



India Advancing Low-GWP Technologies and Workforce Readiness in the MAC sector

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CLIMATE IMPACT PATHWAY — FROM VEHICLE GROWTH TO A LOW-GWP TRANSITION



KEY MESSAGES

- The automotive sector is a major contributor to HFC consumption: **40% of HFC use in the servicing sector and 15% of total HFC emissions in India**
- HFC use in MAC systems is increasing due to vehicle fleet growth and high refrigerant leakage rates.
- Continued reliance on HFC-134a poses both climate and regulatory challenges.
- **Under the Kigali Amendment**, countries are required to progressively reduce HFC consumption and transition to climate-friendly refrigerants.
- **Transitioning to low-GWP refrigerants (R-744, HC-290)** and energy-efficient MAC systems is critical to reducing emissions and HFC consumption.

Current Status & Future Options: Refrigerant Evolution



GWP DECREASING → lower Global Warming Potential is environmentally preferable

DOMESTIC MARKET — MAC REFRIGERANTS IN USE

Vehicle Segment	Refrigerant (GWP)
Passenger Vehicles (ICE & EV)	R-134a (GWP 1430)
Trucks	R-134a
Buses	R-134a & R-407c (GWP 1774)
Refrigerated Vans	R-134a

EXPORT & EMERGING OPTIONS

EXPORT MARKET

OEMs exporting passenger vehicles (esp. to Europe) have adopted **R-1234yf** (GWP ≈ 4).

EMERGING · KIGALI-ALIGNED (4th-GENERATION)

R-1234yf
GWP ≈ 4

R-744 (CO₂)
GWP = 1

R-290
(Propane)
GWP ≈ 3

HFC Phase-Down Schedule (Kigali Amendment)

Reduction Step	Developed	Developing G1	Developing G2	Target Remaining
Baseline Years	2011–2013	2020–2022	2024–2026	—
10% Reduction	2019	2029	2032	90% remaining
30% Reduction	2024	2035	2037	70% remaining
50% Reduction	2029	2040	2042	50% remaining
80–85% Reduction	2036	2045	2047	15–20% remaining

INDIA — GROUP 2

2019

Entered into force in India

2024–26

Baseline period

2028

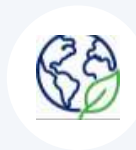
Consumption freeze year

2047

80–85% phase-down target



Kigali Amendment adopted in **2016**, entered into force **1 January 2019**.



Group 1: most developing countries.
Group 2: India, Pakistan, Iran & GCC nations.

A UNIDO-led global initiative, implemented with SIAM — Pilot Projects of R-744 & HC-290 Refrigerant Substitution Technology for Electric Vehicles & Supporting the transition from HFC-134a toward benign alternatives in the MAC) sector.



Promote Low-GWP Refrigerants

Demonstrate & promote R-744 and HC-290 solutions for vehicle air-conditioning.



Capacity Building

Implement a Train-the-Trainers programme for the MAC servicing sector.



Strengthen Servicing Practices

Technical knowledge-sharing programmes for industry stakeholders.

4 CORE OBJECTIVES

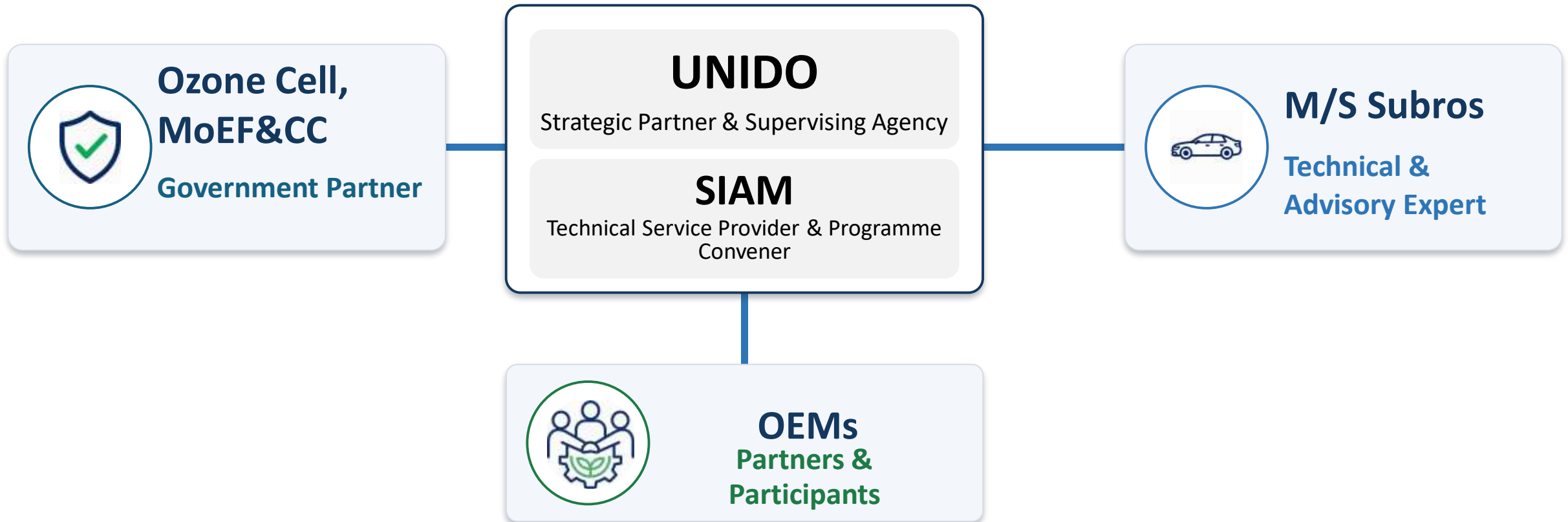


Replication & Scale-Up

Case studies & guidance documents to support wider global adoption.

PROJECT DURATION: JULY – NOVEMBER 2026

SIAM and UNIDO anchor a multi-stakeholder ecosystem driving India's low-GWP MAC transition.



SIAM serves as the **Programme Convener, primary coordinating & administrative agency**, responsible for six core functions:



Project Execution

Execute project activities and disseminate best environmental practices in the servicing sector.



Stakeholder Coordination

Coordinate with OEMs, Tier 1 suppliers, and service-sector organizations.



Train-the-Trainers Programme

Establish the training framework and implement an international Train-the-Trainers course to disseminate learnings nationally.



Programme Management

The learnings from Project will be hosted on a website updated regularly for trainers and trainees on best practices by SIAM/M/s

Subros.



Training Material Development

Draft training material on principles and practices of MAC technical development to support follow-up industry training.



Best-Practice Workshop

Organize one training workshop on best servicing practices in the MAC sector.

#	Activity	Expected Deliverable	Tentative Timeframe
1	Draft training material on the principle and practice of technical development of MAC to support follow-up training of industry enterprises.	Training material	Q2 2026
2	Establish the training framework and implement an international “Train the Trainers” course for servicing-sector trainers to disseminate learnings within their country.	Training guideline	Q2 2026
3	Organize 1 training workshop on best servicing practices in the MAC sector, including gender consideration.	Workshop Report	Q2 2026
4	Deliver a presentation at a side event / international training session on Best Servicing Practices on MAC at the OEWG and/or SEA Regional Network Meeting, including gender consideration.	Presentation	Q2 2026
5	Deliver a presentation a high-level outreach event to disseminate results from the India R290 pilot projects at the OEWG and/or SEA Regional Network Meeting to promote industry technical exchange.	Outreach event	Q2 2026
6	Produce a 500-800 words web article summarizing the training outcomes.	Article in Word Format	Q3 2026
7	Support production of a case study or guidance document to support replication or scale-up of activities/results (inputs from Outcome 1 & 2 by FECO and TATA Motors).	Case study Report	Q3 2026

SIAM- UNIDO ToT program builds a robust, future-ready capacity within India's automotive servicing ecosystem.



Certified Trainer Pool — Build a national pool of certified trainers for servicing next-generation refrigerants (HC-290, R744).



Low-GWP Adoption — Support safe, efficient adoption of next-generation refrigerants, including alternate low-GWP refrigerants such as HC-290 (propane).



Close Skill Gaps — Address skill gaps in servicing modern MAC systems — heat pumps, multiple secondary-loop architectures, and multi-refrigerant scenarios.



Safe Handling & Recovery — Promote safe handling, installation, recovery, recycling, and leak management, ensuring technician safety for flammable refrigerants such as HC-290.



UNIDO-CCAC Alignment — Align with ongoing UNIDO-CCAC demonstration projects and complement technology pilots (e.g., Tata Motors HC-290 AC system initiative).



Scalable Dissemination — Enable scalable knowledge dissemination through trained trainers from OEMs, Tier 1 suppliers, and international experts.



Institutional Capacity — Build sustainable institutional capacity by integrating training within SIAM's technical committees and industry networks.

Four pillars of impact spanning environment, capacity, industry, and long-term climate goals.



Environmental Outcomes

- Reduced HFC emissions.
- Increased adoption of low-GWP refrigerants.



Industry Outcomes

- Stronger OEM and service ecosystem readiness.
- Wider industry adoption of best practices.



Capacity Outcomes

- Certified trainers developed.
- Improved servicing competency.



Long-Term Outcomes

- Support Kigali compliance.
- Accelerate sustainable cooling transition.

Collective impact: a climate-aligned, skilled, and self-sustaining MAC sector ready for the low-GWP transition.

MAC Refrigerants in India: 2026–2035 transition pathway across six priorities.

Shift to Low-GWP Refrigerants

India to Adopt R-1234yf in medium term, & R-290 for long term, aligned with the Kigali Amendment.

Strengthen Standards & Safety

Align with Montreal Protocol and Kigali requirements.

Upskill the Ecosystem

Build technician readiness for new refrigerants.

Recycling & Disposal

Develop refrigerant recovery and EPR mechanisms.

Indigenous Innovation

Promote local R&D and affordable MAC technologies.

Transition Support

Technical & financial support under the India Cooling Action Plan and industry collaboration.

UNIDO – SIAM INITIATIVE | MOBILE AIR CONDITIONING SECTOR

THANK YOU

Questions & Discussion

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Society of Indian Automobile Manufacturers
Building the Nation, Responsibly