

JOINTWAY Study on HVACR

Alternative Refrigerant

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Montreal Protocol

Newly Aligned Appendix For HFCs

| Category | Developed Countries | Developing Countries | World's hottest countries India / Pakistan/ Iran/ Saudi Arabia / Kuwait |
|-----------------|---|---|---|
| Baseline | Average production and consumption 2011-2013 | Average production and consumption 2020-2022 | Average production and consumption 2024-2026 |
| Schedule | Freezing HFC Use 2018 Starting Reduction 2019 Reducing to 15% By 2036 | Freezing HFC Use 2024 Starting Reduction 2029 Reducing to 20% By 2045 | Freezing HFC Use 2028 Starting Reduction 2032 Reducing to 15% By 2047 |

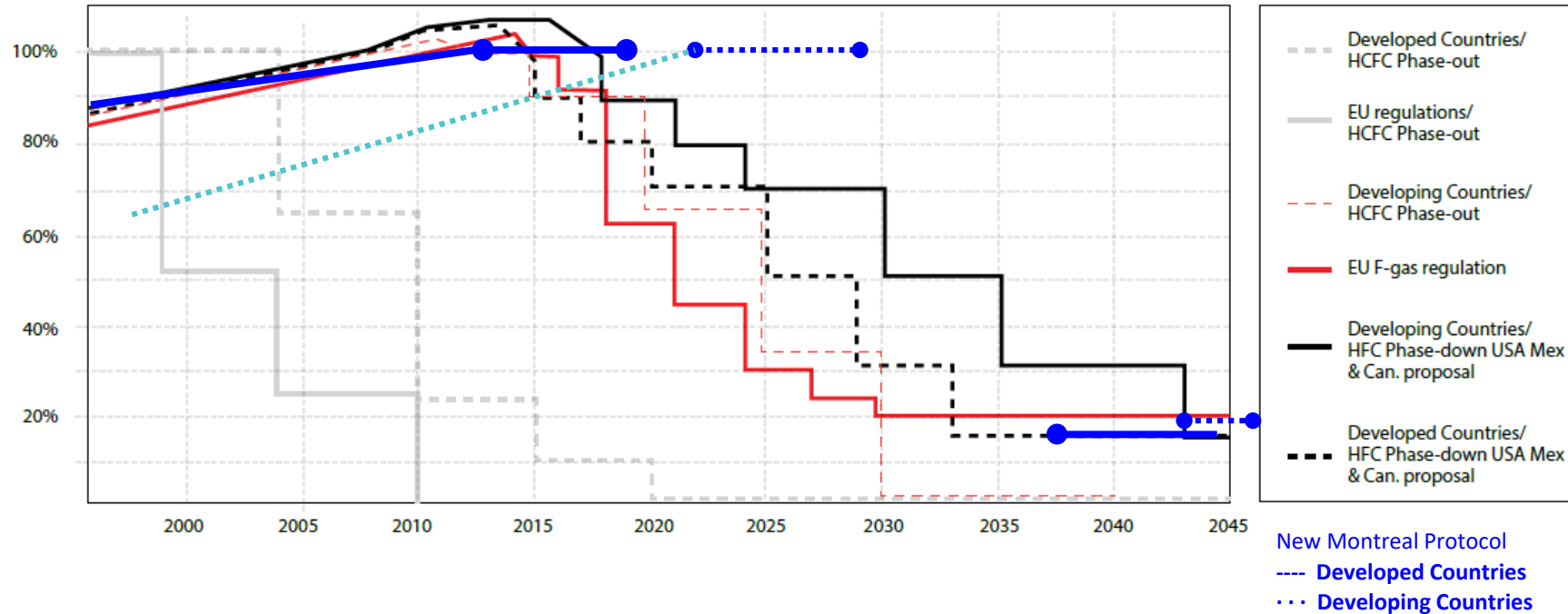
| | Current HFCs R134a/R410A | R32 (HFC) | HFO HFO1234yf/ze | CO ₂ | Hydrocarbons |
|-----------------------------------|-----------------------------|-----------|---------------------|-----------------|--------------|
| GWP | 1430/2088 | 675 | 4-6 | 1 | <10 |
| Compressor design and cost | | | | Higher pressure | |
| Energy efficiency | | | | | |
| Safety | A1 | A2L | A2L | A1 | A3 |

The Appendix Does Not Mention About The GWP Information Like F-gas
Need To Understand More On This Point For R32

Potential Alternative Refrigerants By CRAA 2014 China

| System Types | Compressor Types | Existing Refrigerants | Potential Alternatives |
|-------------------------------------|---------------------|--------------------------------|--|
| Small /Mid Size Cooling(HP) Chiller | Rotary/Scroll | R-22 /R410A | R410A (Near Term) R-32 (Medium/long Term) |
| Large Size Cooling(HP) Chiller | Screw/Centrifugal | R-22 /R-123 / R-134a | R-134a (Near Term) R-1234ze(E) (Medium/long Term) HFO Blend (Medium/long Term) |
| Heat-Pump Water Heater | Rotary/Scroll | R-22 / R-134a R410A / R407C | R-134a / R410A (Near Term) R-32 / CO ₂ (Medium/long Term) |
| PAC Unit | Rotary/Scroll/Screw | R-22 /R-142b R410A / R407C | R410A (Near Term) R-32 (Medium/long Term) |
| RAC | Rotary | R-22 / R410A | R410A (Near Term) R32,R290 (Medium/long Term) |
| VRF | Rotary/Scroll | R410A | R410A (Near Term) R-32 (Medium/long Term) HFO Blend (Medium/long Term) |

Refrigerant Regulation Timeline And China Refrigerant Consumption And Possible Solutions



| | Refrigerant Consumption | Compressor | Now | Possible Future | NPD Coverage |
|---------------------|-------------------------|--------------------------|----------------------|---------------------|--|
| Residential AC | 60% | Rotary | R22/R410A | R32/R290 | NA |
| Light Commercial AC | ~20% | Scroll/Rotary | R22/R410A | R410A/R32 | Yes |
| Commercial AC | ~10% | Screw/Centrifugal/Scroll | R134a Type/R22/R410A | HFO type/ R410A/R32 | Yes |
| Refrigeration | ~10% | Recip/Scroll | | HFO Blends/R32 | No Confirmed Candidate Yet, But in Follow-up |

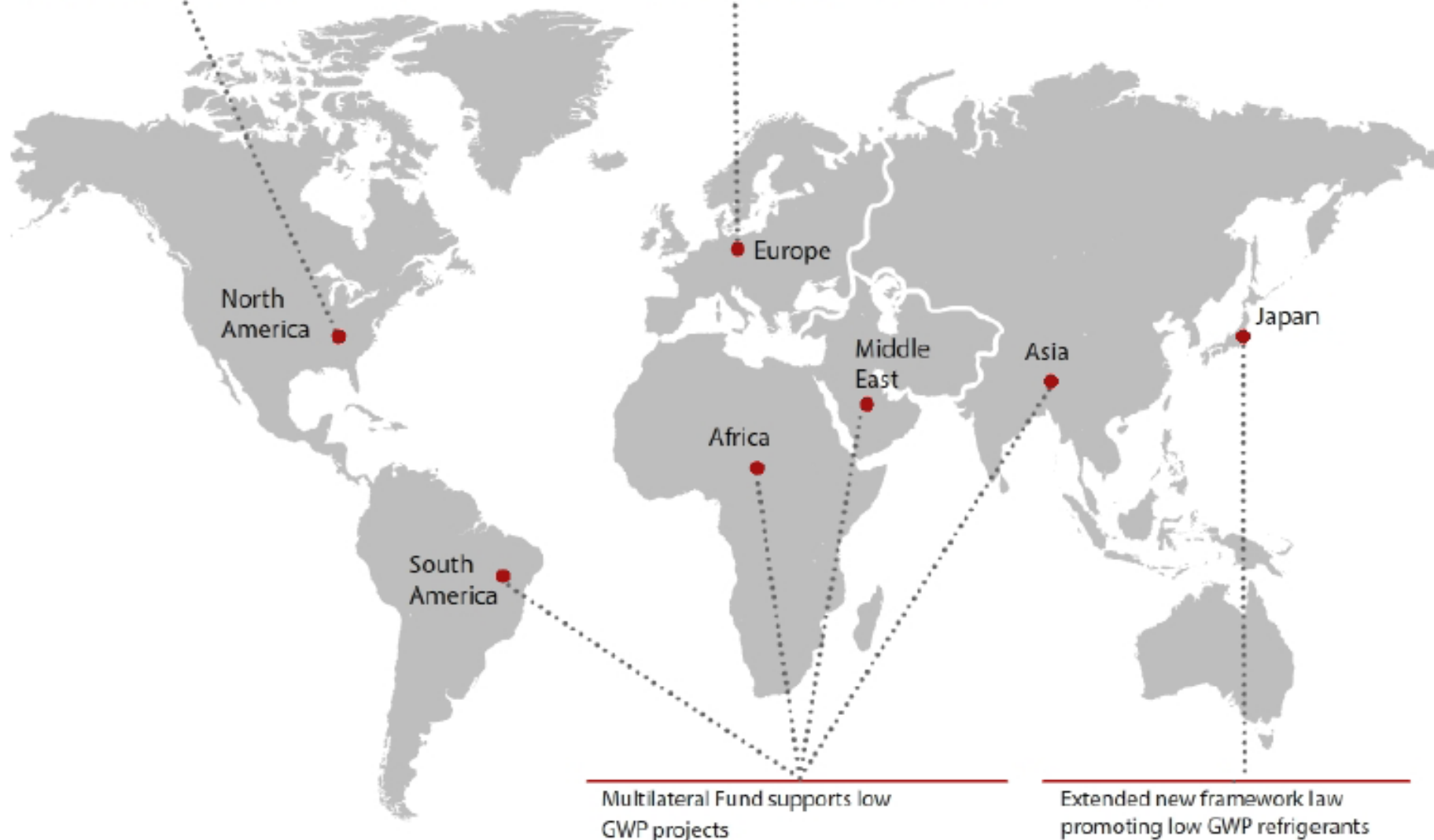
HFCs逐步削减修正案

- 2016年10月15日，《蒙特利尔议定书》第28次缔约方会议于卢旺达首都基加利通过了关于削减HFCs的修正案：

| 国家类别 | 发达国家 (第二条款缔约方) | 发展中国家 (第五条款缔约方) |
|------|--------------------------|--|
| 基线 | 2011-2013平均值 | 2020-2022平均值 |
| 削减进度 | 2019年开始削减 2036年削减至15% | 2024冻结年 2029开始削减 2045削减至20% |
| 特殊情况 | 部分发达国家： 2020开始削减 | 部分发展中国家（印度、巴基斯坦、伊拉克等）： 2028开始冻结 2032开始削减 |

SNAP delisting of HFC (R134a)
in favour of HFO (R1234yf)

HFC phase down starting in 2015
ending with 79% cut down in 2030

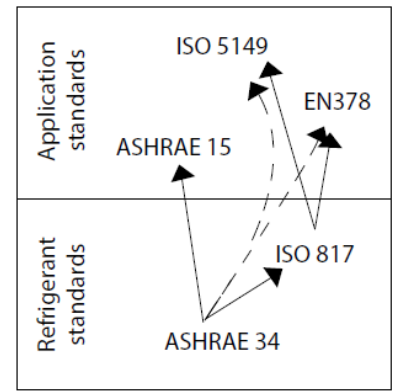


Worldwide:

- Ongoing discussions concerning a global phase down under the Montreal Protocol
- National tax schemes on HFC
- National incentives and subsidies

ASHRAE 15: Linked to building regulations

EN 378: Linked to compliance with EU laws (MD and PED directives)



ASHRAE 15 or ISO 5149: Voluntary

ISO 5149: Available but voluntary

ISO 5149: Mandatory

AS/NZS 1677: Partly mandatory but changing to ISO 5149



EPA Issued Notice Of Public Rulemaking On Delisting HFCs, August 6, 2014

| Refrigerant | Supermarket* | | Condensing Units* (field charged) | Standalone Self Contained Comm. Ref. Eqpt* (factory charged sealed systems) | Vending Machines | Foam | Auto AC |
|---|--------------|-------------|--------------------------------------|--|---------------------|--------------------------------------|---------------------|
| | Direct | Sec. | | | | | |
| R404A/507A | JAN 2016 | JAN 2016 | JAN 2016 Delay 6 years | JAN 2016 Delay 6 years | JAN 2016 | | |
| HFC-227 ea., R-407B, R-421B, R-422A, R-422C, R-422D, R-428A, R-434A | JAN 2016 | JAN 2016 | | | | | |
| R407A, R407F | | | | JAN 2016 (New) Do not delist | | | |
| R134a | | | | JAN 2016 (New) Do not delist | JAN 2016 (New) | JAN 2017 Delay 6 years | 2021 Model (New) |
| Various Blends, GWP 600-3990** | | | | JAN 2016 (New) | | | |
| Various Foam Refs** | | | | | | JAN 2017 Delay 6 years | |
| Various Auto Blends** | | | | | | | 2017 Model (New) |

*New and retrofit only; Service is allowed

** Check EPA Documents for details

Aerosol Application not shown in above table

Industrial, Ice Making heads, Warehouses and Transport Applications are not Included in This NOPR but comments have been requested.

**Do Not Delist Now In Industrial And Ice: No Alternates Without Glide
S.Mkt, Transport – No Comment**

**Emerson Submitted Written Comments, Along With 93 Others
Expect EPA Response And Final Rule Q1 CY2015**