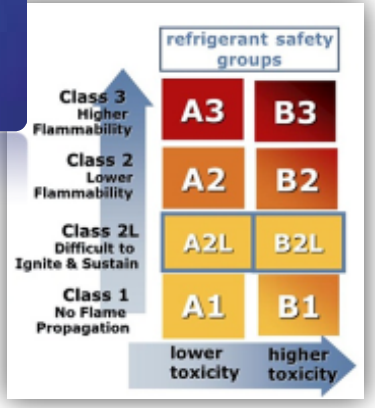
AHRI Low-GWP Alternative Refrigerant Evaluation Program



http://www.ahrinet.org/arep.aspx







In 2010 ASHRAE 34 Development of a new class "2L," defined as:

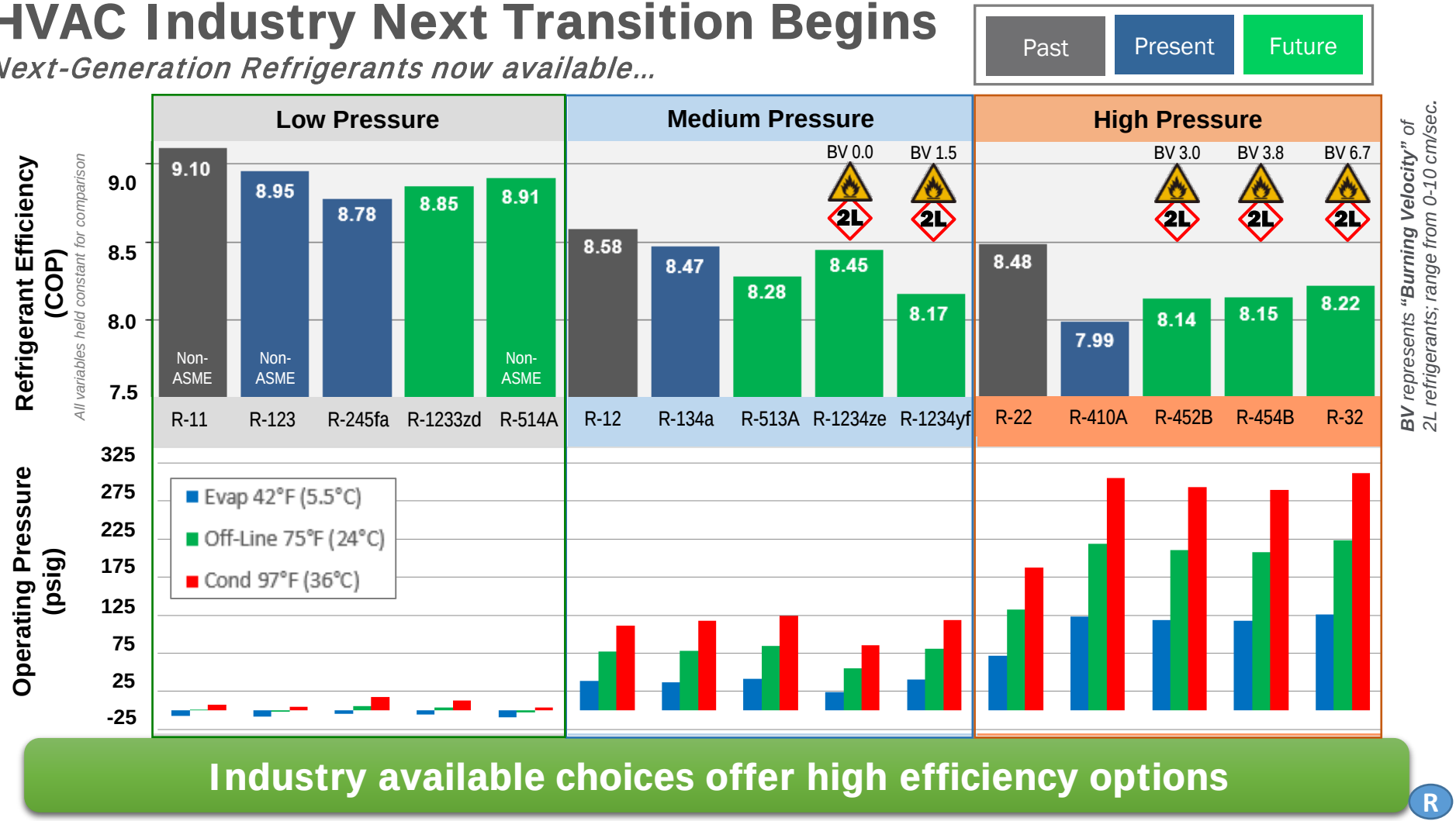
"Difficult to Ignite & Sustain"

Not all 2L refrigerant are equal

Some next-generation refrigerants offer new challenges

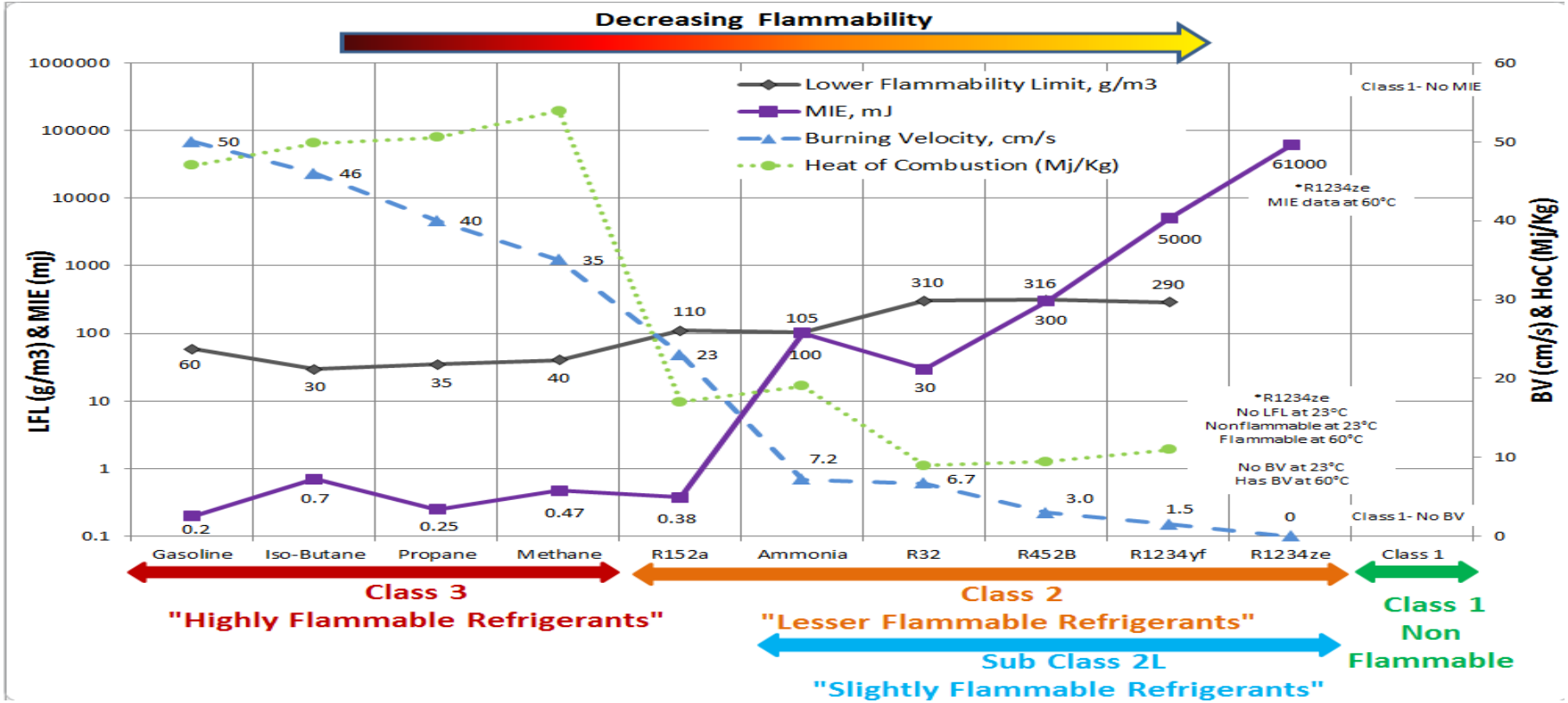
HVAC Industry Next Transition Begins

Next-Generation Refrigerants now available…



Industry available choices offer high efficiency options

Flammability Properties Vary



The definition of "2L" is being evaluated

High Pressure Replacements

HCFC → **HFC** → **Low GWP**

R-22

Glide

Blend
50% R-125
50% R-32

Flammable

Blend
52% R-134a
25% R-125
23% R-32

Driving Factors
- Performance
- Safety
- Cost

Blend
26% R-1234yf
7% R-125
67% R-32

Blend
31% R-1234yf
69% R-32

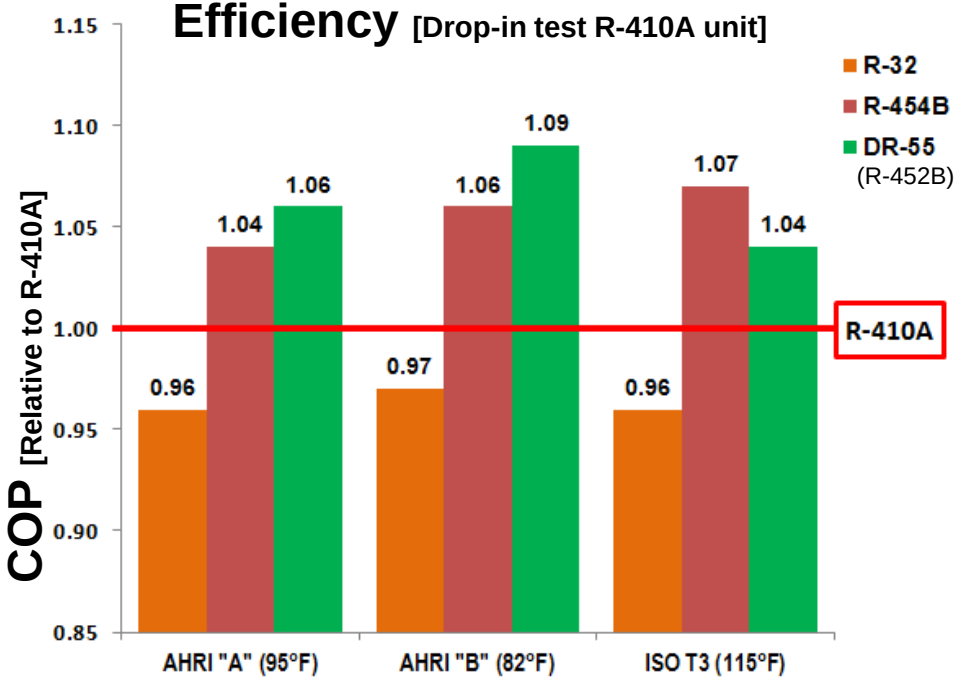
		High Pressure				
		R-22	R-410A	R-452B	R-454B	R-32
Flammability	ASHRAE Class	Non (1)	Non (1)	Slight (2L)	Slight (2L)	Slight (2L)
	BV (cm/s)			3.0	3.8	6.7
Toxicity		Lower (A)	Lower (A)	Lower (A)	Lower (A)	Lower (A)
Fluid Efficiency	Theoretical		7.99	8.14	8.15	8.22
	Drop-in	*n/a*	*n/a*	*8.39*	*8.40*	*7.83*
Capacity Change	Theoretical		1	~2% loss	~3% loss	~9% gain
	Drop-in	*n/a*	*n/a*	*same*	*same*	*same*
GWP		1810	1924	675	466	677
ODP		0.05	0.00	0.00	0.00	0.00

Next transition with high pressure refrigerants

High Pressure Refrigerant Replacements

Drop-in test results

- Drop-in of R-452B into York residential heat pump designed for R-410A
- Chemours made no system or lubricant changes to the unit
- R-452B delivered:
  - ✓ nearly 5% improvement in energy efficiency
  - ✓ equivalent cooling capacity
  - ✓ discharge temperatures similar to R-410A.



http://www.coolingpost.com/world-news/is-dr-55-best-option-to-replace-r410a/

R-452B: Better performance than R-410A at all 3 global conditions

High Pressure Refrigerant Replacements

Safety review

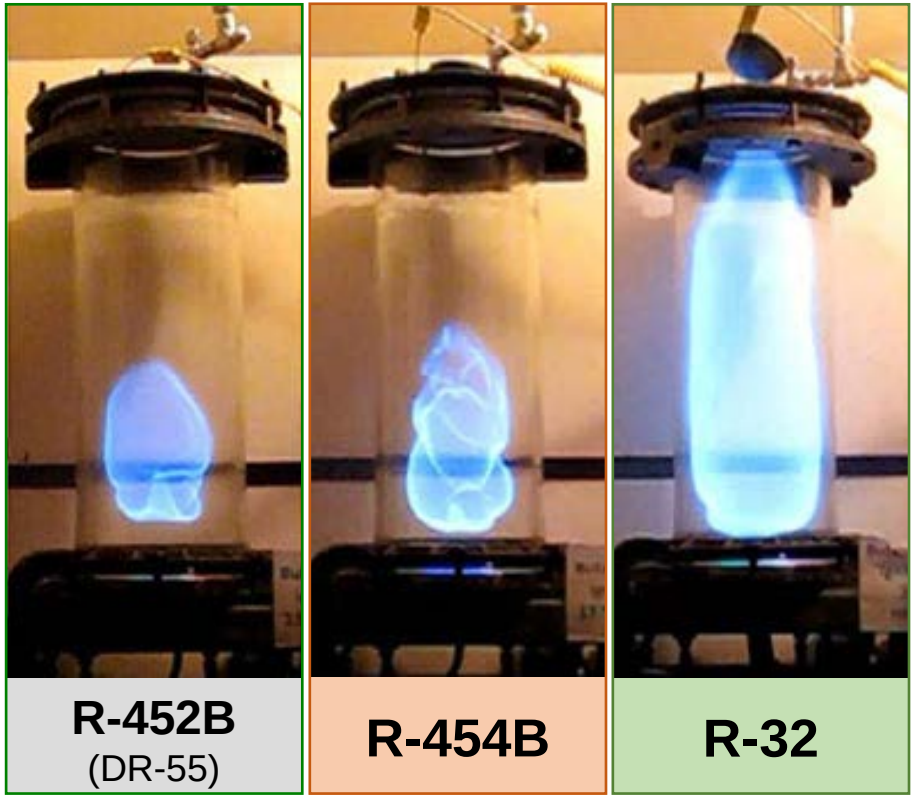
Tests have shown that R-452B exhibits:

- ✓ a slower burning velocity (BV) and
- ✓ higher minimum ignition energy (MIE) requirement when compared to R-32

➢ ***R-452B is 5X less flammable than R-32***

Although R-452B has the same A2L "mildly flammable" classification as R-32, Chemours maintains that some global OEMs have indicated that the lower flammability properties are compelling and are likely to be an important consideration in product selection, especially for larger charge size equipment.

➢ ***AND… Almost 70% reduction in GWP vs. R-410A***



Not all 2L refrigerants are the same…

Refrigerant Choices & Comparison

Screw & Centrifugal Technology Options

	Low Pressure			Medium Pressure			
	R-123	**R-1233zd**	**R-514A**	**R-134a**	**R-513A**	**R-1234yf**	**R-1234ze**
Flammability	Non **(1)**	Non **(1)**	Non **(1)**	Non **(1)**	Non **(1)**	Slight **(2L)**	Slight **(2L)**
Toxicity	Higher **(B)**	Lower **(A)**	Higher **(B)**	Lower **(A)**	Lower **(A)**	Lower **(A)**	Lower **(A)**
Fluid Efficiency	9.4 COP	9.3 COP	9.4 COP	8.5 COP	8.3 COP	8.2 COP	8.5 COP
Capacity Change	1	35% Gain	Similar	1	Similar	5% Loss	25% Loss
GWP	79	1	< 2	1300	573	1	1

Chiller efficiency impacted by refrigerant choice

History of HVAC/R Refrigerants

1st Generation	2nd Generation	3rd Generation	4th Generation
"What Ever Worked"	**"Safety & Stability"**	**"Ozone Protection"**	**"Global Warming"**
1830's – 1930's	**1930's – 1990's**	**1990's – 2010's**	**2010 - ??**
• Limited applications mainly industrial • Poor safety & high cost	• Innovation enabled exponential societal improvements	• Preserved 2nd gen. innovations, safety, stability and efficiency	• Fewer optimal choices • Safety & design challenges

• Carbon Dioxide (CO_2)
• Water (H_2O)
• Ammonia (NH_3)
• Various HCs
• Sulfur Dioxide (SO_2)
• Methyl Chloride (CH_3Cl)
	• Sulfur Dioxide (SO_2)
	• CFCs & HCFCs
	  • R-11
	  • R-12
	  • R-22
	  • R-502
	  • R-113
	  • R-114
	  • Many more blends….
		• Sulfur Dioxide (SO_2)
		• HCFCs & HFCs
		  • R-123
		  • R-134a
		  • R-407C
		  • R-410A
		  • R-404A
		  • Many more blends….
			• Sulfur Dioxide (SO_2)
			• HFOs & HFC/HFO Blends
			  • R-1234yf
			  • R-1234ze
			  • R-1233zd
			  • Blends….
			• Renewed Interest "Natural"
			  • CO_2
			  • HCs

Societal demands continue to drive refrigerant innovations

What refrigerant do I buy?

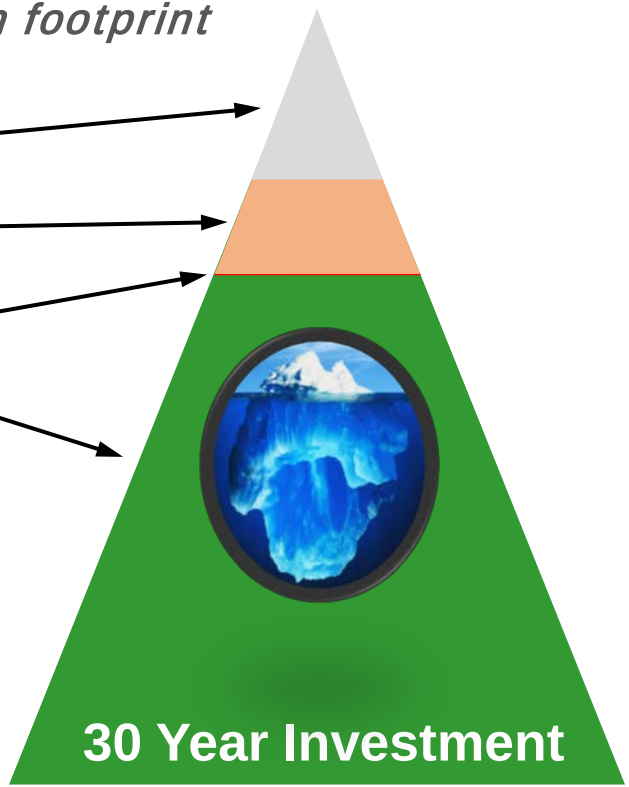
- There are **no** perfect refrigerants
- Take a balanced approach:
  Safety, Environmental Impact, Efficiency
- R-123, R-134a, R-410A, R-404A, R-407C are all responsible HVAC refrigerant choices... *today*
- Leak tightness is key!
  Means lower emissions, higher efficiencies, lower cost, safer
- Next-generation alternatives are available; only A1/B1 refrigerants offer clear and immediate solutions... *it's time to evaluate your options*

Understand the facts today; plan for tomorrow

How Can I Protect My Investment?

Total cost of ownership encompasses total carbon footprint

"First Cost" (chiller + refrigerant)	**4.92%**
Lifetime Service Costs*	**6.53%**
Lifetime Refrigerant Supply*	**0.04%**
Lifetime Electrical Costs	**88.51%**



All refrigerants used today are and will be – available for the life of the equipment.

Focus on reliable, efficient designs!

And let the manufacturer worry about the refrigerant!

A balanced approach, with a focus on efficiency

** Based on low-pressure, hermetic design*

Questions?

Thank you for your time and attention!

How do I Find Out More?

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

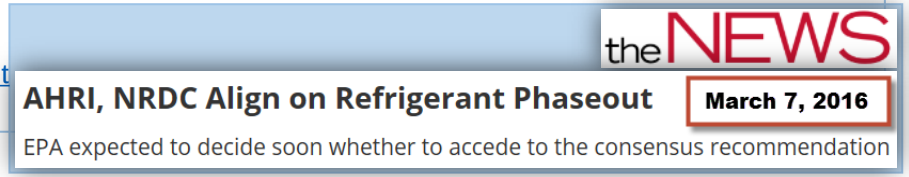
November 2015 meetings:
http://www.coolingpost.com/world-news/world-could-agree-hfc-phase-down-in-2016/
http://www.achrnews.com/articles/131056-montreal-protocol-sets-global-hfc-phasedown

...and industry support:
http://www.racplus.com/newsletter/news/usa-focus/ahri-applauds-hfc-phase-down-decision/8691735.article
http://www.achrnews.com/articles/131199-industry-reacts-to-groundbreaking-hfc-phase-down-discussions

http://www.epa.gov/climatechange/ghgemissions/gases/fgases.html
http://www.coolingpost.com/world-news/us-epa-considers-future-ban-on-r134a-chillers/

Rule 20 (July 2015) – Prohibition on the use of certain high-GWP HFCs as alternatives
Final Rule: https://www.gpo.gov/fdsys/pkg/FR-2015-07-20/pdf/2015-17066.pdf
Fact Sheet: http://www.epa.gov/snap/final-rule-protection-stratospheric-ozone-change-listing-status-certain-substitutes-under

AHRI/NRDC petition (February 1, 2016):
http://www.ahrinet.org/App_Content/ahri/files/News%20Room/Press%20Releases/2016/AHRI_NRDC_Letter_to_EPA_Regarding_Chiller_Action_Under_SNAP_02_01_16.pdf
http://www.coolingpost.com/world-news/r134a-faces-chiller-ban-from-2025/
http://www.achrnews.com/articles/131955-ahri-nrdc-align-on-refrigerant-phaseout



Additional references to learn more about impending transitions

How do I Find Out More? (cont.)

R-452B (formerly “DR-55”):
http://www.coolingpost.com/world-news/is-dr-55-best-option-to-replace-r410a/
http://www.coolingpost.com/world-news/trane-debuts-r410a-replacement/
http://www.acr-news.com/chemours-refrigerant-gains-preliminary-ashrae-classification-1

AHRI’s Low-GWP Alternative Refrigerants Evaluation Program
http://www.ahrinet.org/site/514/Resources/Research/AHRI-Low-GWP-Alternative-Refrigerants-Evaluation

Kujak S., Thompson, M. “Future of refrigeration and air conditioning in 2032; insights into design and market challenges with lower global warming potential (GWP) refrigerant candidates.” Cryogenics and Refrigeration-Proceedings of ICCR2013. Paper ID: B-4-10.

Trane / Ingersoll Rand:
http://company.ingersollrand.com/ircorp/en/discover-us/sustainability/our-climate-commitment.html

Considerations for Next-Generation HVAC Refrigerants (February 2015)
http://www.trane.com/content/dam/Trane/Commercial/global/products-systems/education-training/industry-articles/ENV-APN001A-EN_2015_refrigerants.pdf

HVAC Refrigerants: A Balanced Approach (June 2011)
http://www.trane.com/content/dam/Trane/Commercial/global/products-systems/education-training/engineers-newsletters/energy-environment/adm-apn041-en_0711.pdf

CenTraVac™ Chiller Environmental Product Declaration (EPD) – UL Environment Sustainable Products Guide
http://productguide.ulenvironment.com/ProductDetail.aspx?productID=66583&CertificationID=15&CategoryID=67

Additional references to learn more about impending transitions

Other References:

http://www.unep.org/ozonaction/Portals/105/documents/University%20course%20pack%202016/FS-2-Overview-of-HFC-Markets-final-rev1-.pdf
(Overview of HFC Market Sectors, April 2015)

http://www.epa.gov/ozone/downloads/HFC_Amendment_2013-Summary.pdf
(Nice summary of North American proposal to Montreal Protocol)

http://www.achrnews.com/articles/122923-the-future-of-hfcs-in-montreal-protocol
(April 2013, quotes from other HVAC companies)

http://www.epa.gov/ozone/intpol/mpagreement.html
(Sept 2013, fact sheets on the right side of page – focuses on refrigeration, but shows next refrigerants)

http://www.argusmedia.com/pages/NewsBody.aspx?id=863805&menu=yes
(Sep 2013, G20 nations sign agreement to curtail HFCs)

http://articles.economictimes.indiatimes.com/2013-10-02/news/42617384_1_hfcs-montreal-protocol-climate-change
(Oct 2013, U.S. and India joint agreement on HFC phasedown)

http://www.hydrocarbons21.com/articles/european_parliament_formally_backs_eu_f-gas_regulation_deal
(Mar 2014, New EU F-gas regulation passed)

http://www.alliancepolicy.org/index.php
(Learn more about The Alliance for Responsible Atmospheric Policy)

http://www.bna.com/epa-proposes-prohibit-n17179892134/
(Jul 2014, Article on proposed EPA bans/reductions on HFC refrigerants through SNAP)

Global Pressure on ALL Refrigerants:

- Powell, Peter. “HFCs Are On Shaky Ground.” ACHR News. July 26, 2004.
- Powell, Peter. “Refrigerant Talk Turns to HFOs.” ACHR News. August 11, 2008.
- Turner, Fred. “Commentary: Midgley’s Legacy.” ASHRAE Journal. July 2010.
- Wilkins, Robert. “The Global Debate On The Phasedown of HFC Refrigerants.” Engineered Systems. December 2011.

Additional references to learn more about impending transitions

SNAP Ruling Documentation

(Unacceptable Refrigerants & Those Subject to Restrictions)

U.S. Government Publishing Office/Electronic Code of Federal Regulations
Title 40 > Chapter I > Subchapter C > Part 82 > Subpart G
http://www.ecfr.gov/cgi-bin/text-idx?SID=1336e126c41c481006b799e3ad21d554&mc=true&node=sp40.18.82.g&rgn=div6

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Title 40 → Chapter I → Subchapter C → Part 82 → Subpart G

Browse Previous | Browse Next

Title 40: Protection of Environment
PART 82—PROTECTION OF STRATOSPHERIC OZONE

Subpart G—Significant New Alternatives Policy Program

Contents

Find the Appendix with the ruling of interest:

Appendix U to Subpart G of Part 82—Unacceptable Substitutes and Substitutes Subject to Use Restrictions Listed in the July 20, 2015 Final Rule, Effective August 19, 2015

Appendix U -- http://www.ecfr.gov/cgi-bin/text-idx?SID=1336e126c41c481006b799e3ad21d554&mc=true&node=sp40.18.82.g&rgn=div6#ap40.18.82_1184.u

Title 40 → Chapter I → Subchapter C → Part 82 → Subpart G → Appendix

Title 40: Protection of Environment
PART 82—PROTECTION OF STRATOSPHERIC OZONE
Subpart G—Significant New Alternatives Policy Program

APPENDIX U TO SUBPART G OF PART 82—UNACCEPTABLE SUBSTITUTES AND SUBSTITUTES SUBJECT TO USE RESTRICTIONS LISTED IN THE JULY 20, 2015 FINAL RULE, EFFECTIVE AUGUST 19, 2015

REFRIGERATION AND AIR CONDITIONING—UNACCEPTABLE SUBSTITUTES

End-use	Substitute	Decision	Further information
Retail food refrigeration (supermarket systems) (new)	HFC-227ea, R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	Unacceptable as of January 1, 2017	These refrigerants have GWPs ranging from 2,729 to 3,985. Other substitutes will be available for this end-use with lower overall risk to human health and the environment by the status change date.
Retail food refrigeration (supermarket systems) (retrofit)	R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	Unacceptable as of July 20, 2016	These refrigerants have GWPs ranging from 2,729 to 3,985. Other substitutes will be available for this end-use with lower overall risk to human health and the environment by the status change date.
Retail food refrigeration (remote	HFC-227ea, R-404A, R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A, R-507A	Unacceptable as of January	These refrigerants have GWPs ranging from 2,729 to 3,985. Other

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Refrigerant Update

THE NEXT TRANSITION HAS BEGUN

Thank you for attending!

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