

The background is a vibrant blue collage featuring various HVAC-related components. It includes images of compressor coils, condenser coils, expansion valves, and control boards with digital displays. The components are arranged in a layered, overlapping fashion, creating a technical and modern aesthetic.

Next Generation Refrigerant R32 Performance

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CONTENT

Regulatory and Policy Issues

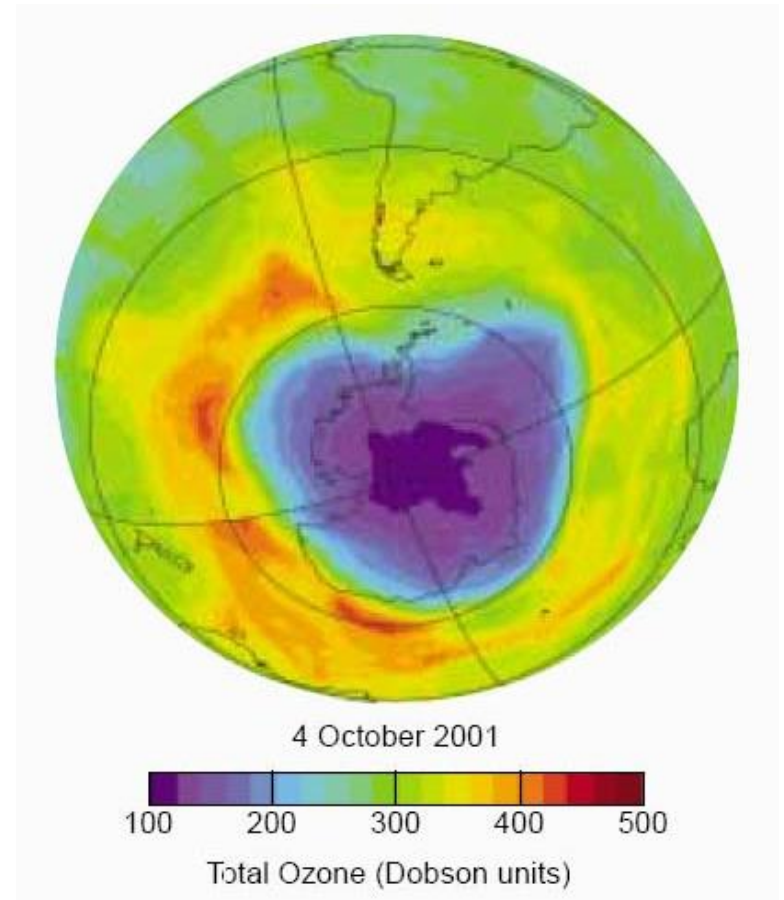
Global Trends and Challenges

R32 Performance

Service Matters

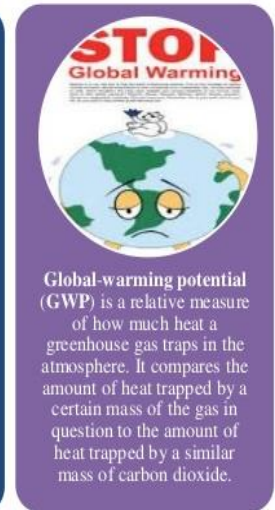
Background

- Environmental Concerns
 - Ozone Depletion Potential (ODP)
 - Ozone is depleted by compounds that contain chlorine that make it into the upper atmosphere
 - To protect the ozone, the Montreal Protocol (1987) has phased out CFCs and HCFCs



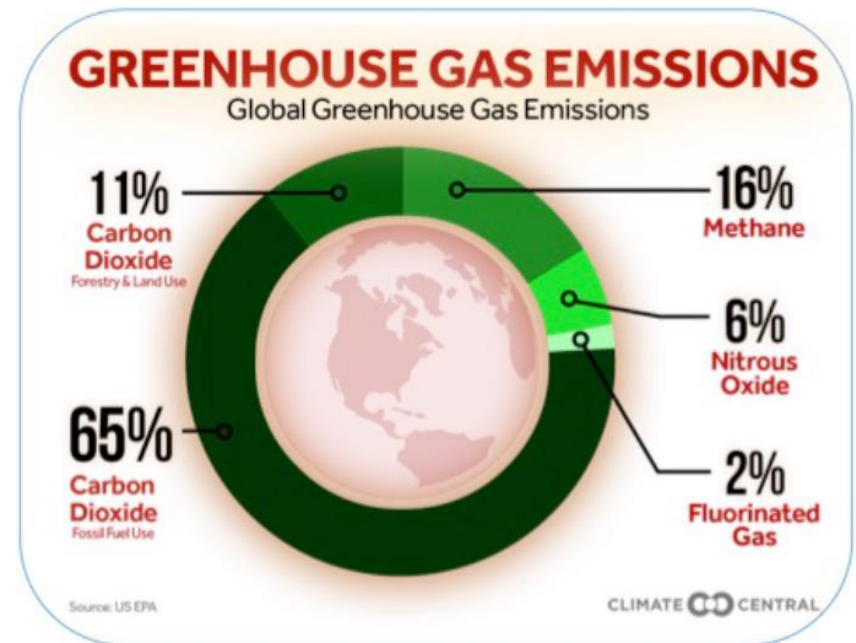
Background

- Environmental Concerns
 - Global Warming Potential (GWP)
 - GWP is a measure of the relative impact a refrigerant has on global warming when compared to CO₂
 - GWP value is used to compare the abilities of different greenhouse gases to trap heat in the atmosphere
 - Kyoto Protocol (1997) controls the emission of Greenhouse gases



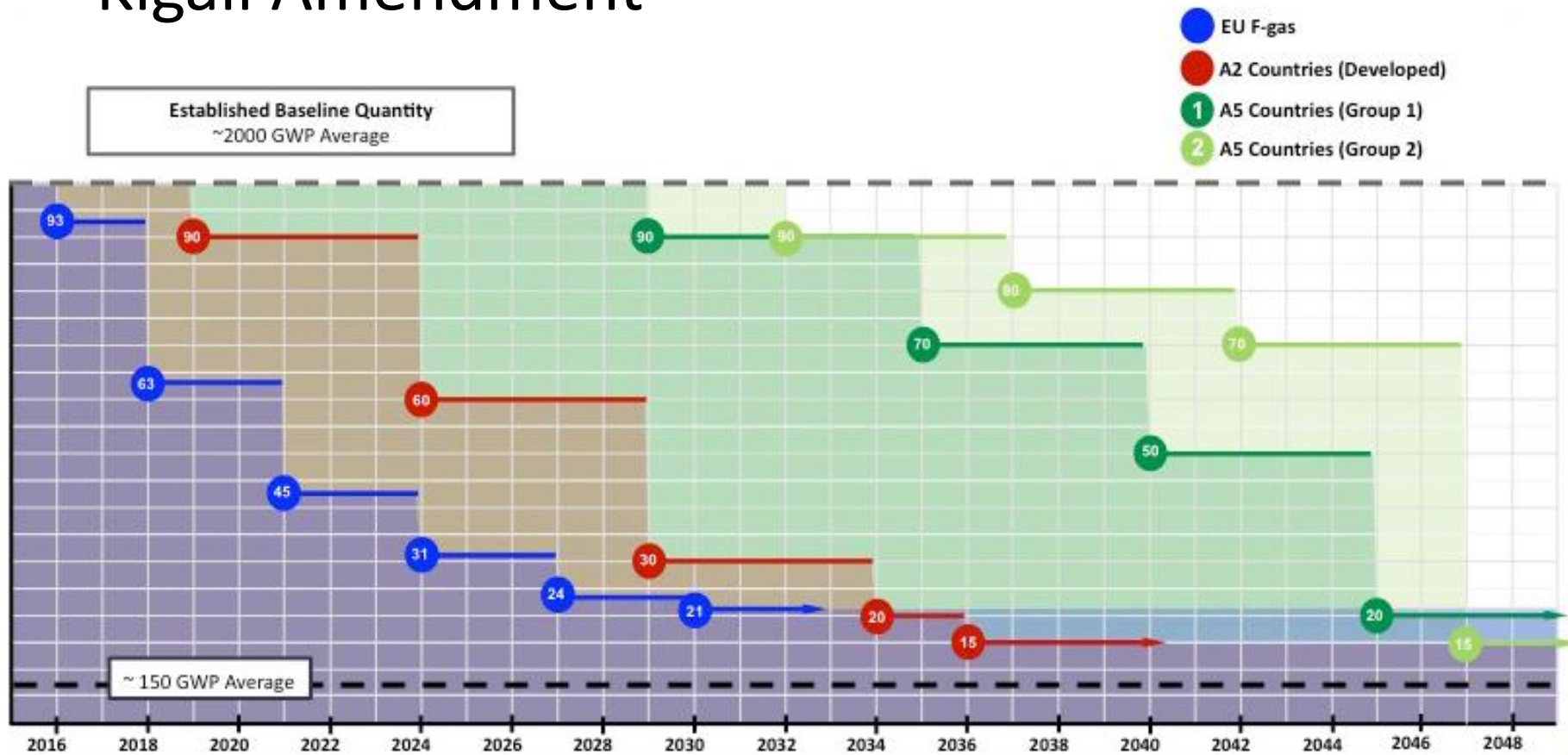
Background

- Environmental Concerns
 - Ozone Depletion Potential (ODP)
 - Global Warming Potential (GWP)
- A need to increase energy efficiency
- Maintain safety and reliability levels



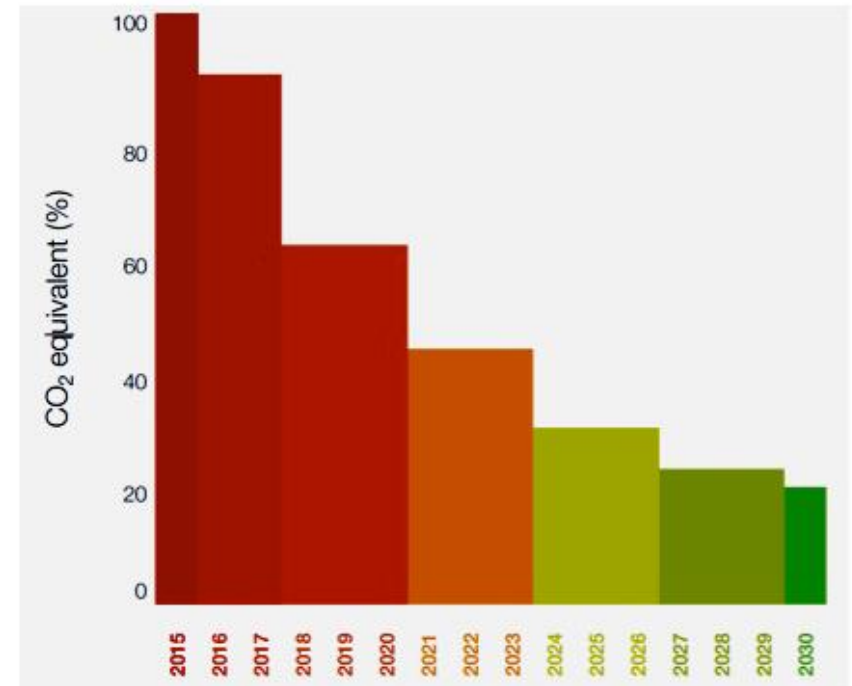
Regulatory and Policy Issues

- Kigali Amendment



Regulatory and Policy Issues

- European Union **F-Gas**
 - More rigorous than the Kigali Amendment
 - Cut HFC use by 79% between 2015 and 2030
 - Reducing quotas
 - Sector prohibitions on HFCs



Regulatory and Policy Issues

- European Union **F-Gas**

20.5.2014

EN

Official Journal of the European Union

L 150/223

Products and equipment	
Where relevant, the GWP of mixtures containing fluorinated greenhouse gases shall be calculated in accordance with Annex IV, as provided for in point 6 of Article 2	
	Date of prohibition
14. Movable room air-conditioning equipment (hermetically sealed equipment which is movable between rooms by the end user) that contain HFCs with GWP of 150 or more	1 January 2020
15. Single split air-conditioning systems containing less than 3 kg of fluorinated greenhouse gases, that contain, or whose functioning relies upon, fluorinated greenhouse gases with GWP of 750 or more	1 January 2025

EU f-gas Regulation(517/2014)

Restricts the amount of use of high GWP Substances

Regulatory and Policy Issues

- Japan
 - Ozone Layer Protection Act
 - Act on Rational Use and Proper Management of Fluorocarbons
 - Kigali Amendment
 - Sector Limitations

Designated Products	Target GWP	Target Year
Residential AC	750	2018
Commercial AC (Split/<6HP)	750	2020
Larger Commercial AC (Split/ excluding VRV)	750	2023
Centrifugal Chillers	100	2025
Mobile AC	150	2023
Condensing unit & Refrigerating unit	1500	2025

Regulatory and Policy Issues

- North America
 - Canada (Environment and Climate Change Canada)
 - United States (EPA)
 - Clean Air Act
 - Significant New Alternatives Policy (SNAP)
 - U.S. State-level actions



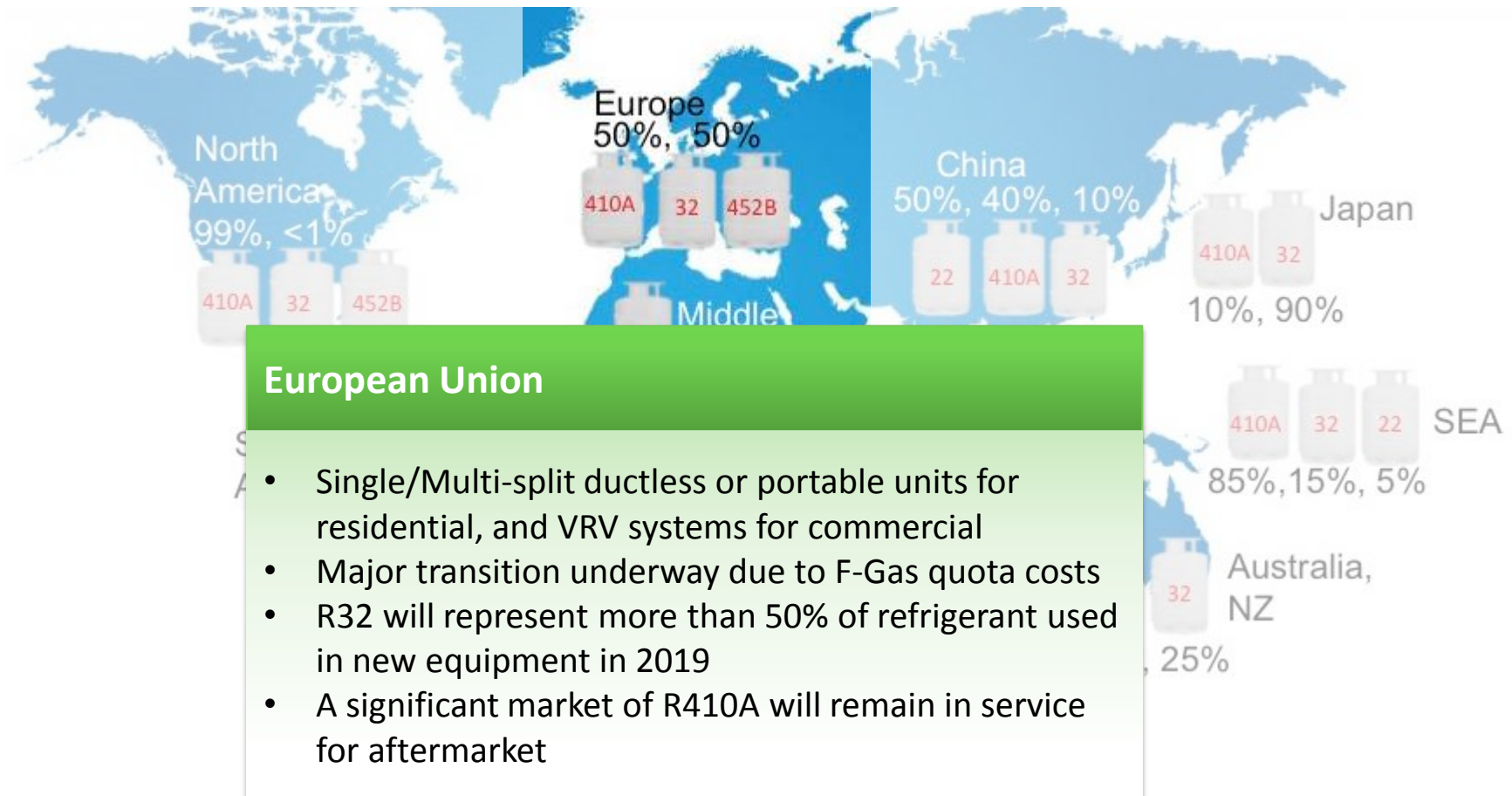
Environment and
Climate Change Canada



SNAP
SIGNIFICANT - NEW - ALTERNATIVES - POLICY

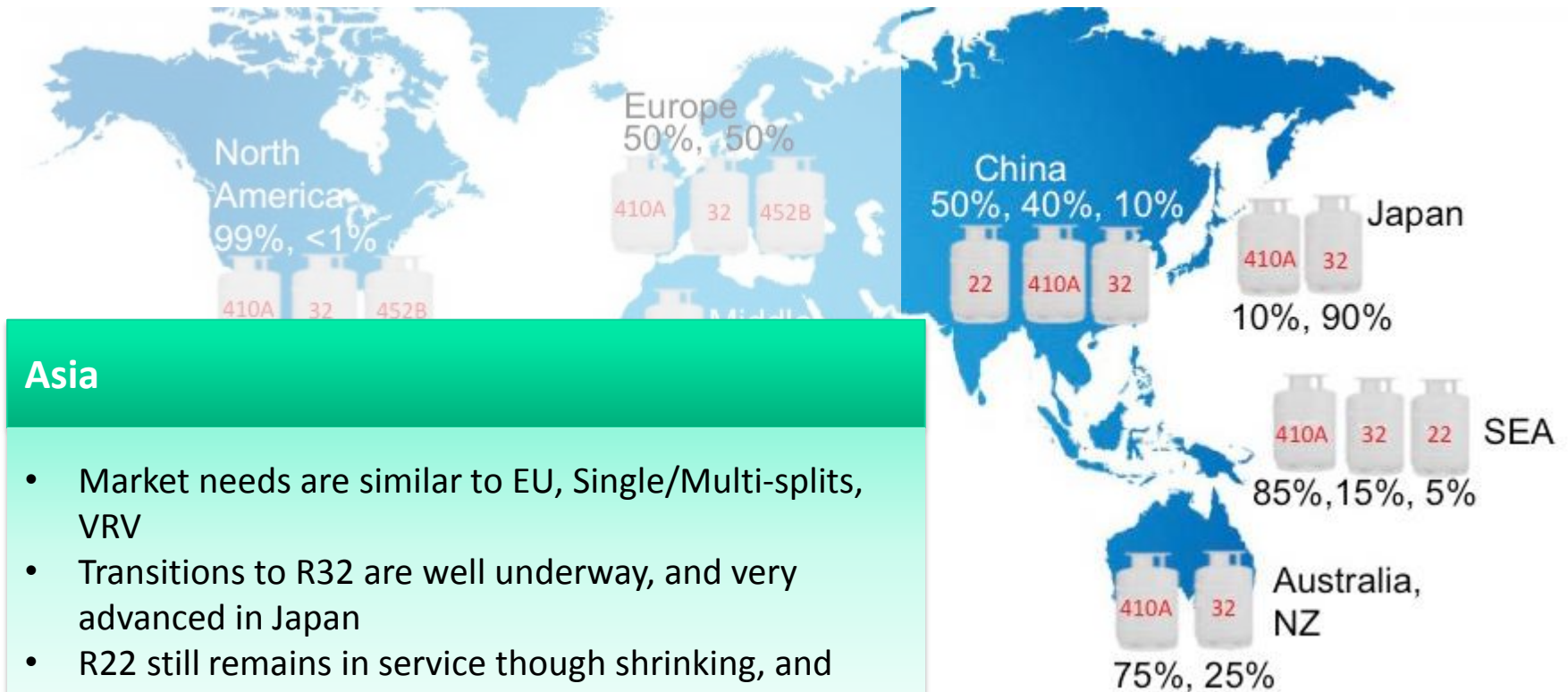
Global Trends and Challenges

Global AC refrigerant usage today in new builds



Global Trends and Challenges

Global AC refrigerant usage today in new builds

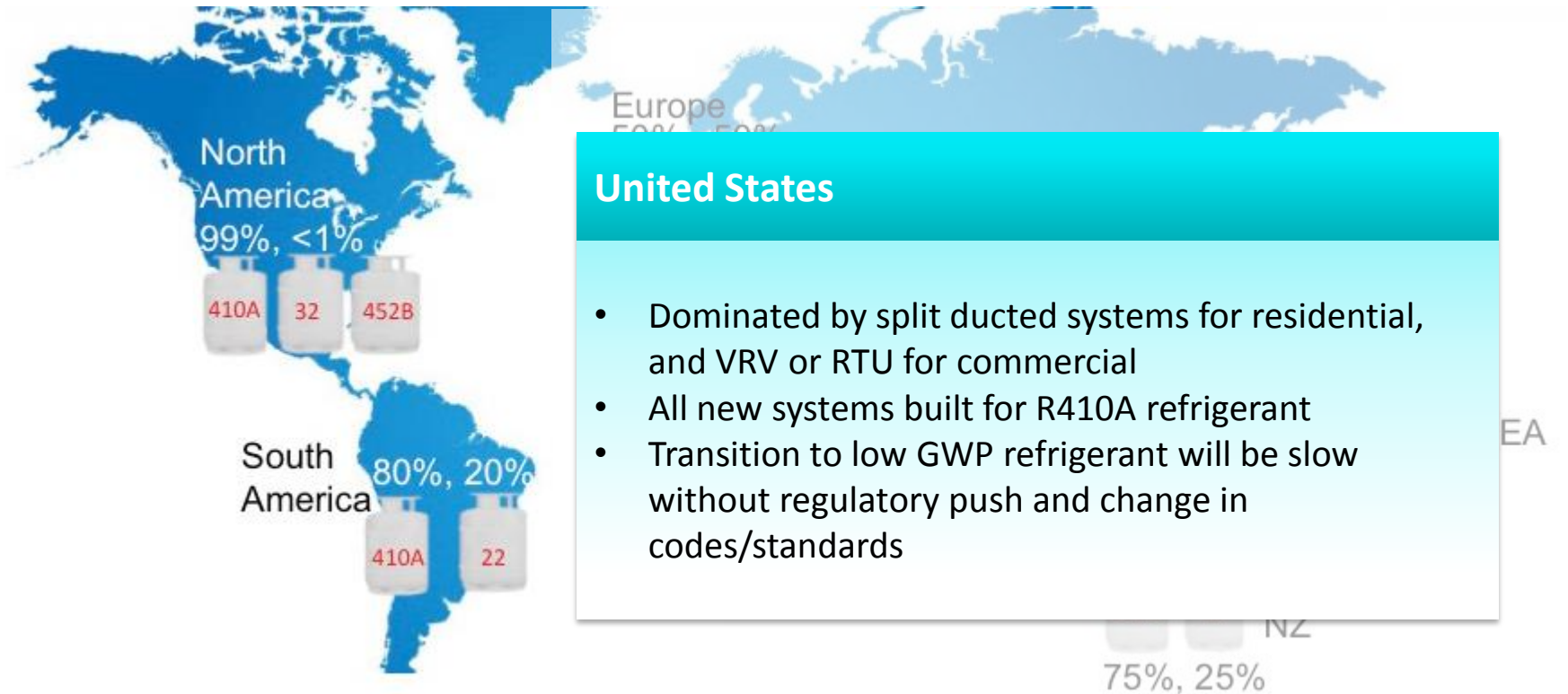


Asia

- Market needs are similar to EU, Single/Multi-splits, VRV
- Transitions to R32 are well underway, and very advanced in Japan
- R22 still remains in service though shrinking, and many nations have adopted R410A or R32
- Codes and standards allow usage of A2L and A3 refrigerants in some countries

Global Trends and Challenges

Global AC refrigerant usage today in new builds



Global Trends and Challenges

Safety Considerations

- Toxicity
- flammability

Environmental Considerations

- ODP
- Direct GWP
- Indirect GWP



Design Considerations

- Components, hardware
- Capacity, efficiency, glide, compressor discharge temperature
- Extreme ambient conditions

Cost-effectiveness

- Transition costs
- Product costs & Complexity
- Reuse of existing products

R32

Characteristics & Performance

Environmental performance

No impact on the ozone layer and lower global warming impact

1

Efficiency

Capacity at least equivalent to that of conventional refrigerants while offering energy efficiency during air conditioner use

2

Economic performance

Low cost of refrigerant, low air conditioner production costs

3

Safety

No toxicity, and extremely low risk of flammability

4

R32

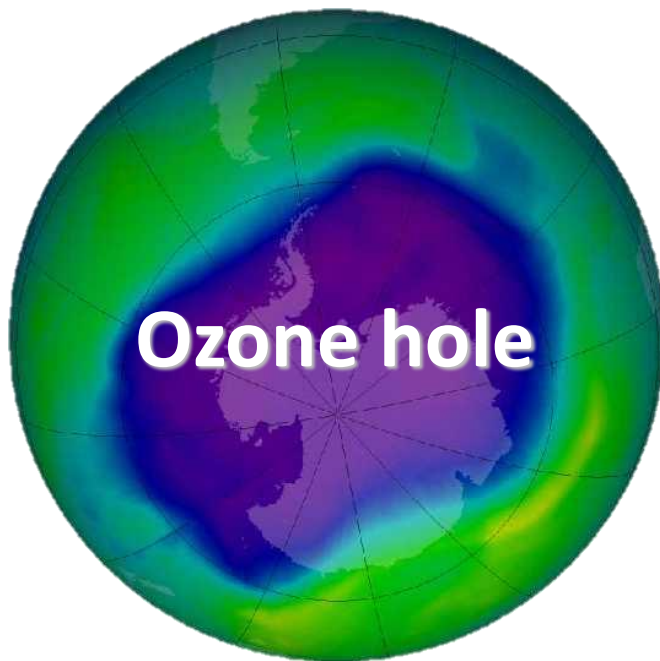
Characteristics & Performance

Environmental performance

No impact on the
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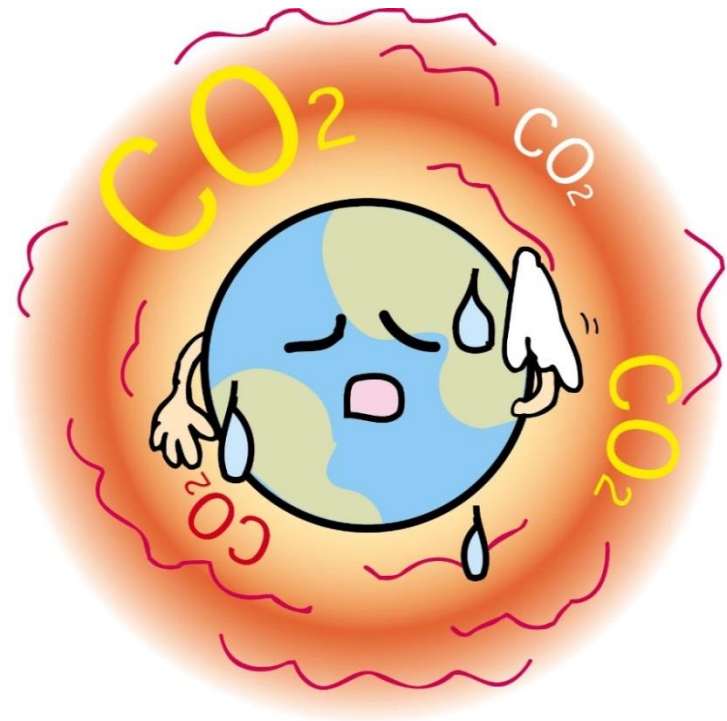
Environmental Performance

Ozone Depletion



Ozone Depletion Potential
(ODP)

Global Warming



Global Warming Potential
(GWP)

Environmental Performance

Environmental Impact of Air Conditioner Refrigerants and Trends

	Ozone Depletion Potential (ODP)	100 Year Global Warming Potential of Different Refrigerants* ¹
R12 (CFC)	1.0	10,900
R22 (HCFC)	0.055	1,810
R410A (HFC)	0	2,090
R32 (HFC)	0	675

Current Refrigerants for Split Units

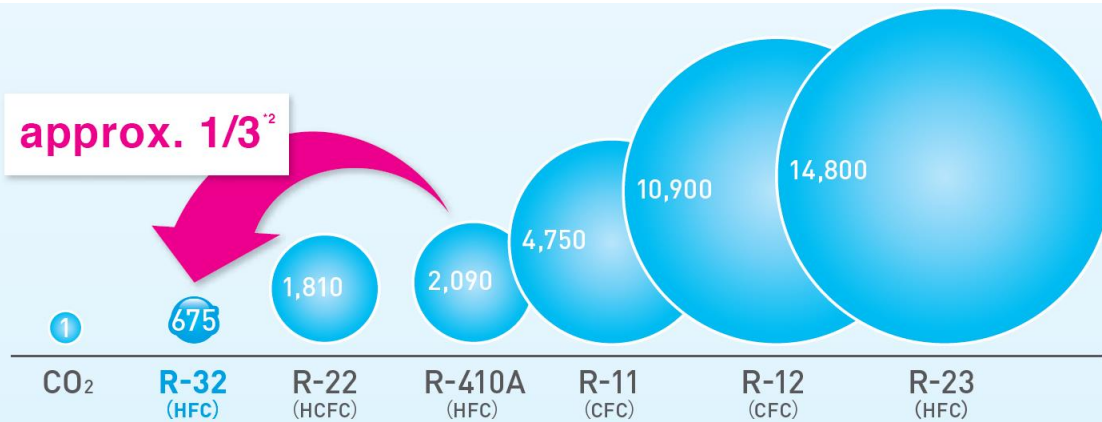
R22
(GWP 1810)

R407C
(GWP 1770)

R410A
(GWP 2090)

Zero ODP but with high GWP

approx. 1/3²

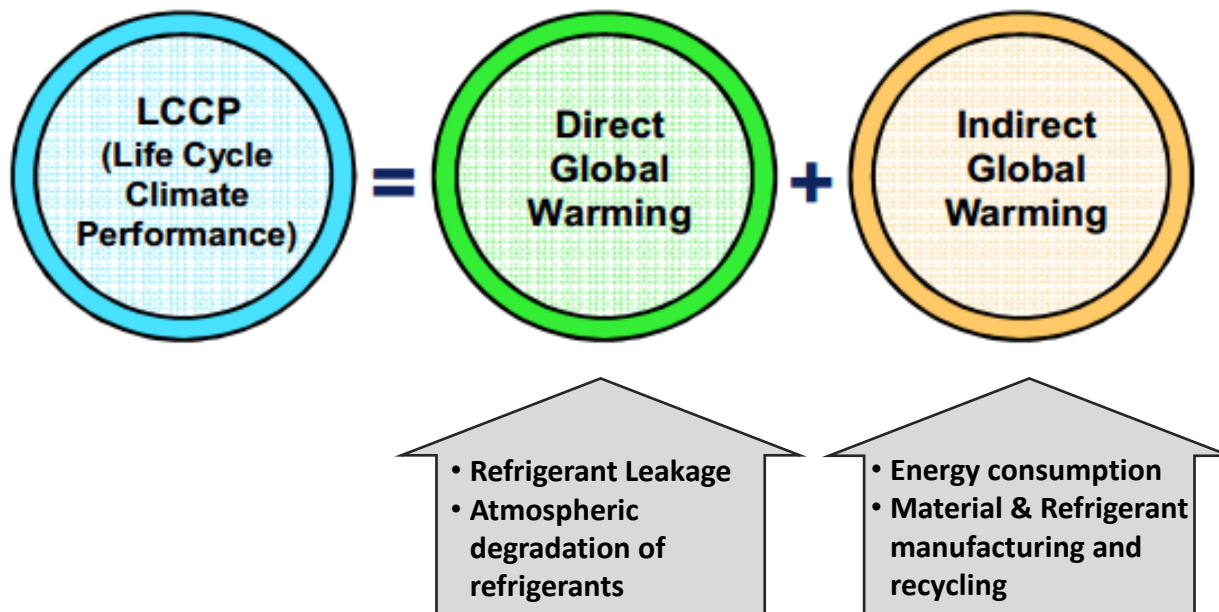


Switching to the refrigerant with low GWP (Global Warming Potential)

Overall Environmental Impact

- **LCCP (Life Cycle Climate Performance)**

- shows more realistic view of total environmental impact of refrigerants

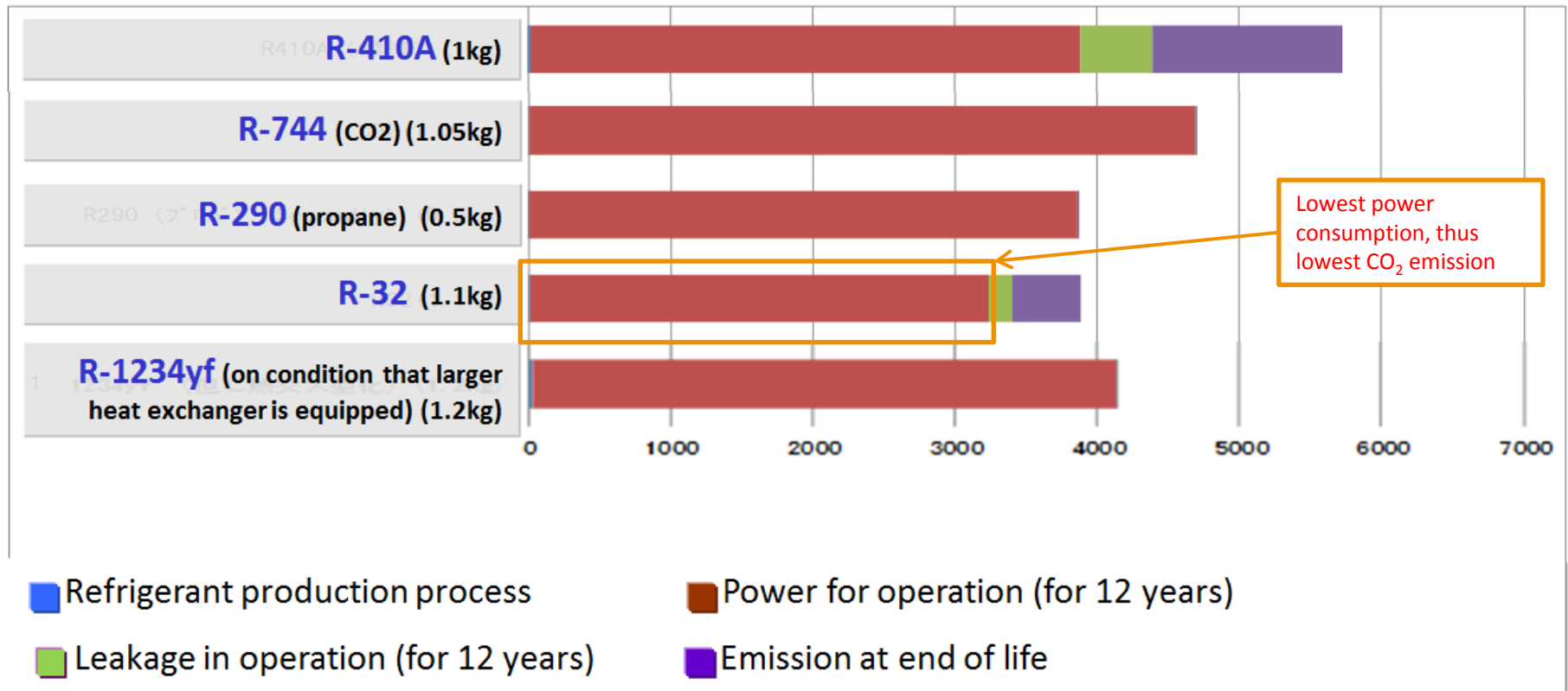


Refrigerants	GWP
R-22	1810
R-410A	2090
R-32	675
Propane	< 3
CO2	1
R-1234yf	4

GWP shows a refrigerant physical characteristic only.

No life cycle evaluation!

LCCP of Major Alternative Refrigerants



Assumptions for calculation : 4kW cooling capacity type room air conditioner

CO₂Emission factor 0.425[CO₂-kg/kWh], Product lifetime 12 years, Operating hours 9hrs/Day, Refrigerant leak rate during operation 2%/year, Refrigerant recovery rate at end of life 30%

R32

Characteristics & Performance

Efficiency

Capacity at least equivalent to that of conventional refrigerants while offering energy efficiency during air conditioner use

2

Economic performance

Low cost of refrigerant, low air conditioner production costs

3

Refrigerant Candidates for Split A/C

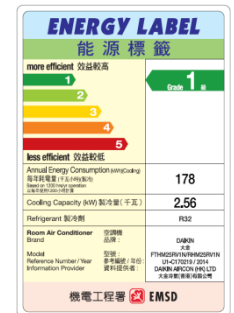
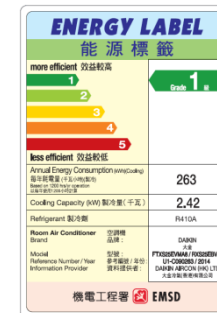
Refrigerants		Properties						
		ODP	GWP (IPCC4th)	Pcond (M Pa)	Vol. Cool. Capacity (vs R22)	Theoretical COP (vs R22)	Flammability	Toxicity
HCFC R22		0.05	1810	1.73	100	100	Non	Low
HFC	R407C	0	1770	1.86	102	99	Non	Low
	R410A	0	2090	2.72	141	92	Non	Low
	R32	0	675	2.80	160	97	Low	Low
	R1234yf	0	4	1.16	57	90	Low	Low
Non-HFC	R290 (Propane)	0	<3	1.53	83	98	High	Low
	R744 (CO2)	0	1	10	243	41	Non	Low

Efficiency Performance

	Model	25 Class	35 Class	50 Class	60 Class	71 Class
Annual Energy Consumption kWh (Cooling)	R410A [FTXS_EVMA]	263	312	545	644	671
	New R32 [FTHM-RV1N]	178	304	425	528	577
	Energy Saving	32%	2%	22%	18%	14%

Same Selling Price!

*Annual Energy Consumption data from Energy Label



R32

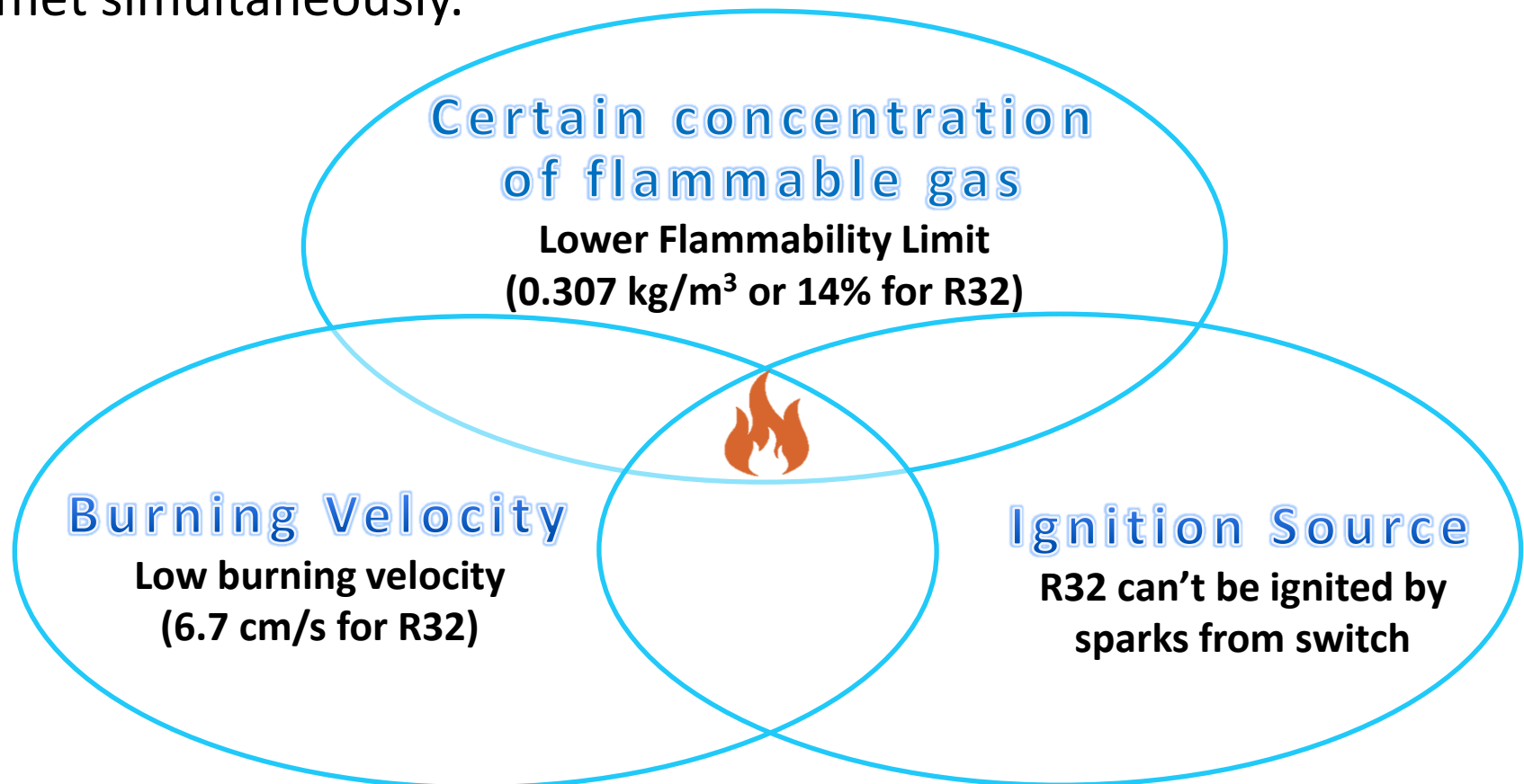
Characteristics & Performance

Safety

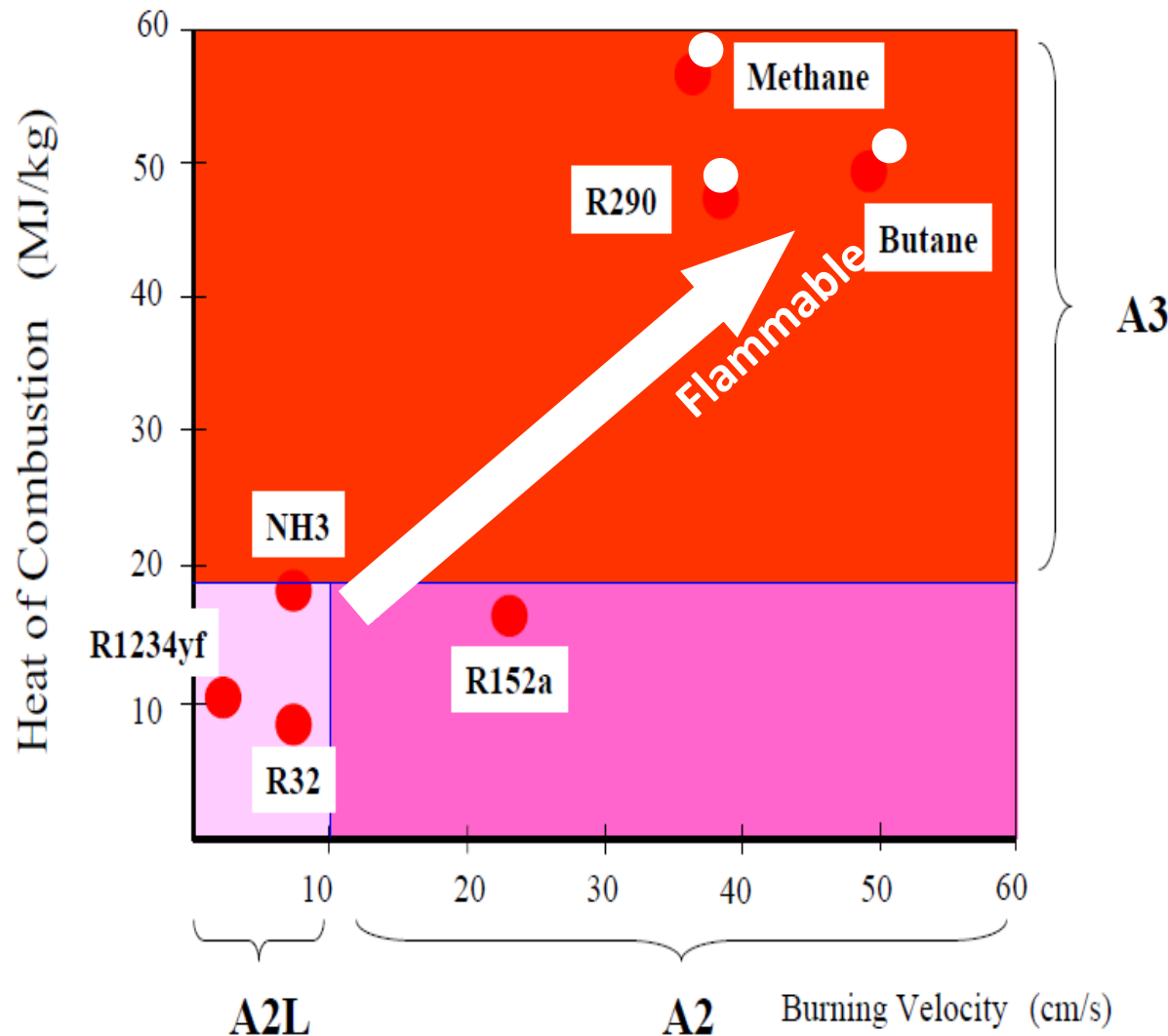
No toxicity, and
extremely low risk
of flammability

Flammability Risk Assessment

To ignite a refrigerant gas mixture, 3 specific conditions must be met simultaneously.



Flammability Risk Assessment



ASHRAE 34

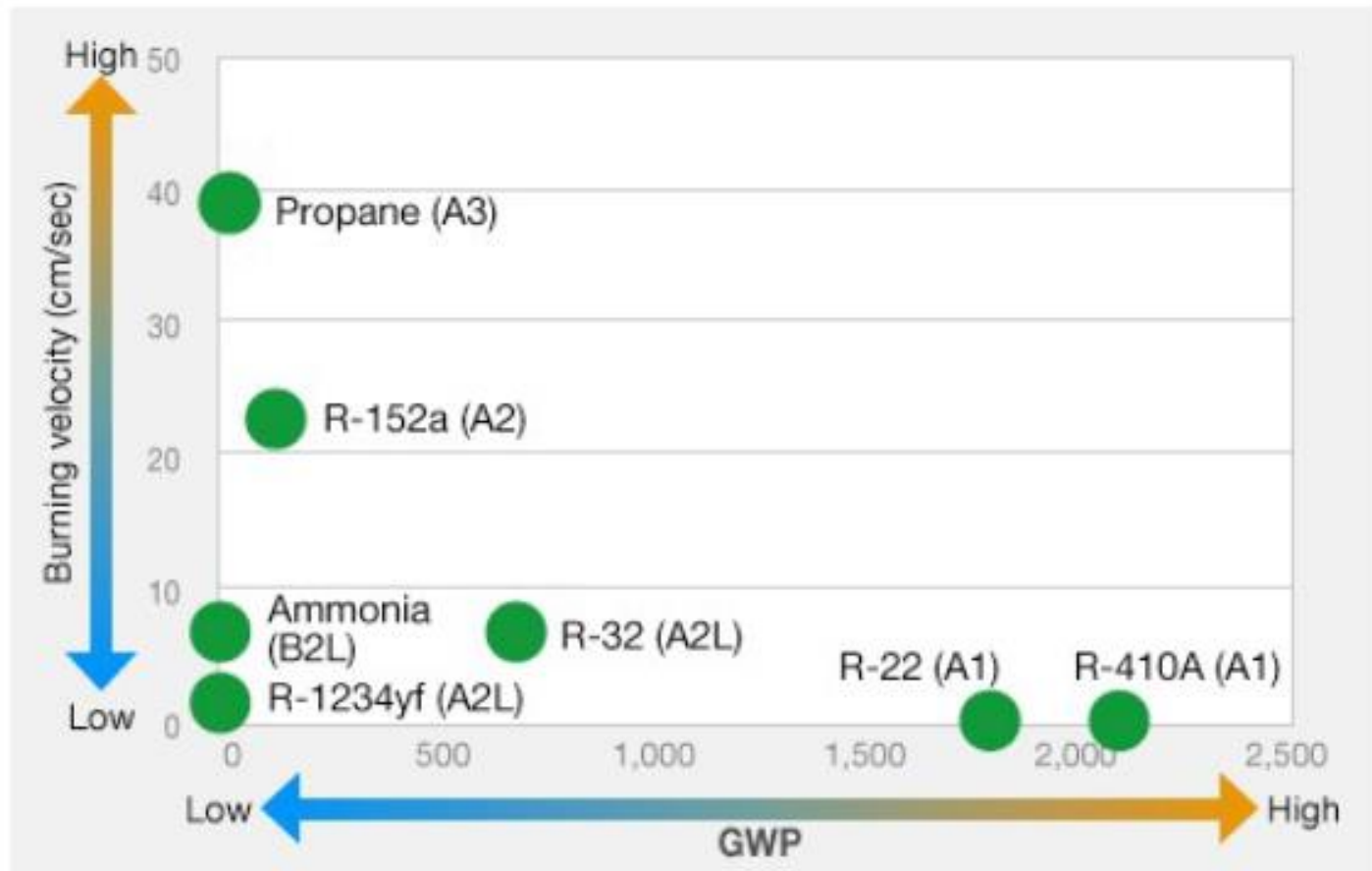
Class	
Non-flammable	1
Mildly flammable	2L
Lower flammable	2
Higher flammable	3

R32 is classified A2L.

*In 2010, ASHRAE opens a new Class A2L for mildly flammable refrigerants. Class A2L refrigerant has a burning velocity less than **10 cm/s** which is too slow to cause horizontal flame propagation nor explosion and a heat of combustion of less than 19 MJ/kg.*

Flammability Risk Assessment

Relationship between Burning Velocity and GWP



Source: Japan Refrigeration and Air Conditioning Industry Association (JRAIA)
Risk Assessment of Mildly Flammable Refrigerants : Final Report 2016

Safety Standards for Refrigerants & Equipment

Product Safety Standards

- ❖ International:
 - IEC 60335-2-40
- ❖ Europe:
 - EN 60335-2-40
- ❖ North America:
 - UL/CSA 60335-2-40
- ❖ Japan:
 - JIS C 9335-2-40
 - JRA GL16, JRA 4070



Safety Standards for Refrigerants & Equipment

Group Standards and Codes

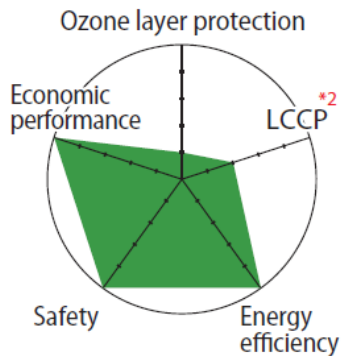


- International:
 - ISO 817
- Europe:
 - EN 378
- North America:
 - ASHRAE Standards 15,34
 - CSA B52.2
 - International Mechanical Code
 - Uniform Mechanical Code
- Japan:
 - High Pressure Gas Safety Act (KHK)

Refrigerants currently
used in developing
countries

R22

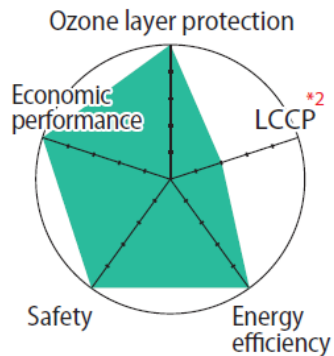
(HCFC)



Refrigerants currently
used in industrialized
countries

R410A

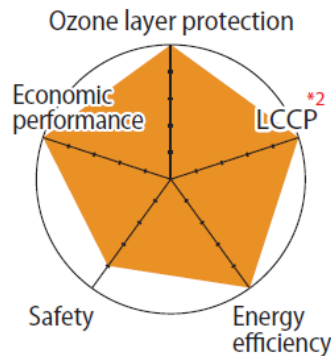
(HFC)



Next-generation refrigerants

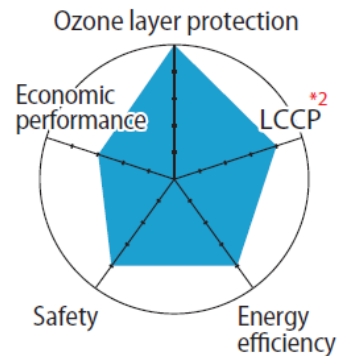
R32

(HFC)



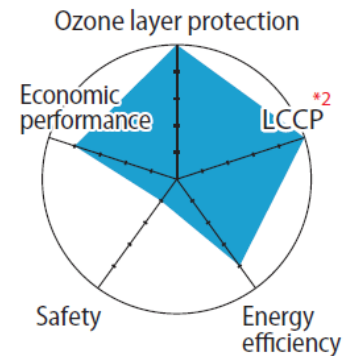
R1234yf

(HFO)



R290

(Propane)



There are no Perfect Refrigerants. R32 is the Most Balanced Choice for Split Units.

Zero ODP &
Lowest LCCP

Higher
Efficiency

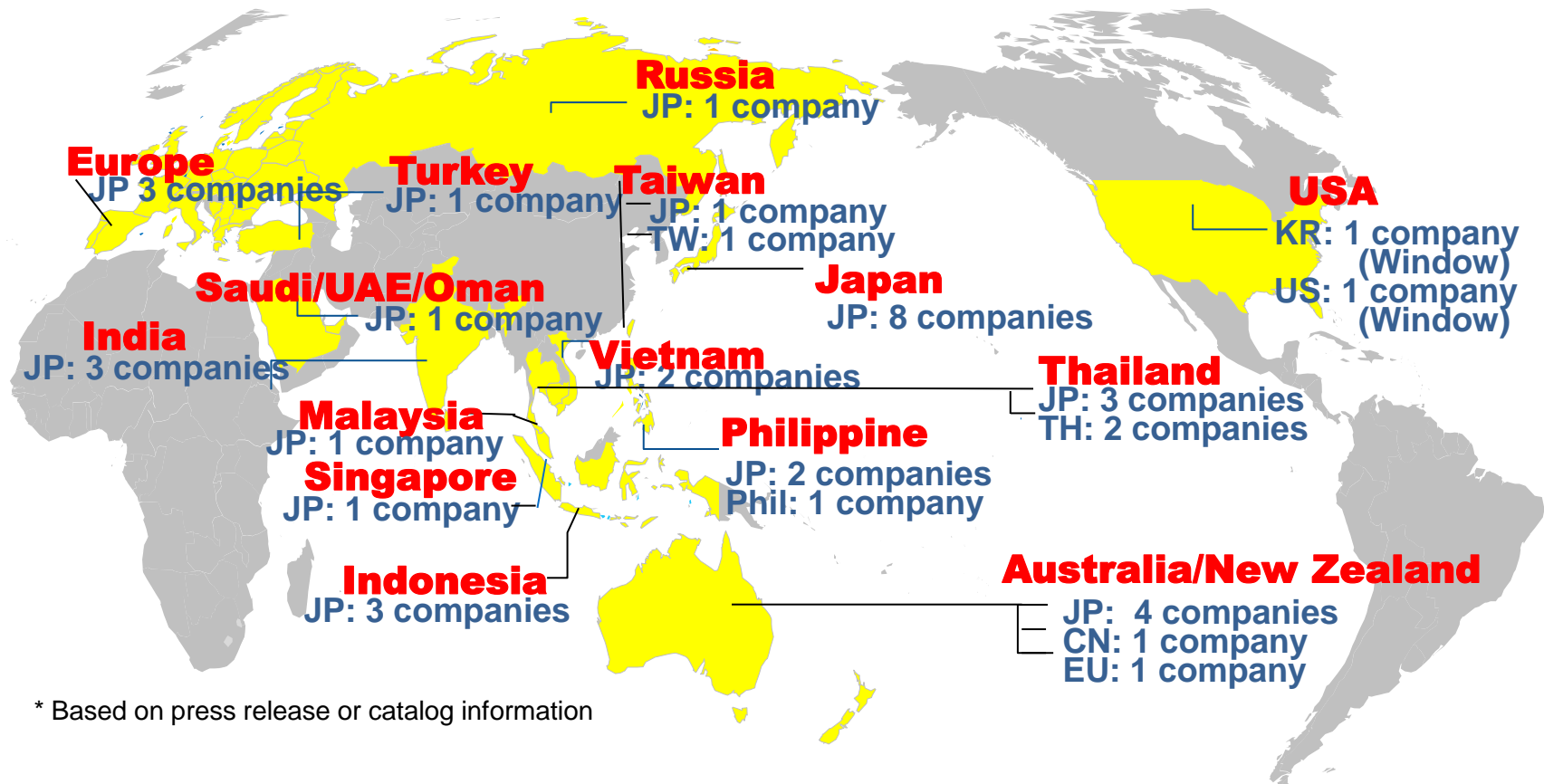
Cost
-effective
Solution

Acceptable
flammable
(Class A2L)

R32 around the World

- Daikin sold about **17 million units** in **60 countries**
- About **68 million** R32 RAC units have been sold in the world

(*Estimation as of Dec 2018 by Daikin)



* Based on press release or catalog information

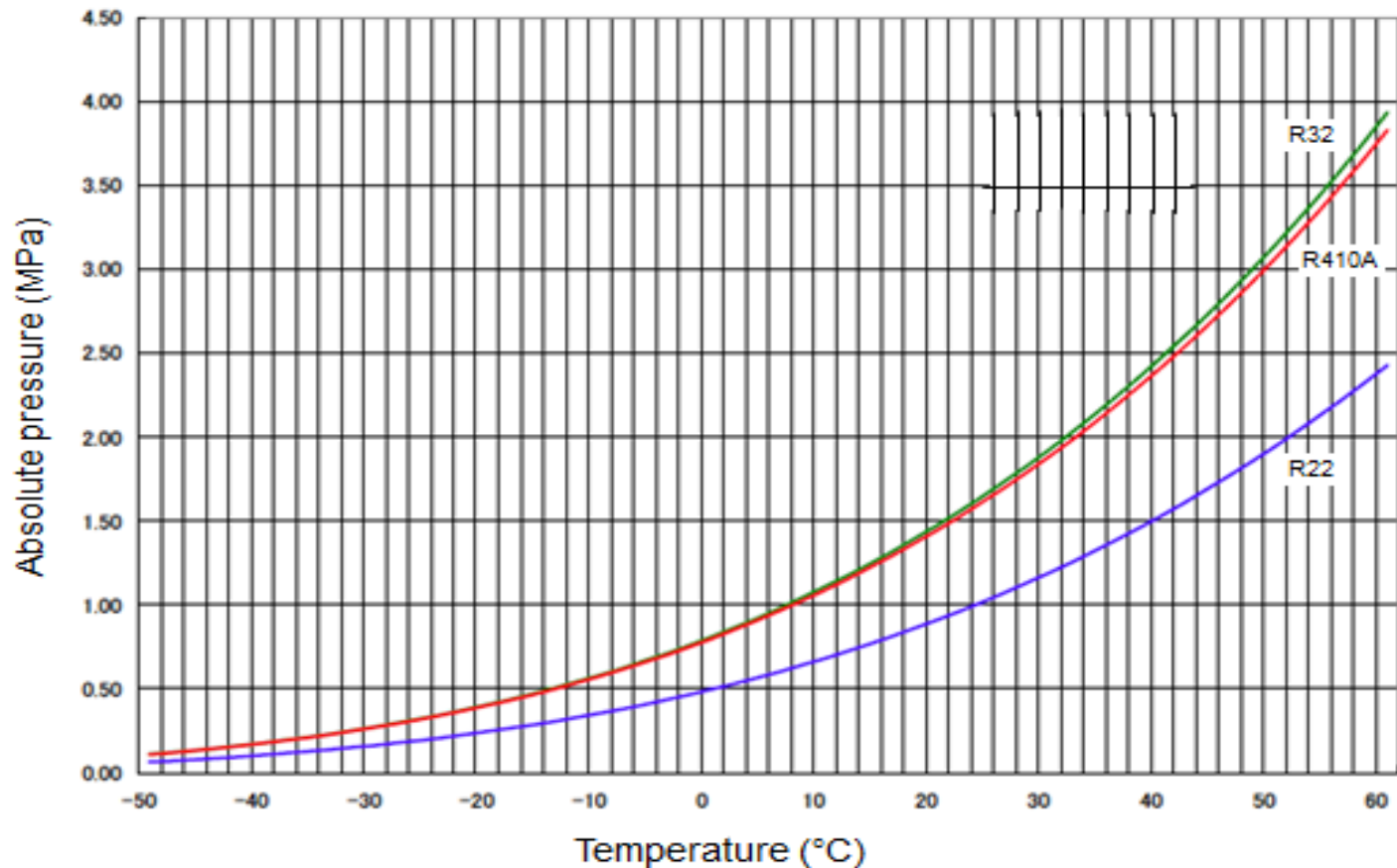
Services Matters



Similar Characteristics













R32 & R-410A

<Refrigerant Properties of R32, R410A, and R22 (Pressure-Temperature Graph)>



Service Tools

Service tool compatibility

Tools (*)	R32	R410A	R22
(1) Gauge manifold 	Compatible		
(2) Charging hose 	Compatible		
(3) Scale 	Compatible		
(4) Pipe bender 	Compatible		
(5) Flare tool 	Compatible		
(6) Torque wrench 	Compatible		
(7) Pipe cutter 	Compatible		
(8) Cylinder adaptor 	Compatible		
(9) Vacuum pump 	Compatible		
(10) Refrigerant recovery unit 	Compatible		
(11) Refrigerant recovery cylinder 	Compatible		
(12) Electric gas leak detector 	Compatible		

Note : May have some restriction on usage due to local regulations

Refrigerant Charges vs. Room Size

(Wall- Mounted)

IEC60335-2-40 (2018 Edition) for residential application

Amount of R32 Refrigerant (kg)	Minimum Room Area (m ²)
Less than 1.80	No Restriction
1.80	2.05
1.95	2.4
2.05	2.66
2.80	4.97
(Current Max Charge of 5HP Multi-Split)	
4.87	15
6.88	30
9.74	60
13.77	120
16.00	162

- **Above 16 kg** can be installed only when mechanical ventilation is provided
- **Under 1.8 kg** there is no floor area restriction

Remarks:

- 1) Current max charge of R32 single split is less than 1.8kg
- 2) Current max charge of R32 5-HP multi-split is 2.8 kg

Risk Mitigation Methods for Refrigerant Release

A1

- Refrigerant Concentration Limit is typically based on Oxygen Deprivation Limit (ODL)
- Maximum Refrigerant Concentration [System Charge divided by the volume of the space] must not exceed the RCL



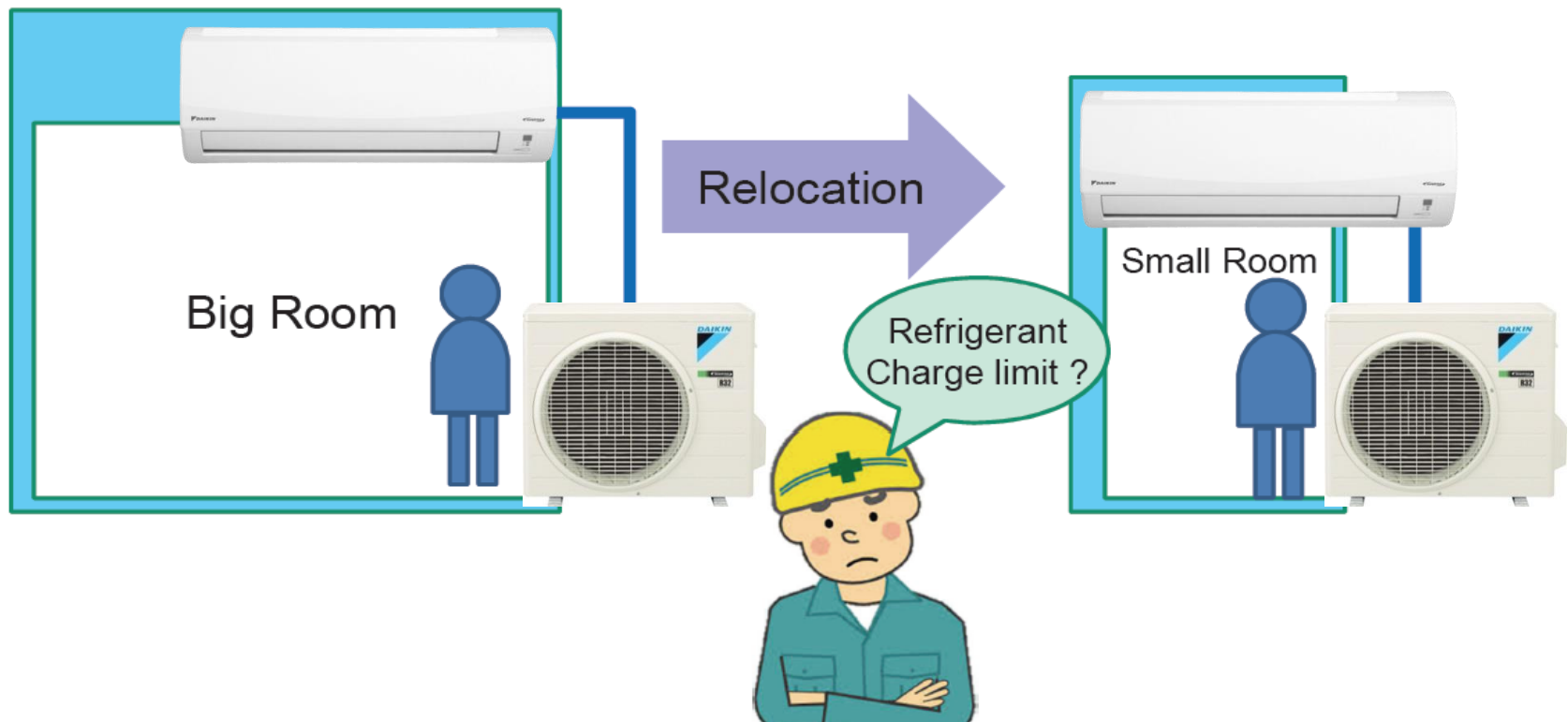
A2L



- Refrigerant Concentration Limit is based on Flammability (LFL)
- Leak tightness
- Limits on charge size
- Refrigerant detection
- Air circulation & ventilation
- Shut-off valves
- Eliminate or reduce proximity to sources of ignition
- Warnings and signage
- Operation, Installation and Service Manuals

Case of Relocation

Check Refrigerant Charge Limit Again !





Key Considerations for Safety

Safety at Workplace

- Workers should be trained for the work before attending any service to the equipment
- Don't smoke
- Keep workplace ventilated
- De-energize the equipment when service
- Check all electric power tools and repair if worn
- If there is a leak, fix the leak first and make sure the area is ventilated before any service



Key Considerations for Safety

Handling Precautions of Refrigerants

- Avoid excessive concentration to keep the place ventilated
- Keep away from flames
- Don't overheat refrigerant cylinders

Key Considerations for Safety

Handling of Pressurized Cylinders

- Use APPROVED cylinders
- Equipped with Liquid/Vapor Valves & pressure regulating valve
- Labeled with name of pressurized gas
- Proper storage
- Light Blue-Green Colour Code for R32



R32

N.W.: 3KGS



Thank You!