



**Availability of PFAS-free alternatives
for
mobile A/C and heat pump systems
in passenger cars for
various future-relevant powertrains**



Sept. 29th 2026
Dr. Roman Heckt

Two NatRef ShowCars in front of the Hotel



The Business Case
Natural Refrigerants

BRUSSELS
29 Sept. 2026



TWO CARS. TWO NATURAL REFRIGERANTS.
R744 Serial Production & R290 Demonstrator

See them live at
ATMOsphere MAC Summit
2026 | Brussels

Showcar I - R744 ID.3 - First Edition

- One of ID.3 1ST Fleet build in 2020
- Real Lifecycle usage in Europe since 6 years
- More than 155.000 km with R744 Thermal Management

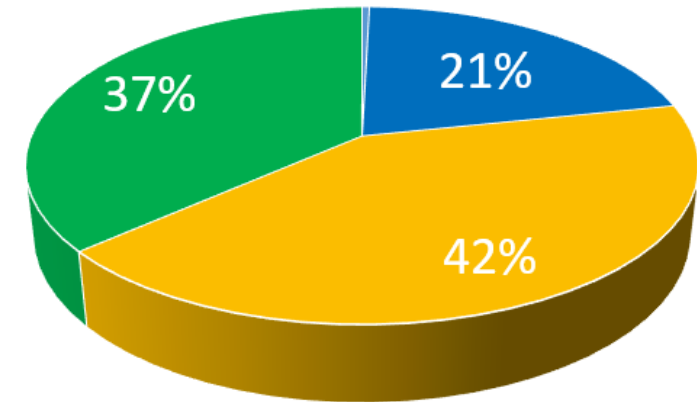


Showcar I - R744 ID.3 - First Edition

- One of ID.3 1ST Fleet build in 2020
- Real Lifecycle usage in Europe since 6 years
- More than 155.000 km with R744 Thermal Management
- R744 heat pump system operates 80% during one year



Mode Variation full Year



■ AC-Modi ■ HP-Modi ■ Reheat-Modi

Today's production vehicles with **R744** Heat Pump



VW ID.3



VW ID.4



VW ID.5



VW ID.7



VW ID.7 Tourer



Ford Explorer



Audi Q4



Skoda Enyaq



Skoda Enyaq Coupe



Audi Q4 Sportback



Skoda Elroq



VW ID. Buzz



Cupra Born



INNOVATION YOU CAN COUNT ON
1.300.000
MORE THAN
VEHICLES ARE HEATED AND COOLED PFAS-FREE
USING THE NATURAL REFRIGERANT R744



❖ **R744** in production **since 2020**

❖ **>15%** of new battery electric vehicles in EU were already equipped with R744 in 2025.
R744 expand to even smaller vehicles in 2026.

Showcar II - R290 ID.3 - Demonstrator

2nd Generation with R290 compact module



- Show car with refrigerant R290 (Propane)
 - Full A/C and heat pump functionality
 - Secondary loop system to avoid leakage risk of flammable R290 inside passenger compartment.
 - Water Cooled Condenser to minimize refrigerant charge
- Full R290 Thermal Management Module integrated
- Vehicle was tested under extreme conditions and show that R290 with secondary loop system meets customer comfort in A/C and heat pump mode as well.



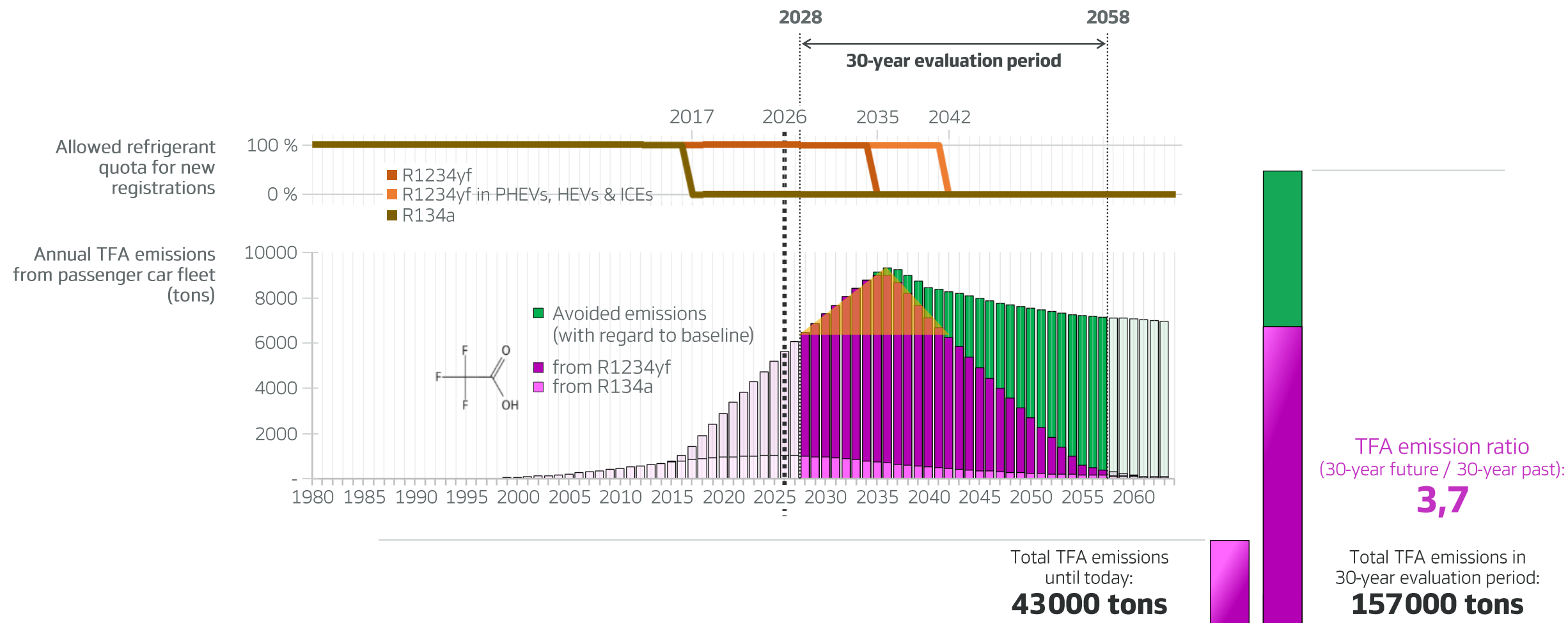
- R744 is in Battery electric vehicles in public usage since six years, R290 finalized the development and could also be applied.

For BEVs are two NatRef options ready to go. No reason to hesitate!

TFA Emission projection

ECHA's updated RO2 proposal (06/2025)

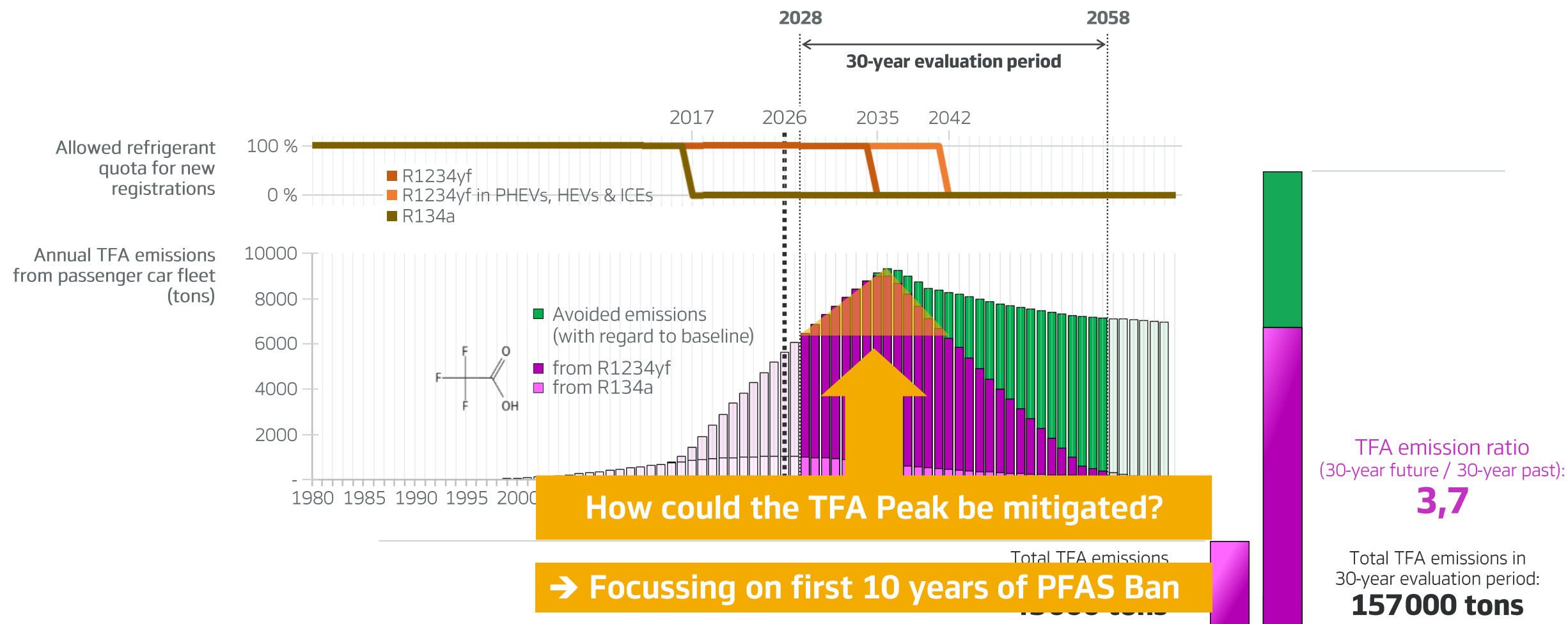
Derogations: **BEV 5y** / **ICE, HEV, PHEV 12y**



TFA Emission projection

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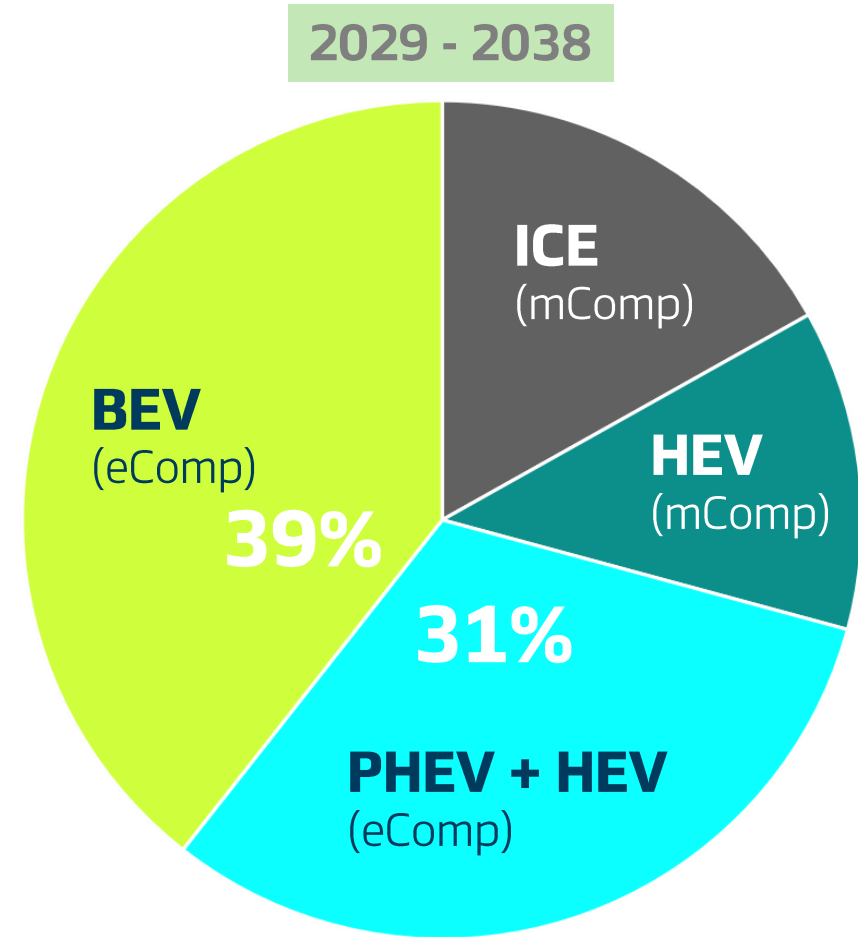


TFA Emissions by Powertraintype

All passenger cars placed in the European market between 2029 and 2038

Assumption: Only Refrigerant-Systems in new cars could be addressed.

- 10 year cumulative TFA emissions caused
 - 39% by BEV
 - 31% by PHEV and HEV with electric compressors
- Mechanical compressors are already fading out in this phase and cause about 1/3 of the TFA emissions.



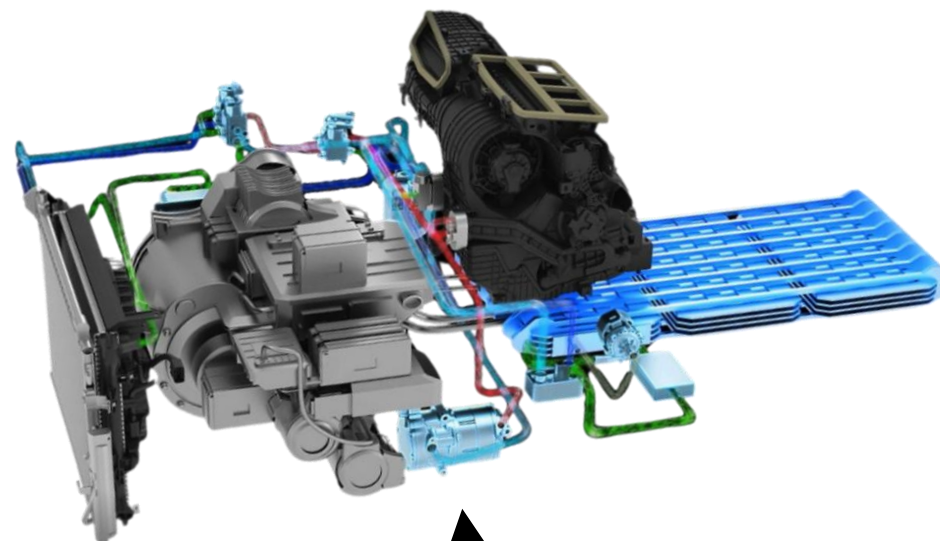
Prevent fundamental differences the transfer of results in BEVs to PHEVs etc.?

Refrigerant Architecture - BEV

Battery electric vehicles

Functional Content

	Cabin Cooling	HV Battery Cooling	Drivetrain Cooling
BEV	✓	✓	✓



- Driven by hermetic electric compressor.
- System could be realized with distributed components or as compact module.
(depending on package space and flammability of the refrigerant)
- The fast charging requirements cause in BEVs the highest functional performance requirements.



Hermetic electrical compressor

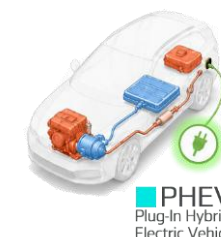
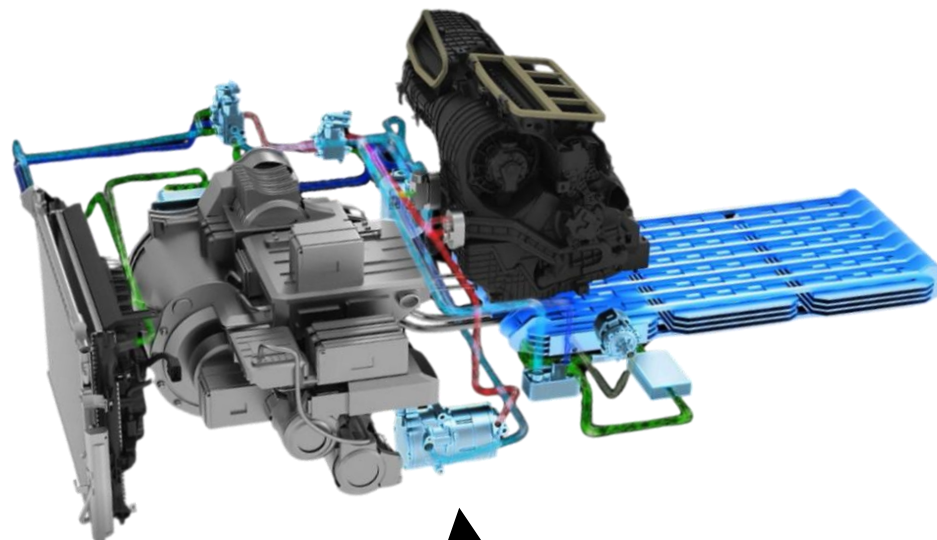
Natural Refrigerant Architecture in BEVs is well known.

Refrigerant Architecture - PHEV

Plug-In Hybrid Electric Vehicle

Functional Content

	Cabin Cooling	HV Battery Cooling	Drivetrain Cooling
BEV	✓	✓	✓
PHEV	✓	✓	✓



- Driven by hermetic electric compressor.
- Build with distributed components or compact module.
(depending on package space and flammability of the refrigerant)
- Hot ICE surfaces or exhaust components near to flammable refrigerant parts need special considerations
- R744 does not pose any additional risks in PHEVs.



Hermetic
electrical compressor

Refrigerant Architecture of PHEV Vehicles very similar to BEVs.

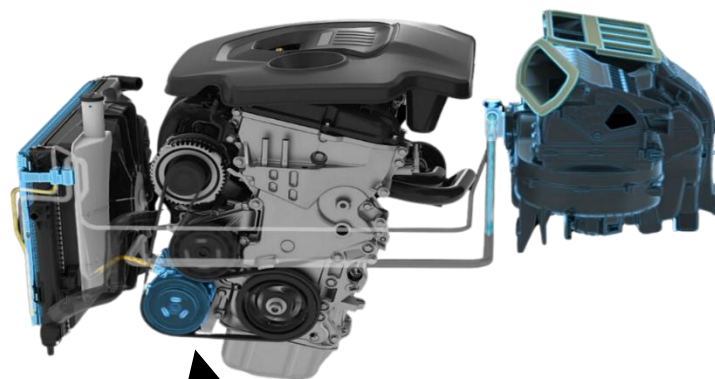
Refrigerant Architecture - pure ICE

Internal Combustion Engine Vehicle

Functional Content

	Cabin Cooling	HV Battery Cooling	Drivetrain Cooling
BEV	✓	✓	✓
PHEV	✓	✓	✓
ICE	✓	✗	✗

- Driven by mechanical belt compressor.
 - Shaft Seal cause leakage issue for R744 mComps (High service costs, etc.)
 - Shaft seal leakages cause igniting risk for R290 (critical safety risk)
- System realized with distributed components.



Belt driven mechanical compressor



ICE
Internal Combustion
Engine Vehicle

Neither R290 nor R744 can simply be applied in pure ICEs.

Refrigerant Arcitecture - HEV

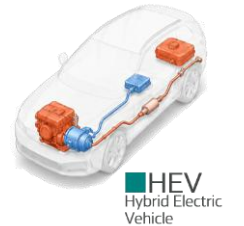
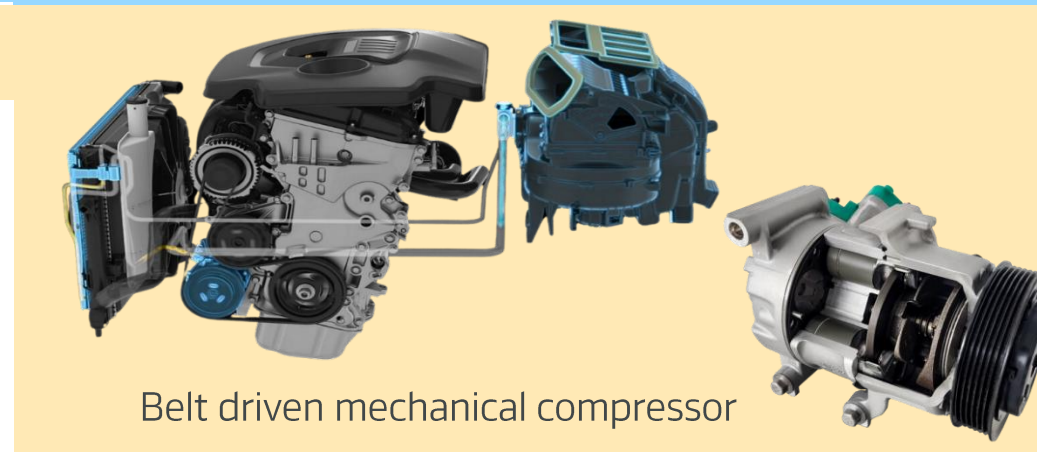
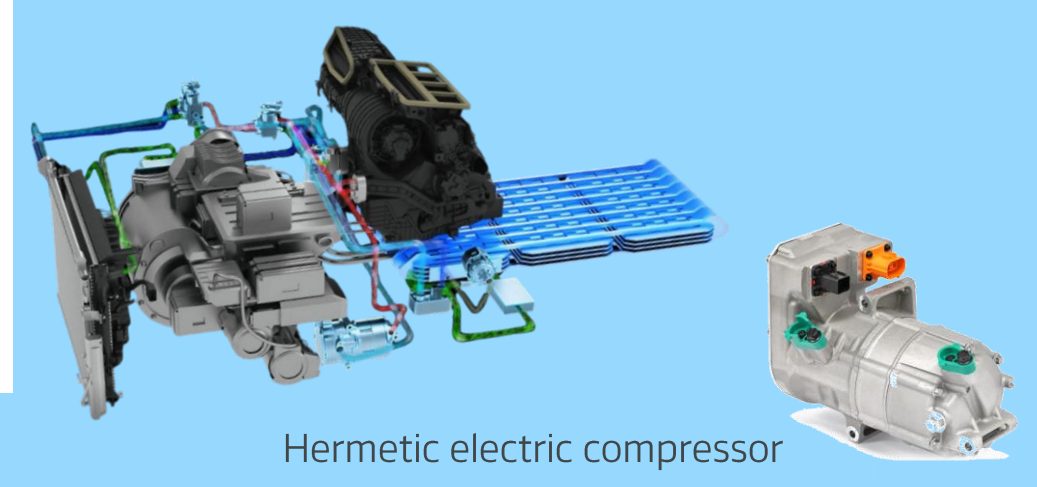
Hybrid Electric Vehicle

Functional Content

	Cabin Cooling	HV Battery Cooling	Drivetrain Cooling
BEV	✓	✓	✓
PHEV	✓	✓	✓
HEV	✓	✗	✗
	✓	✗	✗
ICE	✓	✗	✗

full

mild

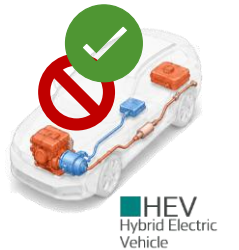
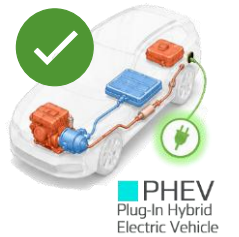
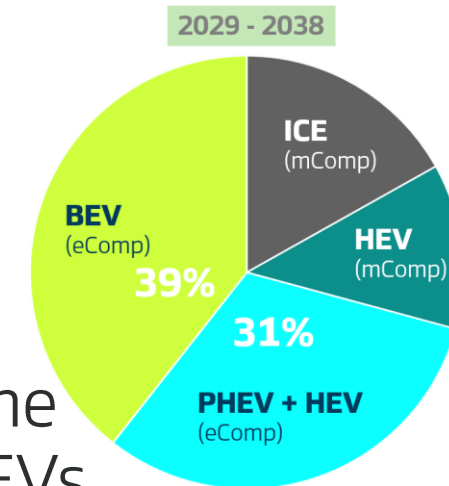


- For HEVs with mechanical compressor use similar systems like pure ICE vehicles.
- HEVs with an electric compressor are more like BEVs and PHEVs.

It is evident that refrigerant systems in full HEVs are more like those in PHEVs, whereas mild HEVs are more like pure ICE vehicles.

Conclusion

- R744 is in Battery electric vehicles in public usage since six years, R290 finalized the development and could also be applied.
- Fundamental differences between electric and mechanical compressors prevent the straightforward transfer of NatRef results from BEVs to vehicles with mComp.
- The NatRef experiences in BEVs could easily be transferred to PHEVs and “full” HEVs.
- The TFA peak can be significantly flattened through the consistent use of natural refrigerants in PHEVs and HEVs.



Let's address the TFA-Peak by application of NatRef in all Vehicles with eComp.

Enjoy reading!



Thank You

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