# 1. Greenhouse Gas Reduction policies: Is the EU entering the right path?

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REFRI-GERATION 2030

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- Where are we on the HFC EU market? First results
- R-404A, R-410A, R-134a issues and replacement options
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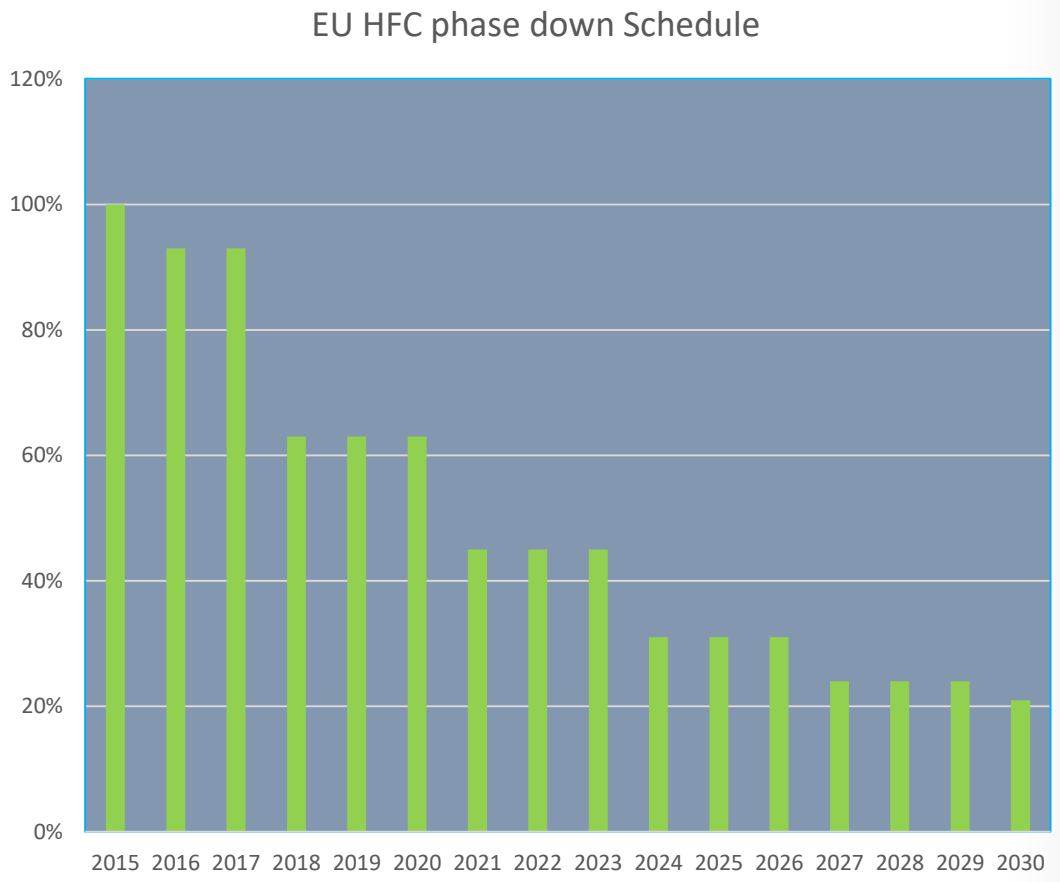
- Conclusions and perspectives

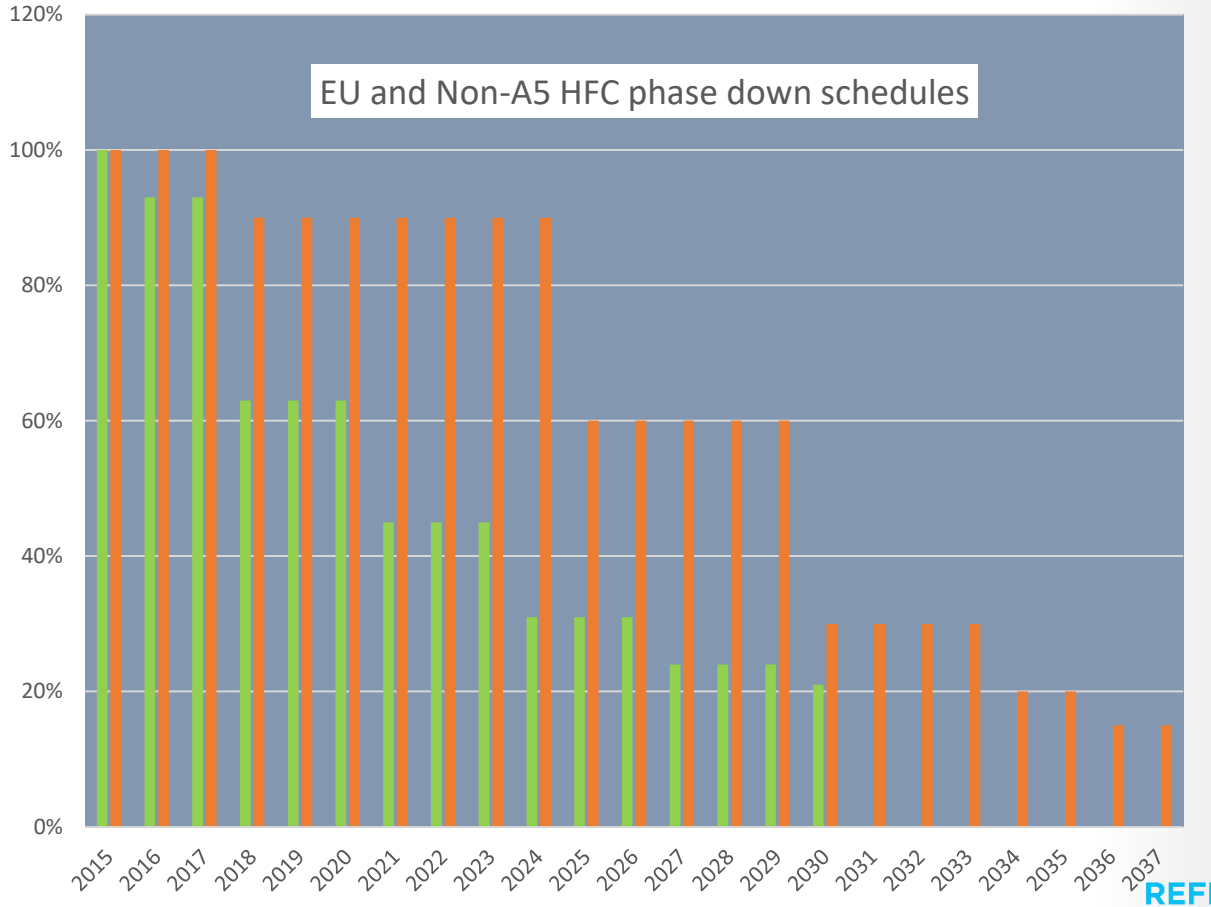
# EU HFC Phase down schedule

- Phase down schedule in 15 years
- 50% reduction in the first 7 years
- Ahead of international schedule
- Promotion of “natural” refrigerants
- Open to HFOs



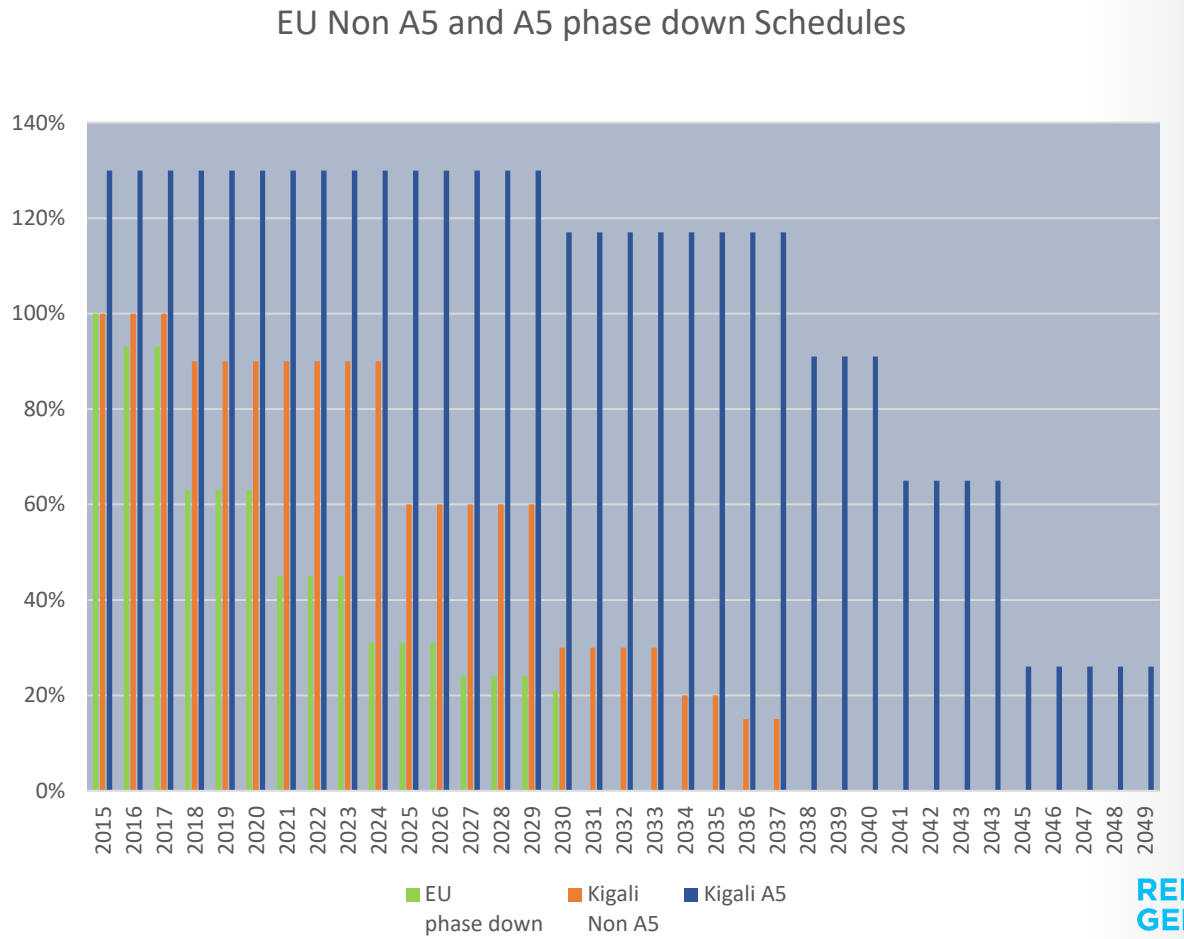
# Developed countries (Non-A5) Schedule

- Phase down schedule in 22 years
- 40% reduction in the first 10 years
- Open to all alternatives
- Key role of the USA and related uncertainties



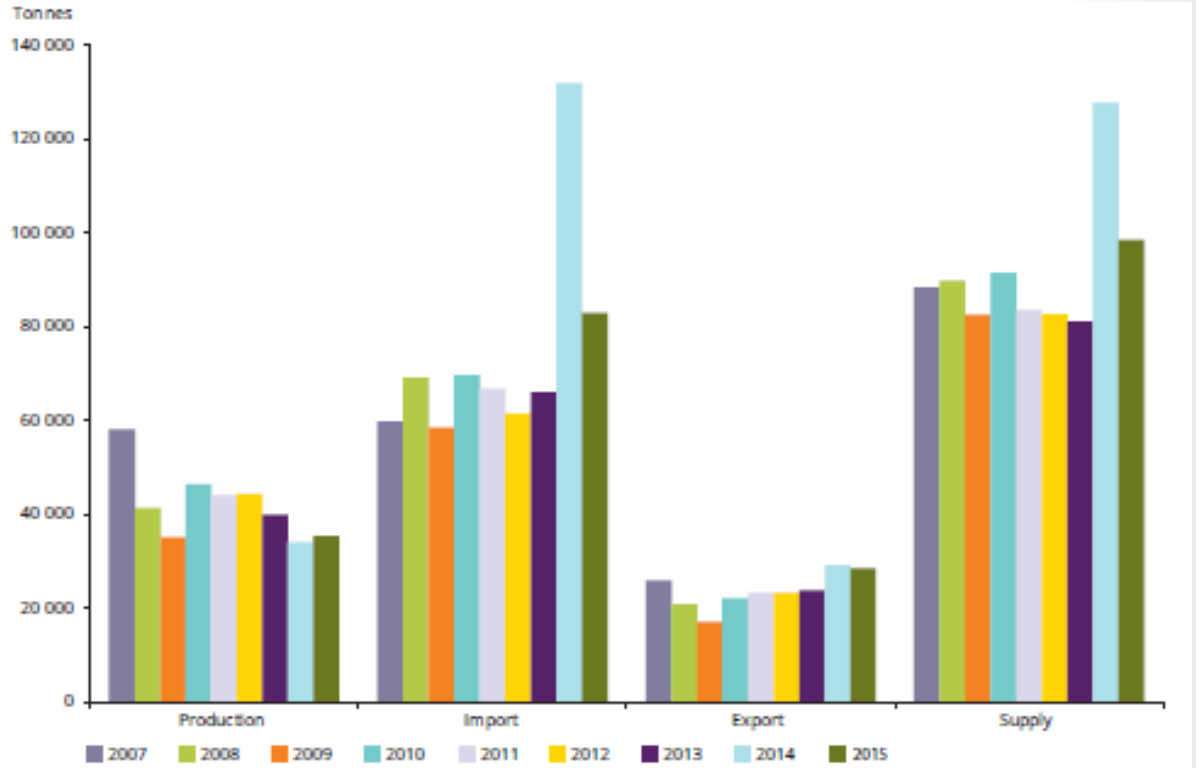
# Developing countries (A5) Schedule

- Phase down schedule in 35 years
- 35% reduction after 26 years
- Many uncertainties
- Key role of China



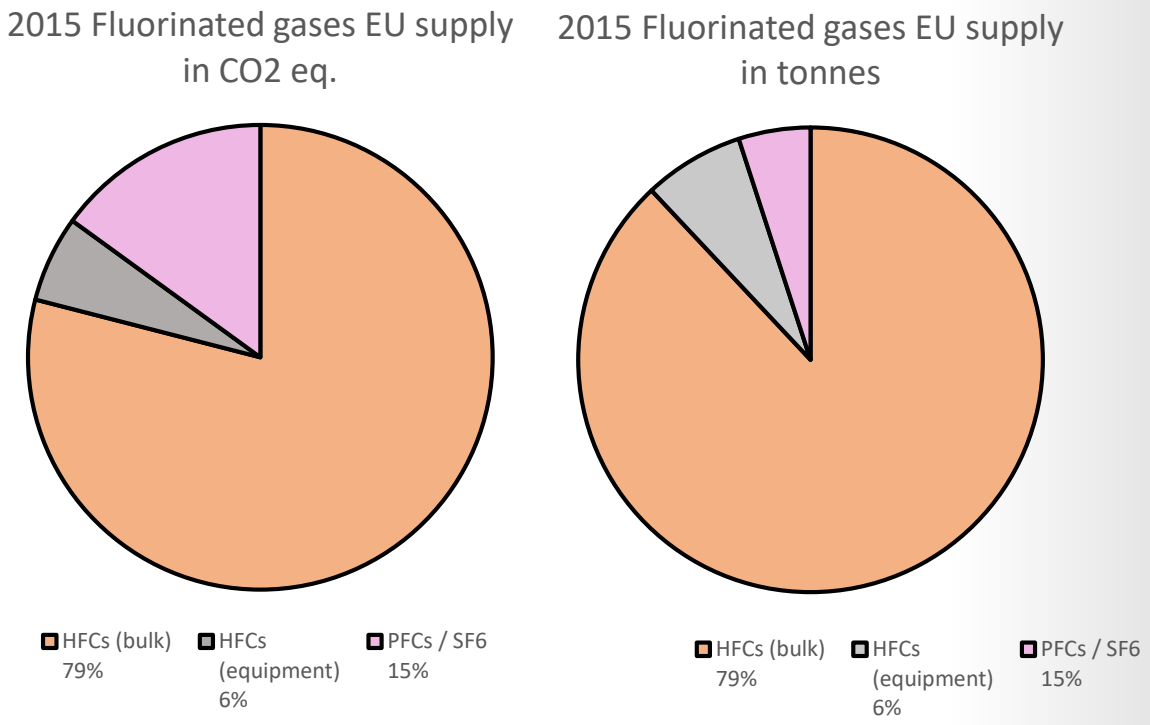
# Where are we on the EU market ? First results - EEA report 2015

- The reference line is the average volume of HFC place on the market from 2009 to 2012
- 2014 is a stock-piling year
- 2015 is the 100% reference line



# Where are we on the EU market ? First results- EEA report 2015

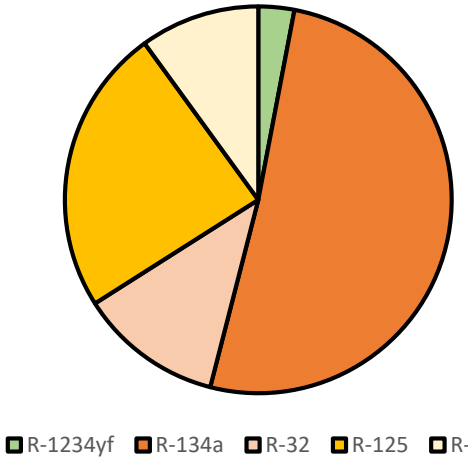
- Refrigerants represent 95% of the HFC uses expressed in tonnes
- And 85% expressed in $CO_2$ eq.
- 88% of HFCs are charged in EU



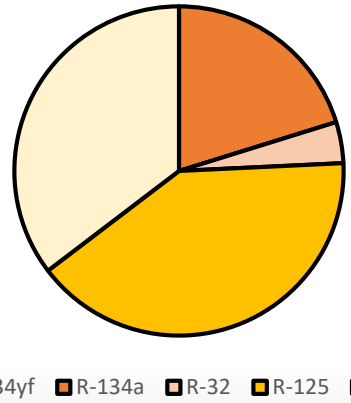
# Where are we on the EU market ? First results - EEA report 2015

- R-134a is still the most used refrigerant
- R-125 supply used in R-404A, R-410A and R-407C represents 40% of $CO_2$ eq. contribution
- R-143a only used in R-404A has 35% $CO_2$ eq. contribution for a 10% contribution in tonnes

2015 EU HFC Supply in tonnes

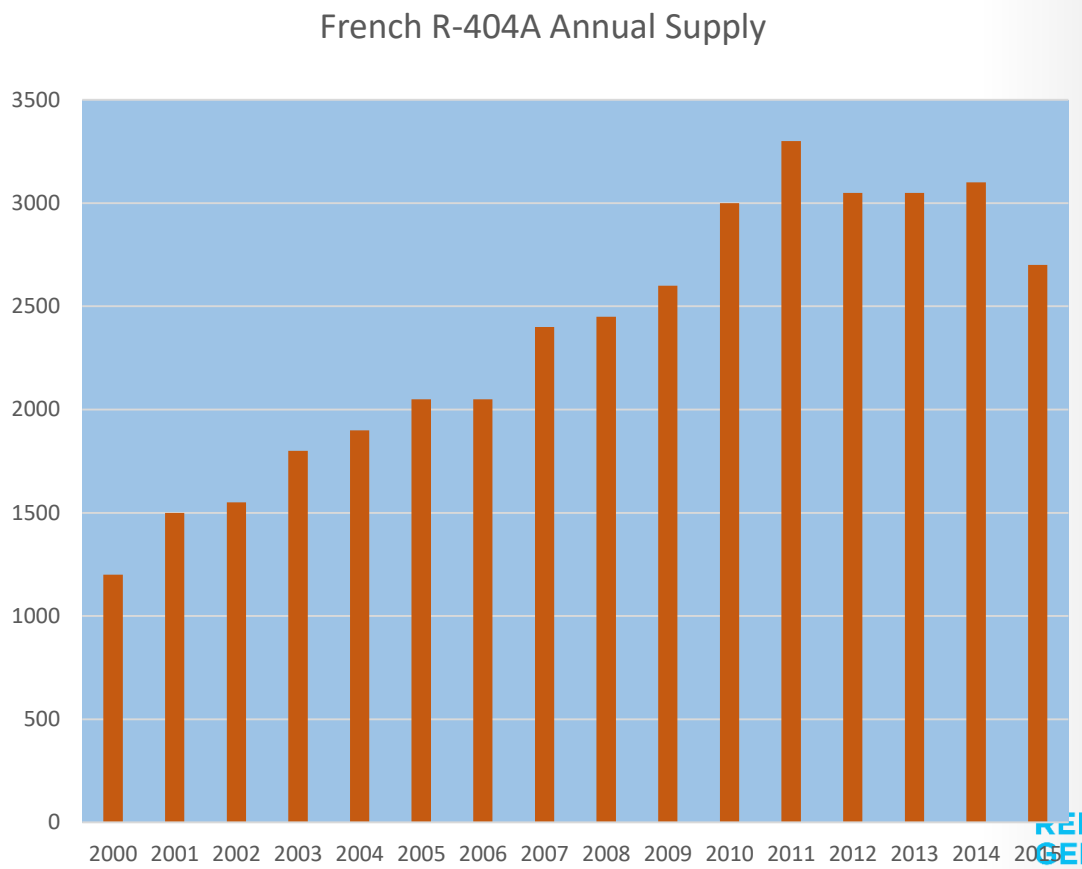



2015 EU HFC Supply in CO2 eq.



# R-404A issues

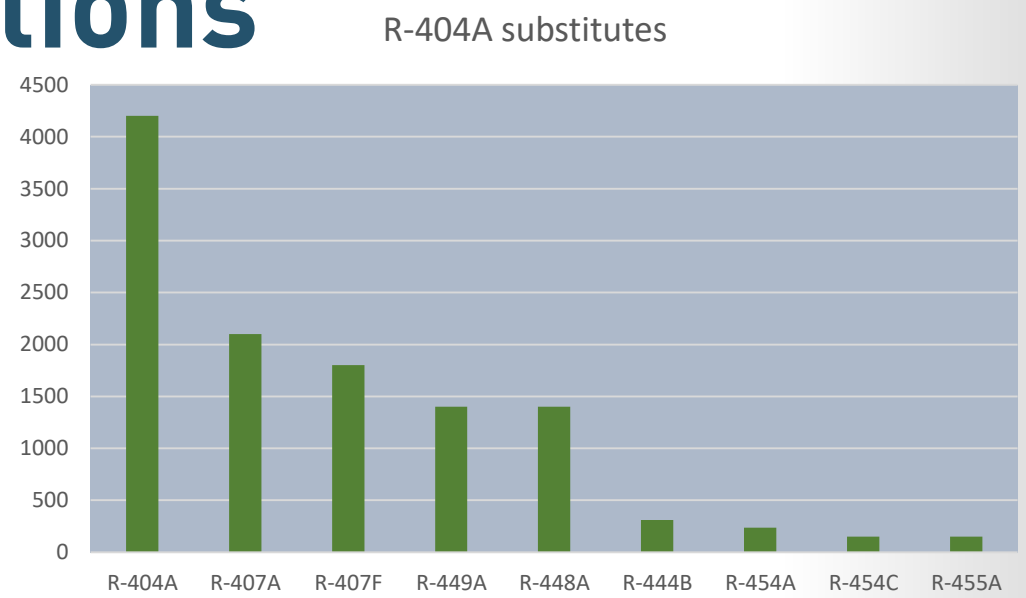
- In 2015 R-404A price is 50% higher than its substitutes
- But still the R-404A price is relatively low 22 €/kg
- The R-143a production has been reduced by 75% in 2015
- R-404A should be substituted more rapidly
- Large commercial companies have committed themselves to lower greenhouse gases emissions

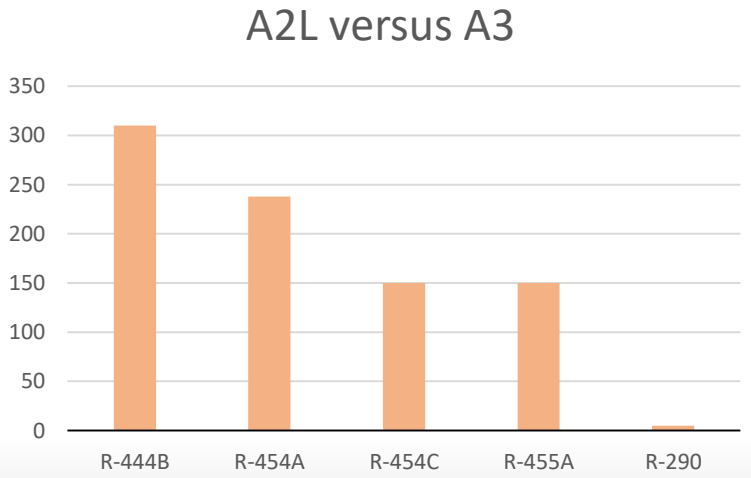



From 2015 French inventories - Armines

# R-404A replacement options

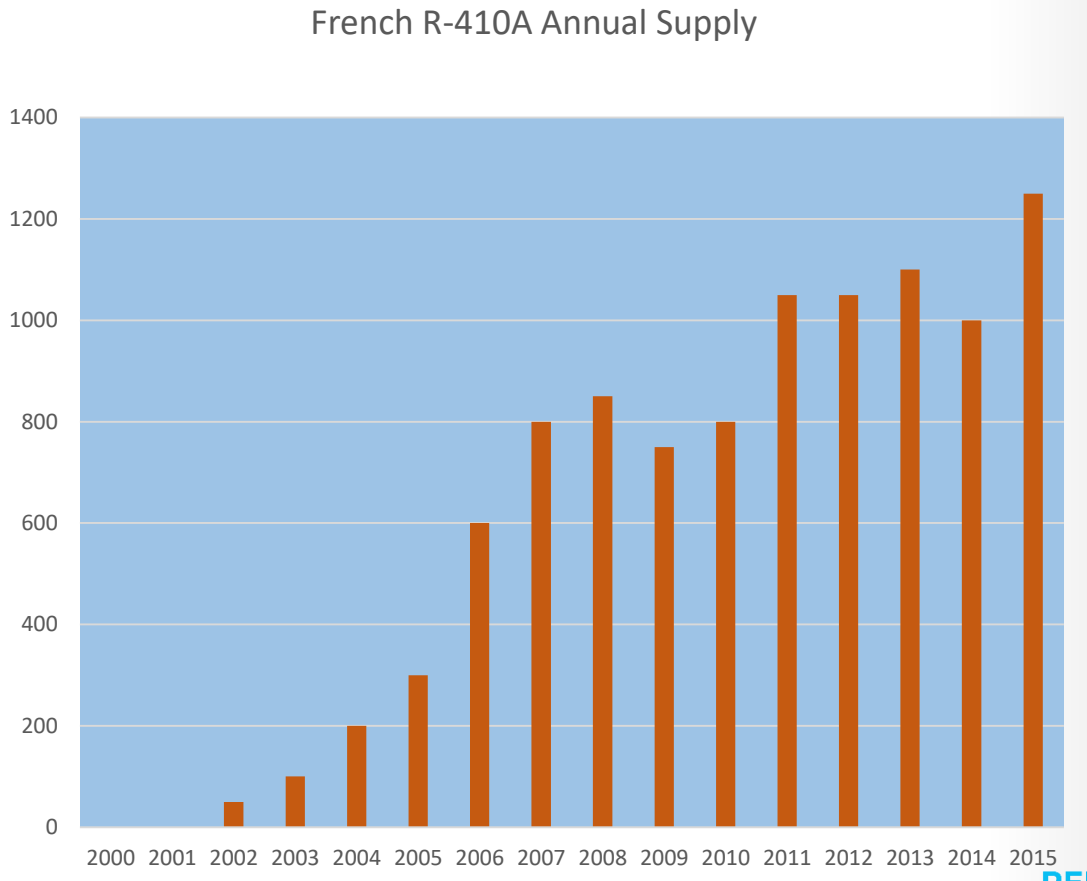
- Intermediate blends (R-407A &F, R-449A, R-448A) for retrofit and no flammability
- Low-GWP substitutes (R-444B, R-454A, R-454C,
  R-455A) all A2L
- R-290 (A3) for small refrigerant charges
- New rules under EN- 378 safety standard
- R-404A should be substituted more rapidly in the next years



# R-410A issues

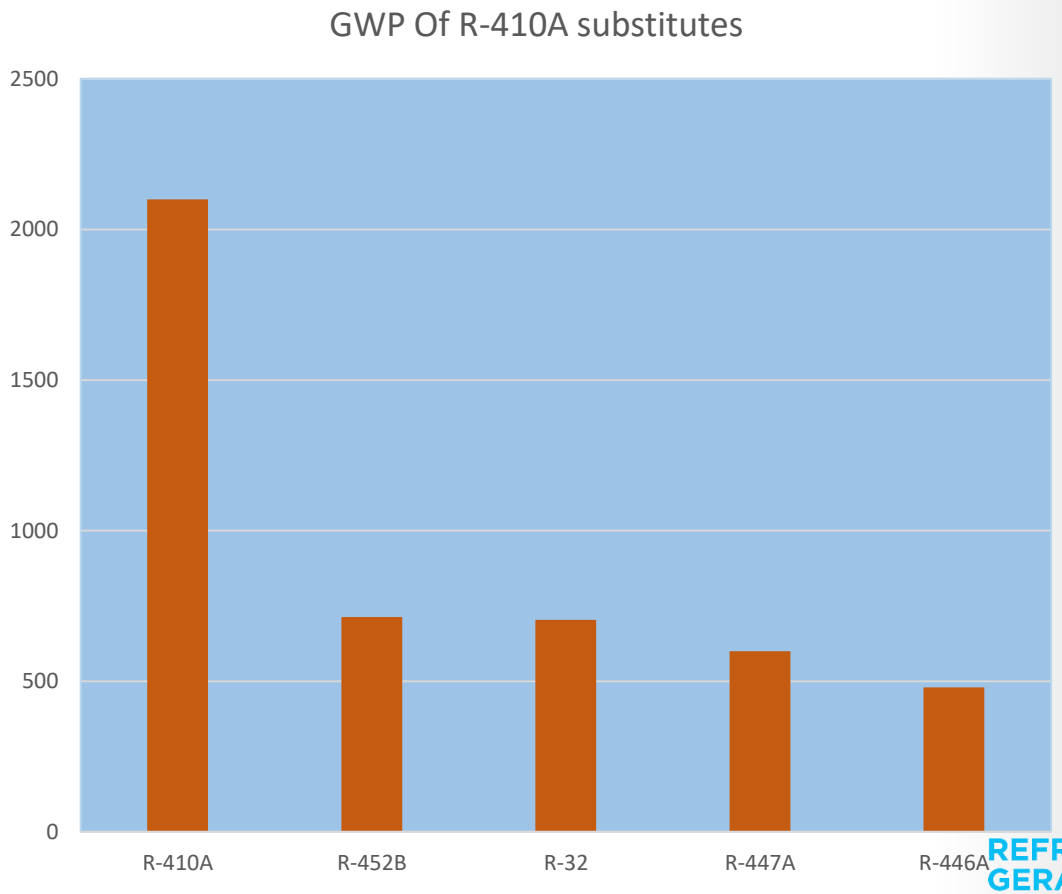
- R-410A is not the 1st priority for replacement
- R-410A price is  low, 15 €/kg
- The R-410A inventory in Europe  is nearly 4 times lower than the R-404A one
- The phase out of R-404A will be quicker than the one of R-410A




From 2015 French inventories - Armines

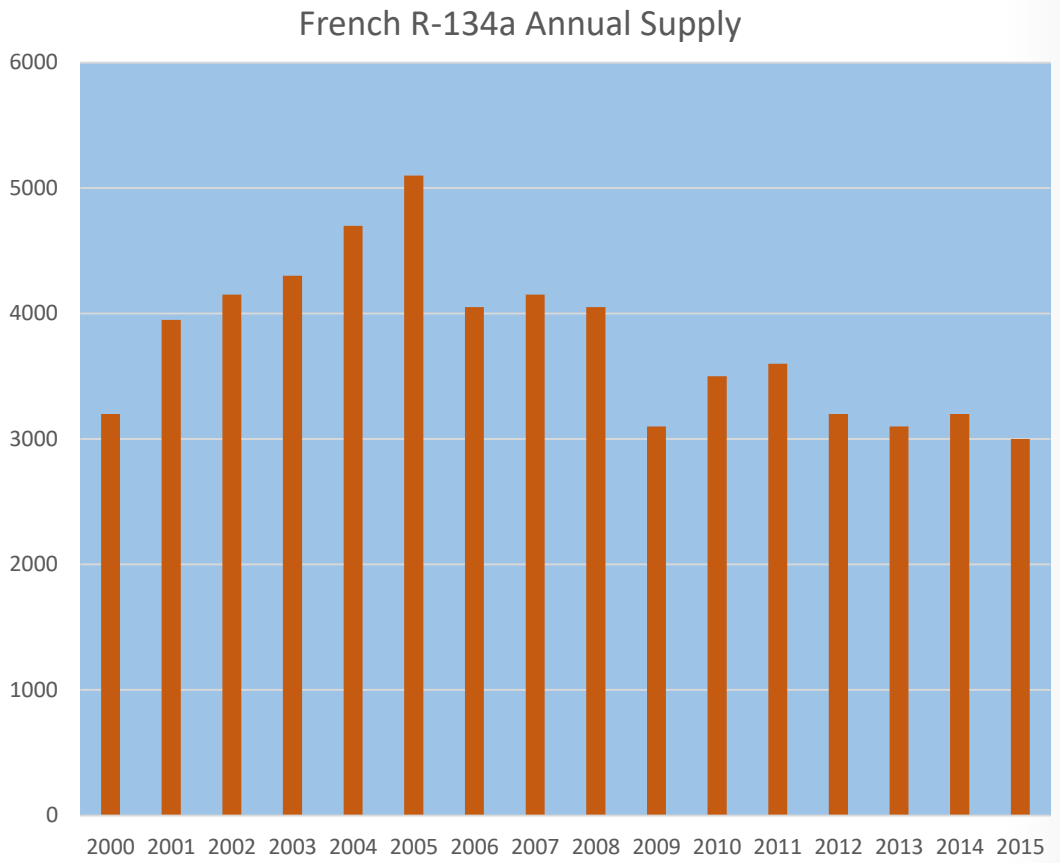
# R-410A replacement options

- The volumetric capacity is essential for AC systems design
- The energy efficiency should be as good as the reference
- No Blends are available without R-32
- R-32 raises the issue of how low is “low GWP”?
- The competition of AC equipment companies is open for the right choice



# R-134a issues

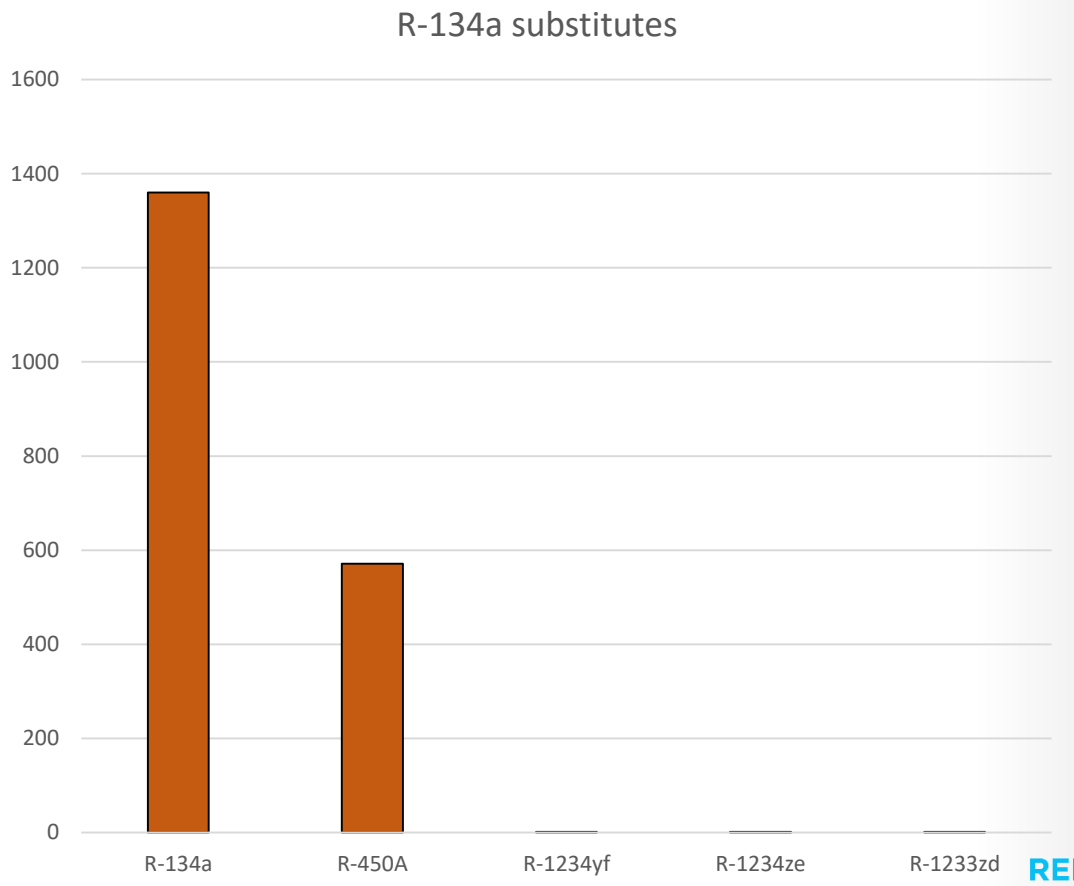
- Still the most used HFC
- Mobile Air Conditioning, Chillers, Small commercial
- The EU R-134a phase-out for MAC is slower than anticipated
- Price is low less than 10 €/kg




From 2015 French inventories - Armines

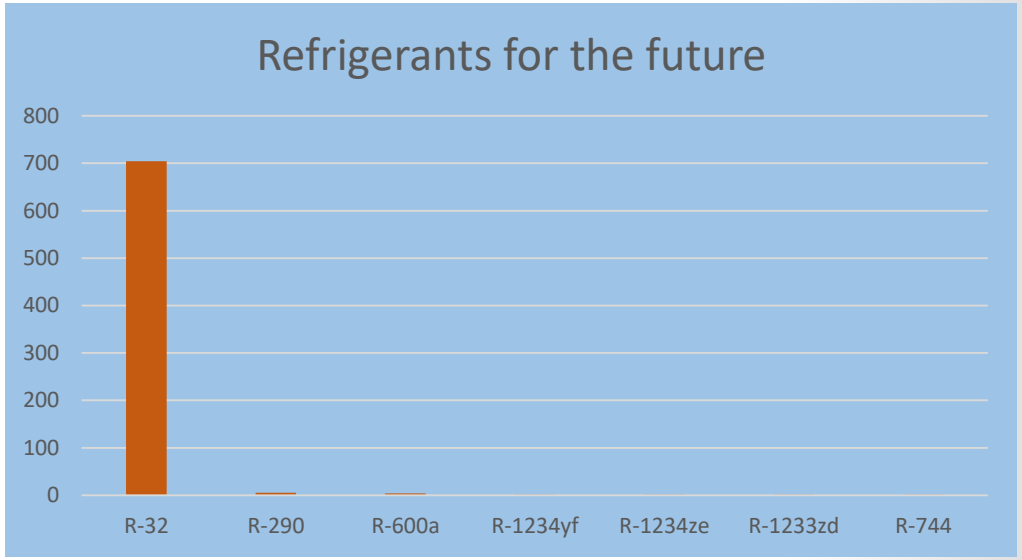
# R-134a replacement options

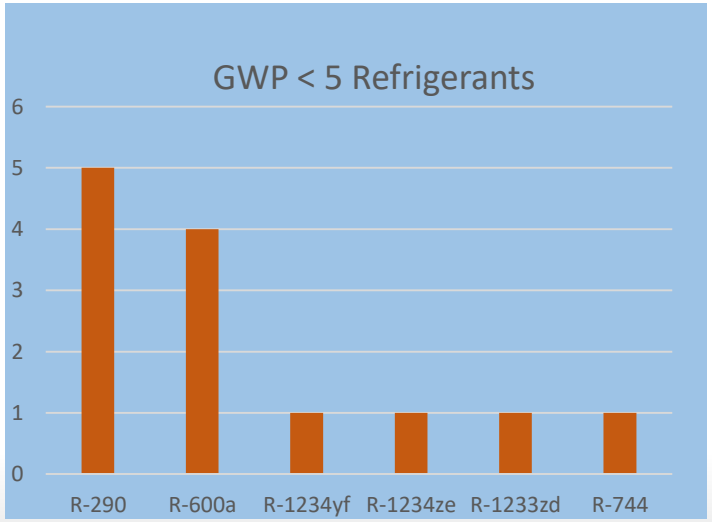
- Very Low GWP substitutes
- R-450A and example of A1 drop-in blend
- R-134a substitutes are chosen depending on the application
- R-1234yf for MAC
- R-1233zd for low-pressure chillers (substitute of R-123)
- R-1234ze for chillers
- R-1234ze pure or in blends for commercial refrigeration



# Refrigerants of the future

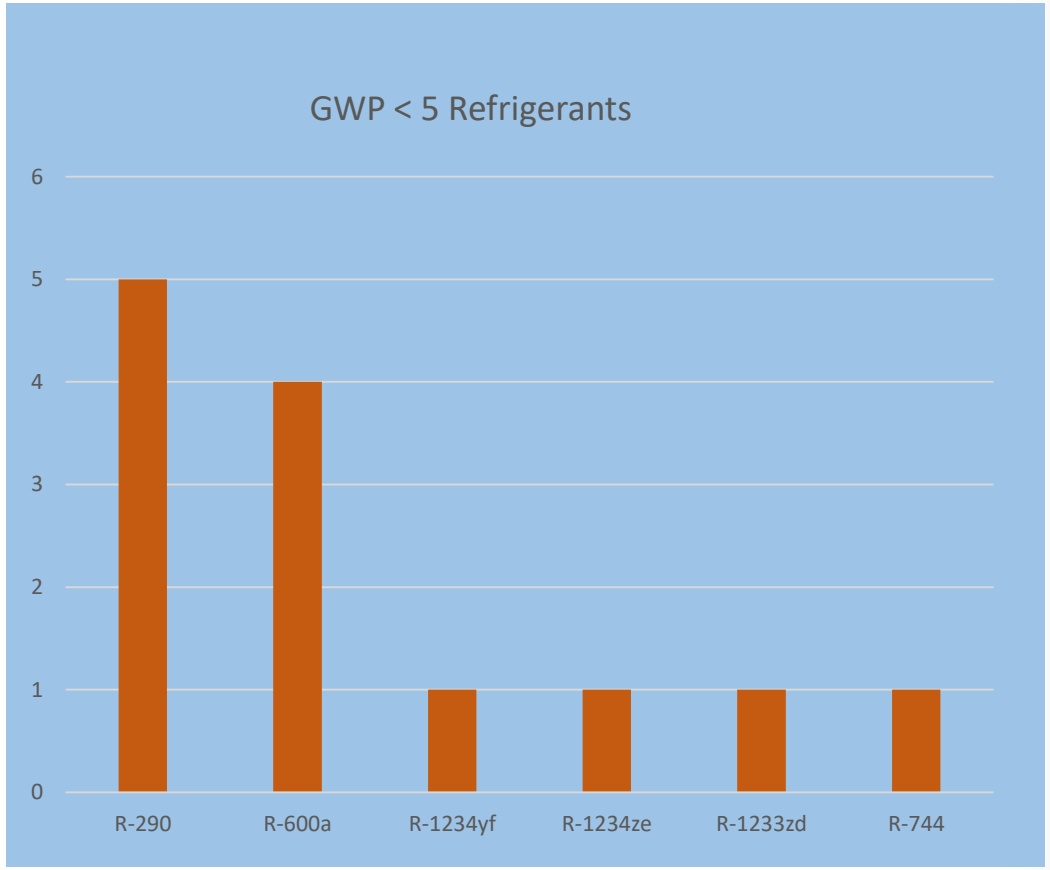
- Flammable refrigerants for low-charge systems (domestic refrigeration, small commercial)
- Pure HFOs (for low and medium-pressure applications)
- HFO/ HFC-32 blends with GWP ↓ 150 for R-404A and R-22 replacement
- HFC-32 and HFO/ HFC-32 blends with GWP ↑ 500 for R-410A replacement
- $CO_2$ for low-temperature two-stage commercial refrigeration, and transcritical cycle for moderate climate



# Refrigerants of the future – the 3 and 2L issues

- Based on GWP HFOs, Hydrocarbons or $CO_2$ are equivalent
- Flammable refrigerants used in public areas require low refrigerant inventory or a secondary loop
- HFOs are 2L refrigerants and so mitigate the flammability risk and higher refrigerant inventory is so possible



# Conclusions and perspectives

- Europe has been leading HFC phase-down schedule since 2004
- Technical challenges have been solved since the 90's and many options have been developed and commercialized
- The rapid switch from HFC-134a to HC-600a for domestic refrigeration in Europe opened the door to lot of changes
- Europe and Japan had equipment companies showing the path of new options
- The EU regulation made in 2004 a technical push for Mobile Air Conditioning first based on $CO_2$ and HFOs came
- HFOs and HFO blends present a new compromise between flammability and low climate impact