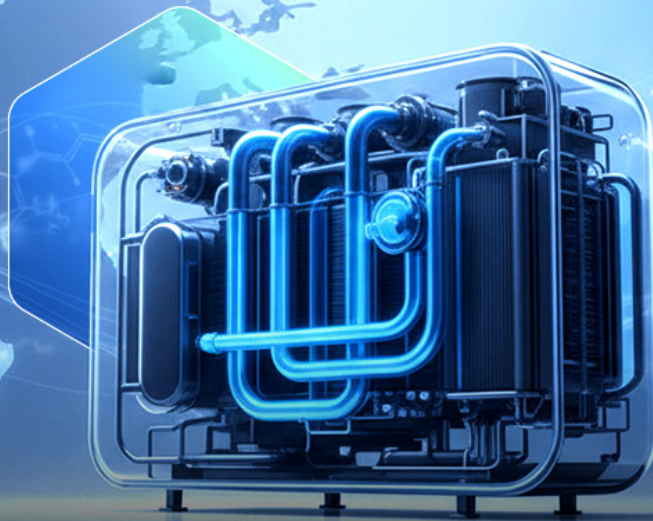


## Case Study



How We

## Helped a Global Client Navigate PFAS Regulations and Unlock Market Opportunities for Natural Refrigerant-based MACs in Europe

### Objective

In response to tightening PFAS regulations under REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), a global client partnered with leB to evaluate the European market for natural refrigerant-based Mobile Air Conditioning (MAC) systems. The engagement focused on use-case viability, competitive strategies, OEM adoption pathways, and regional preparedness to support informed technology and investment planning.

### Our Strategic Approach

To unlock near- and mid-term growth opportunities, leB used a regulation-first, market-backed approach to assess the real-world viability of natural refrigerants in automotive MAC systems, bridging policy signals, application needs, and competitive positioning.

#### Regulatory & Policy Assessment

Analyzed evolving European regulations related to PFAS restrictions under REACH and their implications for conventional refrigerants. Assessed how regulatory pressure is accelerating OEM interest in natural refrigerants such as CO<sub>2</sub>-based systems.

#### Use Case Assessment

Evaluated viable MAC use cases across passenger vehicles, commercial vehicles, and specialty automotive applications. In addition, we assessed performance requirements, system complexity, cost implications, and the suitability of retrofit versus a new platform.

#### Market & Competitive Landscape Analysis

Mapped key technology providers, OEMs, and Tier-1 suppliers active in natural refrigerant-based MACs. Analyzed competitors' technology roadmaps, partnerships, and pilot deployments to understand strategic positioning and white spaces.

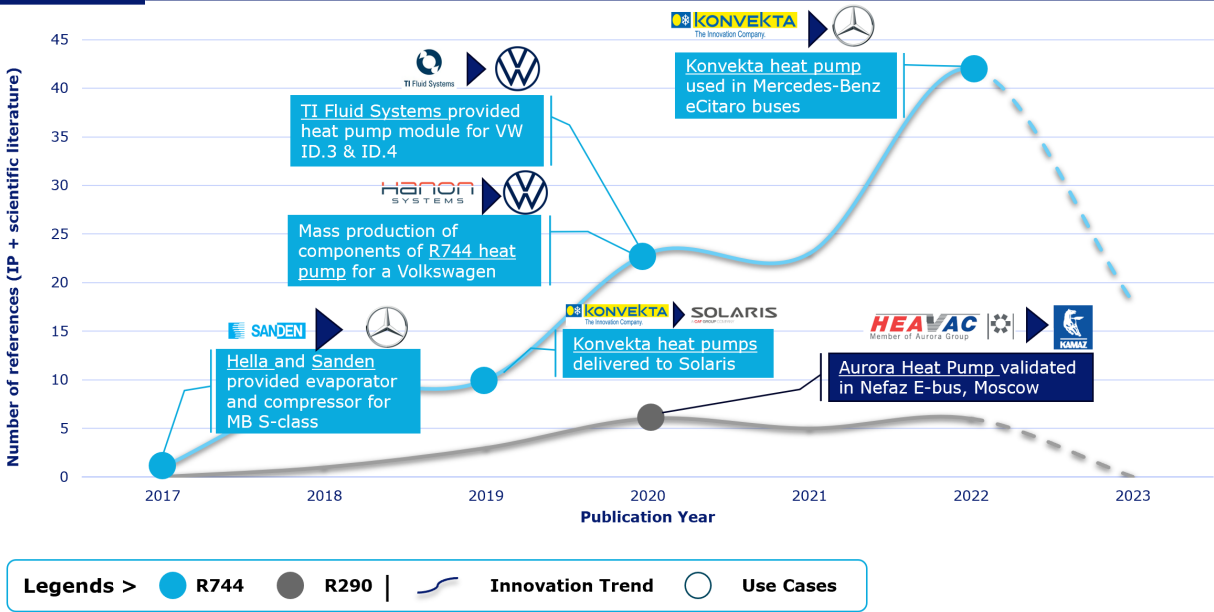
Regional Trends & Adoption Mapping

Assessed adoption timelines & market readiness across key European regions, considering infrastructure maturity, OEM concentration, regulatory enforcement pace, and local supply chain capabilities.

Snippets

Executive Briefings - Innovation and Adoption Trends for R744 & R290

The adoption of the R744 MAC system is high as compared to R290 due to safety concerns with R290; This adoption has been observed mostly in the European region; Light-vehicle OEMs appear to avoid the R744 MAC system due to its negative effects on vehicle efficiency & semiconductor shortage



Executive Briefings - Geographical Hotspot

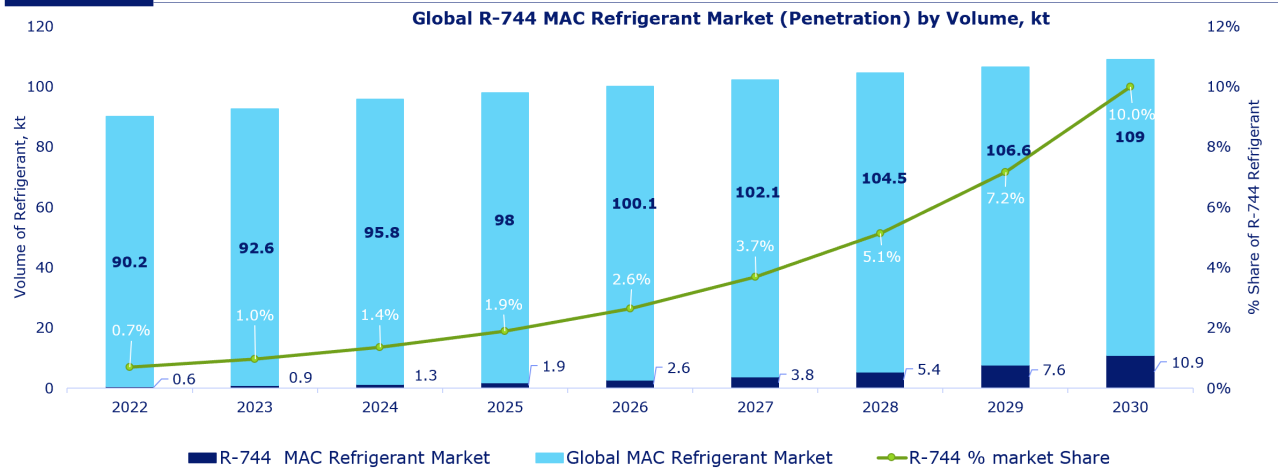
The Chinese region, which lacks a supplier of commercial-level systems, could be suppliers' target market

(1/2)



## Executive Briefings - Natural Refrigerants Market Penetration and OEM Adoption

The global R-744 refrigerant market for automotive applications is currently niche compared to other refrigerants, and R-744 refrigerant adoption is anticipated remain low in the near future



### Adoption Consideration for R-744 by OEMs

- Few OEMs, such as Daimler and Volkswagen, have started to test R-744 MAC refrigerant due to the European MAC directive and the lower flammability of R-744 among low-GWP refrigerants such as R-1234yf
- There are some drawbacks to R-744 MACs, such as it being costlier than R-1234yf, but the companies are exploring the opportunity to reduce the cost of the MAC system by eliminating the few additional objects used for R-744 in the MAC system for R-744, which can reduce the price by around 20%

## Impact

This assessment converted regulatory and market insights into actionable direction by:

- Clarifying key market drivers, including regulatory pressure, OEM adoption strategies, and high-potential use cases for natural refrigerant-based MACs.
- Highlighting regional adoption trends and timelines, enabling targeted prioritization of European markets.
- Streamlining R&D focus by identifying competitors and technologies to monitor closely.
- Supporting early OEM engagements and initial use-case identification to accelerate market entry discussions.

## Conclusion

Through a comprehensive assessment of regulations, use cases, and competitive dynamics, IeB enabled the client to navigate regulatory uncertainty and identify actionable opportunities in natural refrigerant-based MACs. The insights provided a clear foundation for focused R&D investment, strategic OEM engagement, and long-term positioning in Europe's transitioning automotive thermal management market.



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