

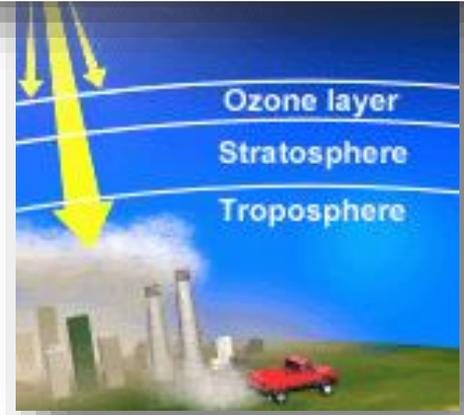
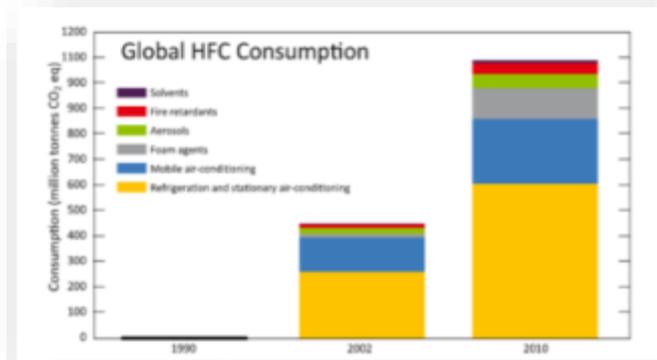
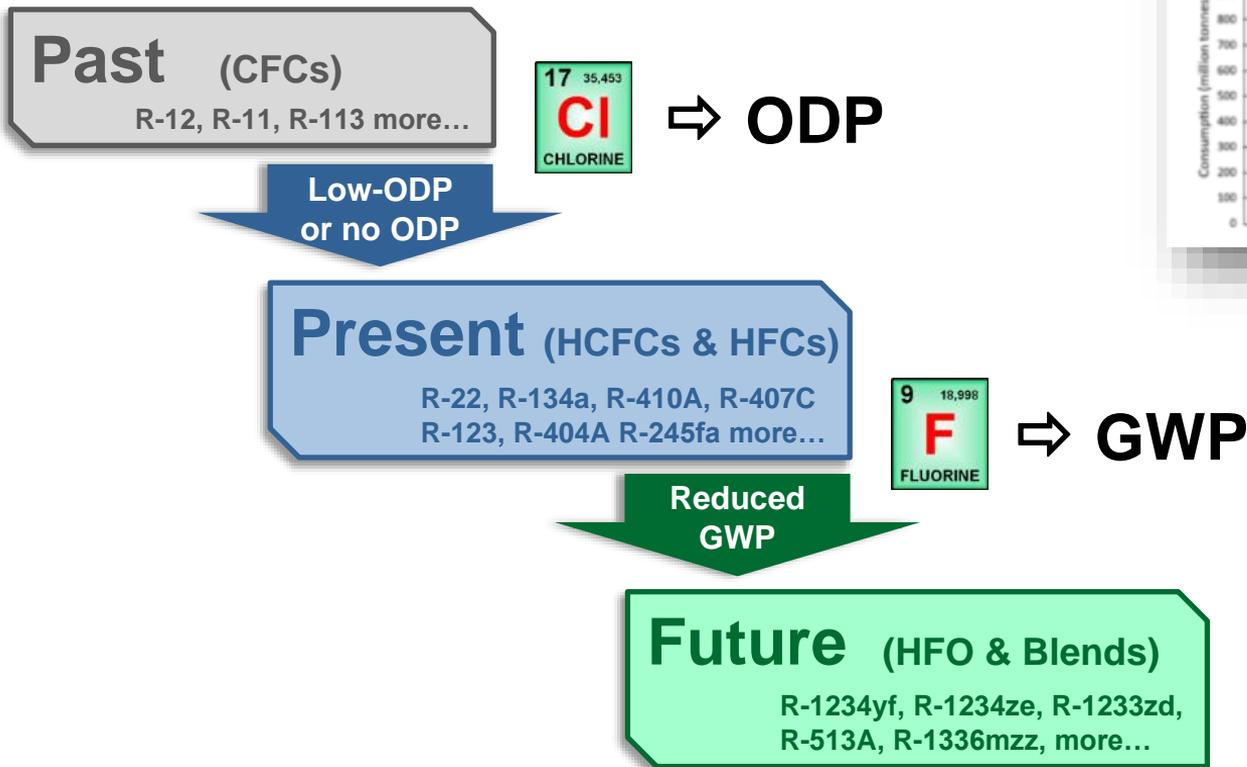
# Refrigerant Update

## THE NEXT TRANSITION HAS BEGUN



**Thomas J. Gorman**  
Applied Chiller Systems  
Product Manager

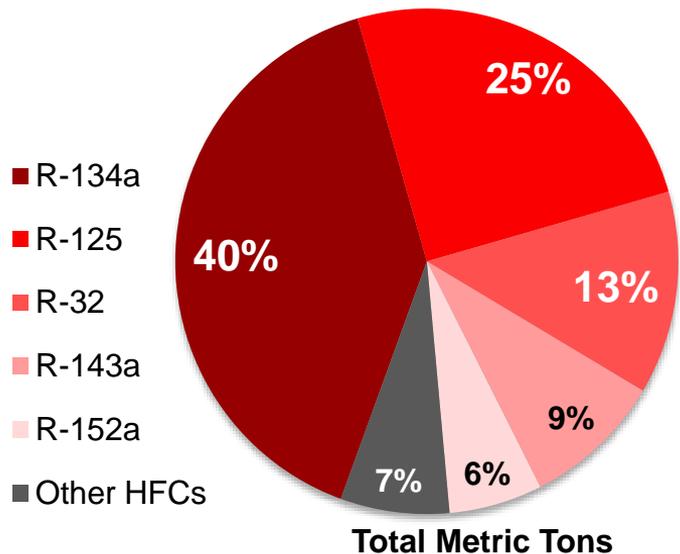
# Understanding the Timeline



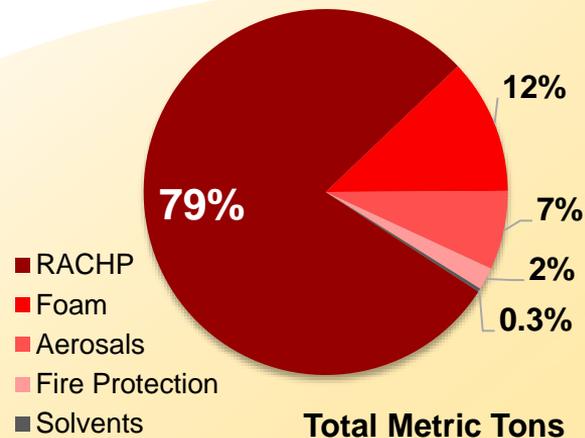
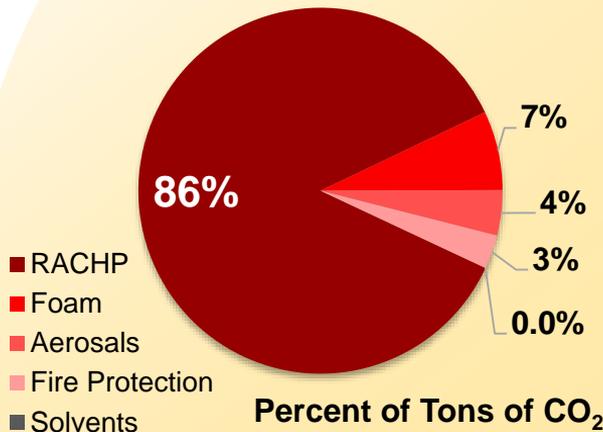
**Short Atmospheric Life  
Reduces Impacts**

**There's more to refrigerant selection than just ODP & GWP**

# Global Consumption of HFCs



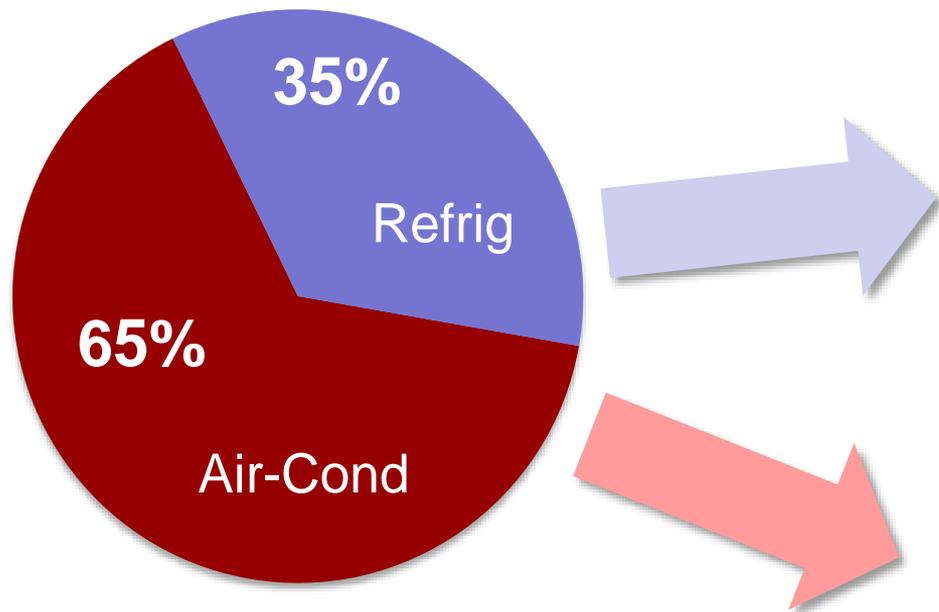
## Markets Using HFCs



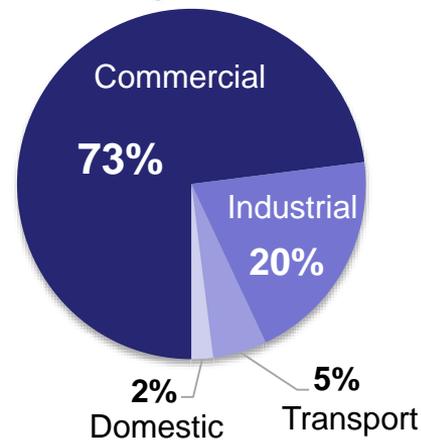
Market	Key HFCs	GWP
RACHP	R-404A	3922
	R-410A	2088
	R-407C	1774
	HFC-134a	1430
Aerosols	HFC-134a	1430
	HFC-152a	124
	HFC-227ea	3220
Foams	HFC-134a	1430
	HFC-245fa	1030
	HFC-365mfc / HFC-227ea	960 - 1100
Fire protection	HFC-227ea	3220
	HFC-125	3500
	HFC-23	14800
Solvents	HFC-4310mee	1640

# Global HFC use in RACHP

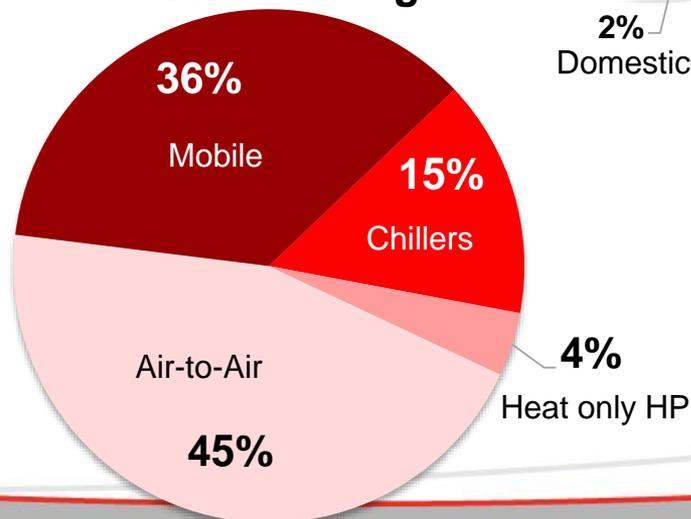
RACHP – “refrigeration, air-conditioning & heat pumps”



## Refrigeration



## Air-Conditioning



# Reductions of HFC Use Already

## European Union

### HFC phase-down



#### HFC phase-down

- The phase-down
  - **All HFC bulk gases** placed on the EU market (imports + EU production)
  - **HFCs in imported pre-charged RAC equipment** reduce quotas for bulk supply from 2017
- Companies are assigned quotas in CO<sub>2</sub> equivalent, leaving flexibility in actual substances to be put on market
  - **More HFCs can be sold when their GWP decrease accordingly!**

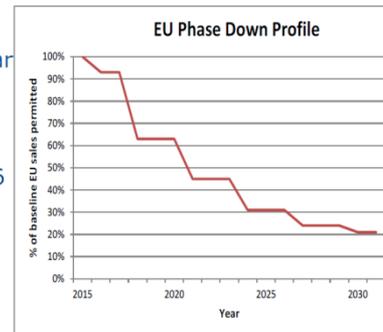
Climate Action

### HFC phase-down



#### EU HFC phase-down, starting in 2015

- **Upstream: Reduce current EU supply of HFCs** in 3 year steps by (almost) 80% in 2030
- Freeze in 2015, first reduction step in 2016
- Tail-end for applications where there are no alternatives today



Climate Action

# Reductions of HFC Use Already

## North America Region



FOR IMMEDIATE RELEASE:  
July 2, 2015

[www.epa.gov/ozone/snap](http://www.epa.gov/ozone/snap)

### FACT SHEET

**Final Rule - Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes under the Significant New Alternatives Policy Program**

#### **7-2-2015 > EPA Final Ruling**

*Change status of certain HFCs to “unacceptable”*

- Retail Food Refrigeration (2017)
- Aerosol and propellants (2018)
- Motor Vehicles (2021 Model)

years since the initial SNAP rule was promulgated, EPA has modified the SNAP lists many times, most often by expanding the

• Foam blowing

• Who is affected?



**SNAP**  
SIGNIFICANT - NEW - ALTERNATIVES - POLICY

FOR IMMEDIATE RELEASE: September 26, 2016

[www.epa.gov/snap](http://www.epa.gov/snap)

### FACT SHEET

**Final Rule 21 - Protection of Stratospheric Ozone: Significant New Alternatives Policy Program New and Changed Listings**

#### **9-26-2016 > EPA Final Ruling**

*Change status of certain HFCs to “unacceptable”*

- All Chillers (Air and Water Cooled)
- Centrifugal & Positive Displacement (2024)
- Using R-134a, R-410A & R-407C

substitutes already on the SNAP lists. In the decades since the SNAP program began, EPA has modified the SNAP lists many times, most

• Clarifies status of acceptable fire suppression alternative

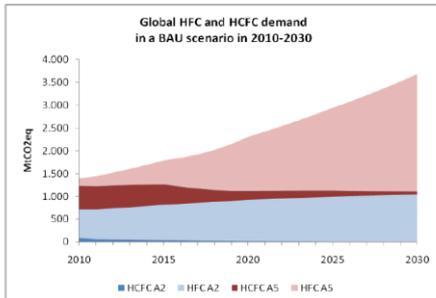
# Concerns in A5 Countries

## Middle East to India Region

### Post-ODS scenarios in A5 and globally

- Increasing projected HFC demand and emissions especially in Article 5 (A5) countries
  - ODS phase-out related
  - Related to economic growth
- High-GWP HFCs and HFC blends often used as substitutes for HCFCs

**HFC banks already there in A5 countries!**



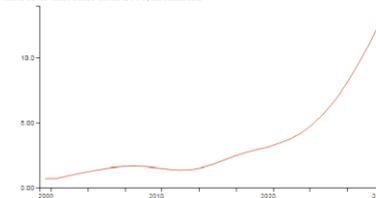
Source: Schwarz et al 2011

### Unitary AC in India

- Unitary AC most common systems in A5 incl. India
- Market saturation still moderate with large growth potential
- Unit sales are projected to increase 8-fold!**
- > 80 % small units < 7 kW (relevant for charge limits)
- Small units account for ~ 50 % refrigerant weight in AC
- Phase down or freeze of GWP-weighted emissions not possible with high-GWP HFCs

**Projected unitary AC unit sales in India:**

Number of unit sales until 2030, in millions



Source: Green Cooling Initiative

# Montreal Protocol HFC Amendment Agreement

Kigali Amendment – Dubai Pathway on HFCs – Global Transitions Based on GWP

October 15, 2016



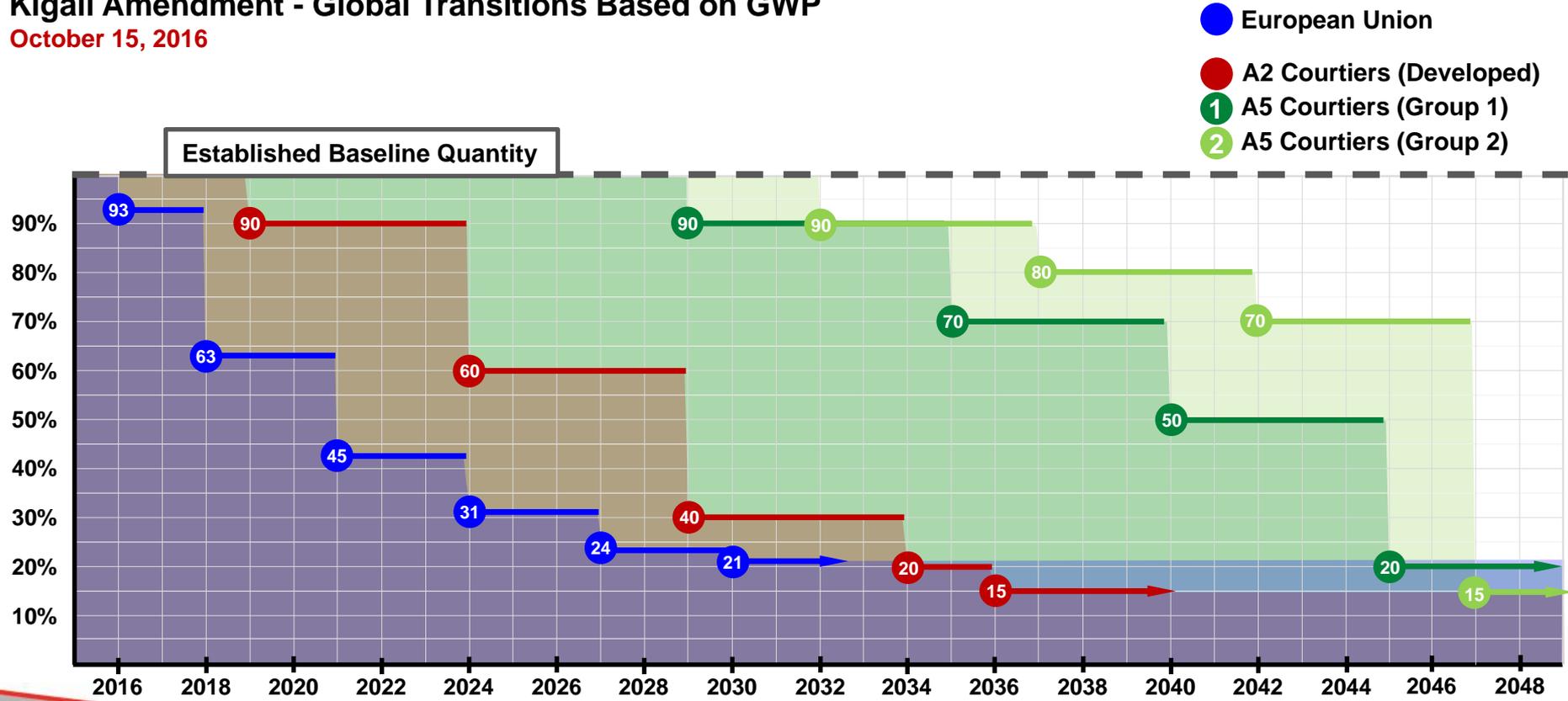
## ***Nations, Fighting Powerful Refrigerant That Warms Planet, Reach Landmark Deal***

KIGALI, Rwanda — Negotiators from more than 170 countries on Saturday reached a legally binding accord to counter climate change by cutting the worldwide use of a powerful planet-warming chemical used in air-conditioners and refrigerators.

# Montreal Protocol HFC Amendment Agreement

## Kigali Amendment - Global Transitions Based on GWP

October 15, 2016



# What is the **INDUSTRY** providing already...

Looking at Air & Water Cooled Chillers using HFC alternatives...

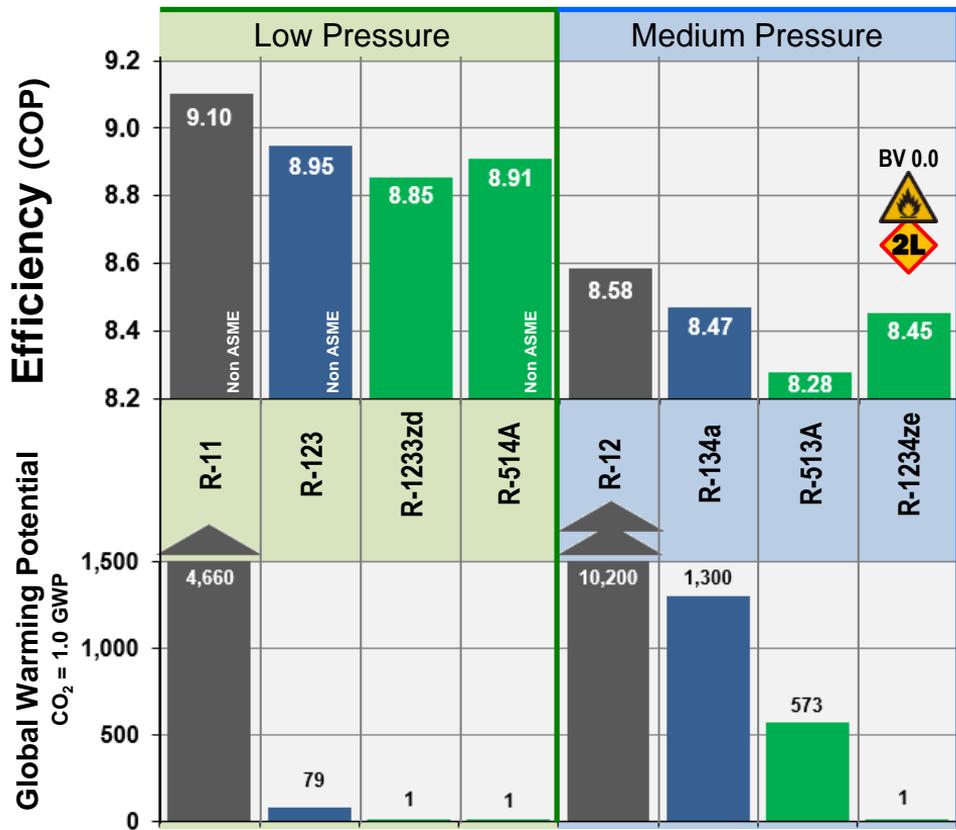
... Just a few of the screw, scroll and centrifugal chillers available now with new HFO or HFO blend refrigerants.



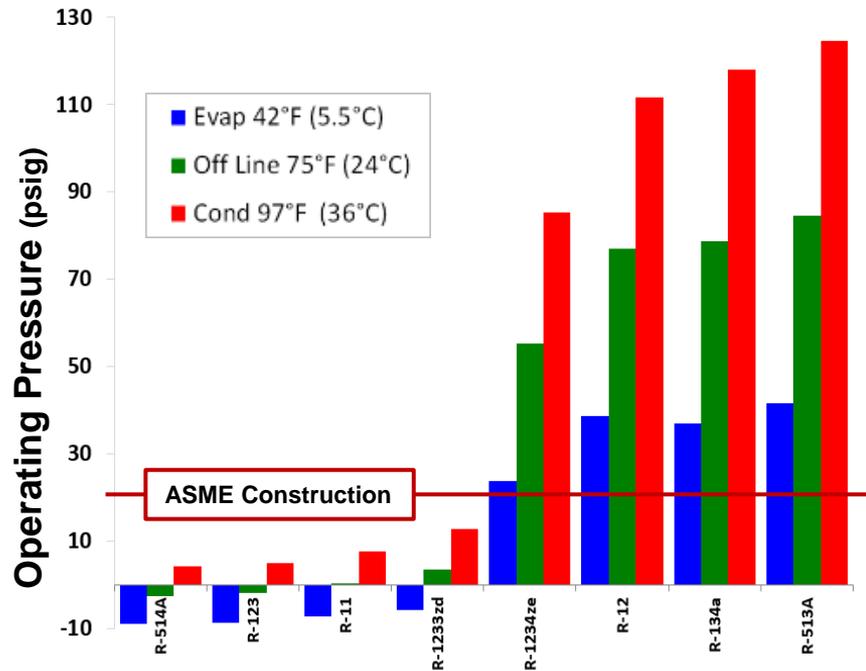
# Questions: What will the impact be on....

- **Safety**
- **Energy Consumption**
- **Cost**
  - ✓ Equipment
  - ✓ Refrigerant
- **Application Requirements**
  - ✓ Capacity Range
  - ✓ High Ambient

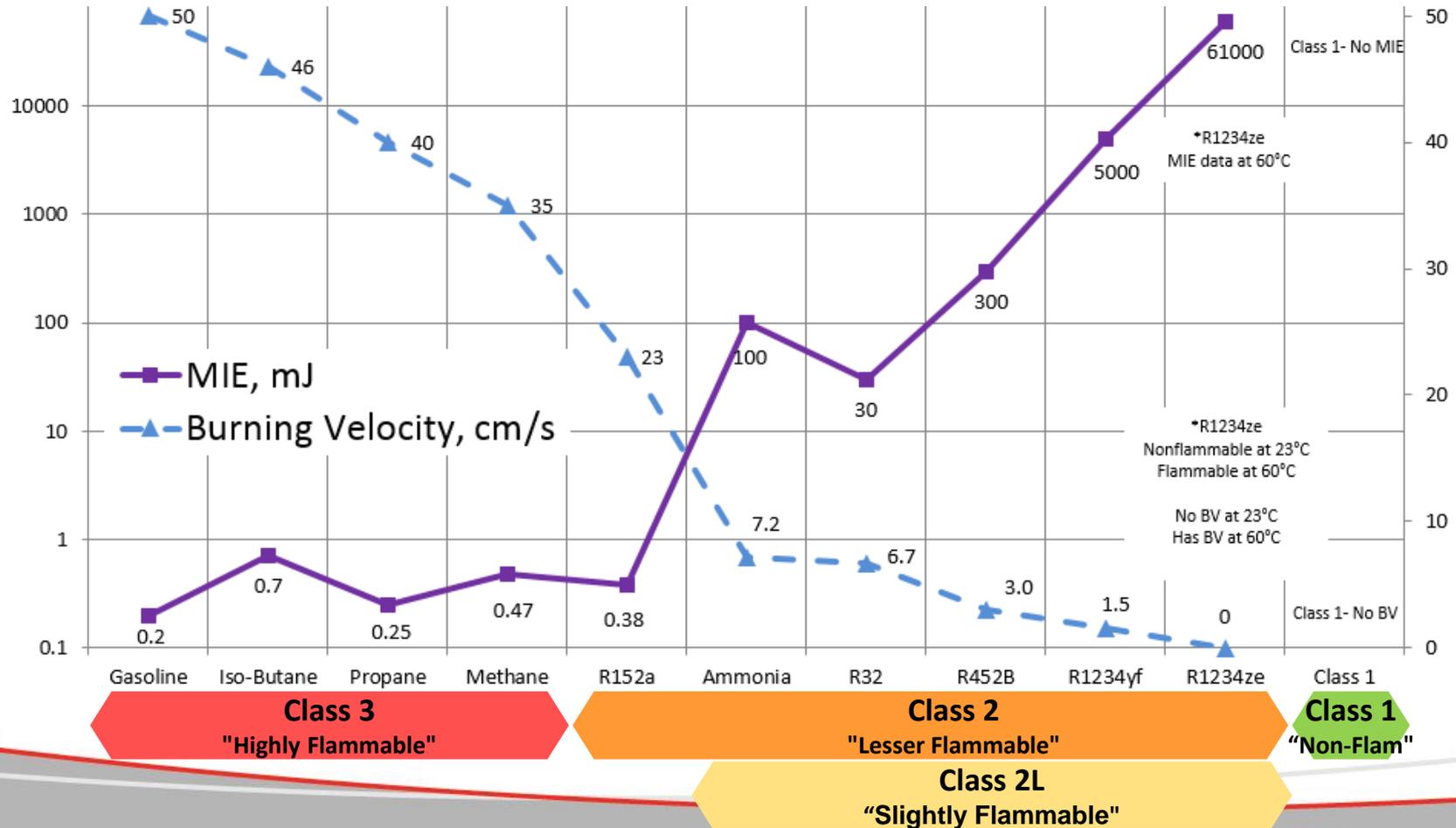
# With choices now available... HVAC Industry Next Transition Begins...



	R-514A	R-123	R-11	R-1233zd	R-1234ze	R-12	R-134a	R-513A
EVAP	(8.95)	(8.63)	(7.34)	(5.87)	23.66	38.73	37.00	41.59
OFF	(2.58)	(1.99)	0.09	3.37	55.21	76.84	78.65	84.53
COND	4.15	4.96	7.65	12.85	85.16	111.53	117.96	124.45



# Flammability Properties Vary



# Centrifugal Refrigerant Choices & Comparison

## Replacements for HFC/HCFC Large Chiller Offerings

	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)
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	Same	1	Same	5% Loss	25% Loss
GWP	79	1	< 2	1300	573	1	1
	In Current Trane Product Offering			In Current Trane Screw Product Offering		Under Evaluation for Trane Products	

### Low Pressure



### Medium Pressure



# Questions

