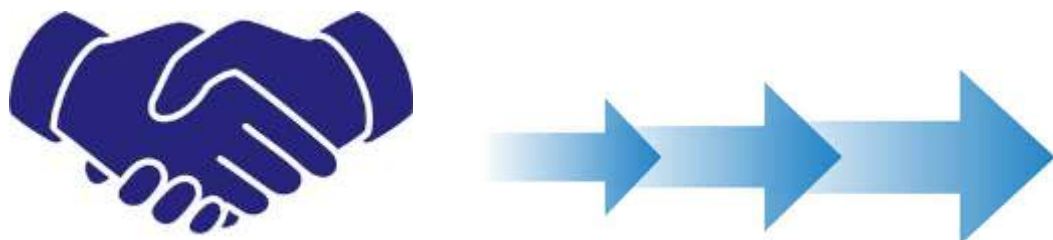


Mangla Cor-Tubi Pvt. Ltd.

TREM V: The Next Big Transformation in Indian Agricultural Industry

Challenges and Way Forward



Moving towards a green future



Mr. Vivek Jakhmola
Director

Mangla Cortubi Pvt Ltd

An Indo-Italian joint venture



Mangla Group
India

+



Cornaglia
Italy

Full-stake supplier for ATS, Exhaust and Tubes

Manufacturing locations

Plant	State	Distance from New Delhi*
● Rudrapur	Uttarakhand	263 km
● Palwal	Haryana	178 km
● Zaheerabad	Telangana	1,550 km

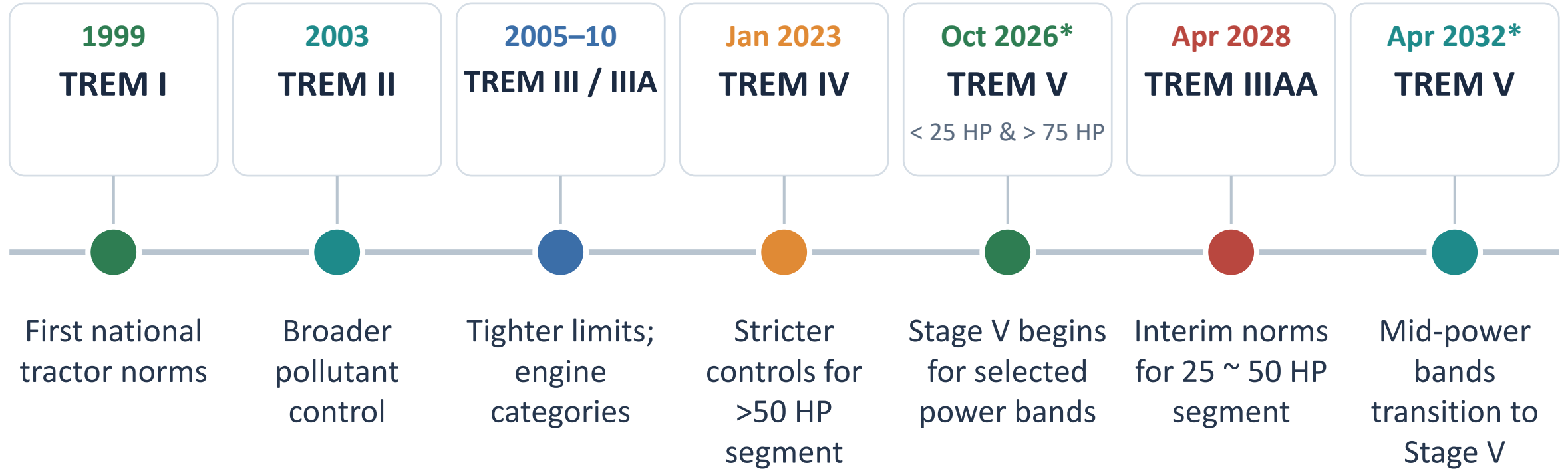
*Approximate

Our Presence



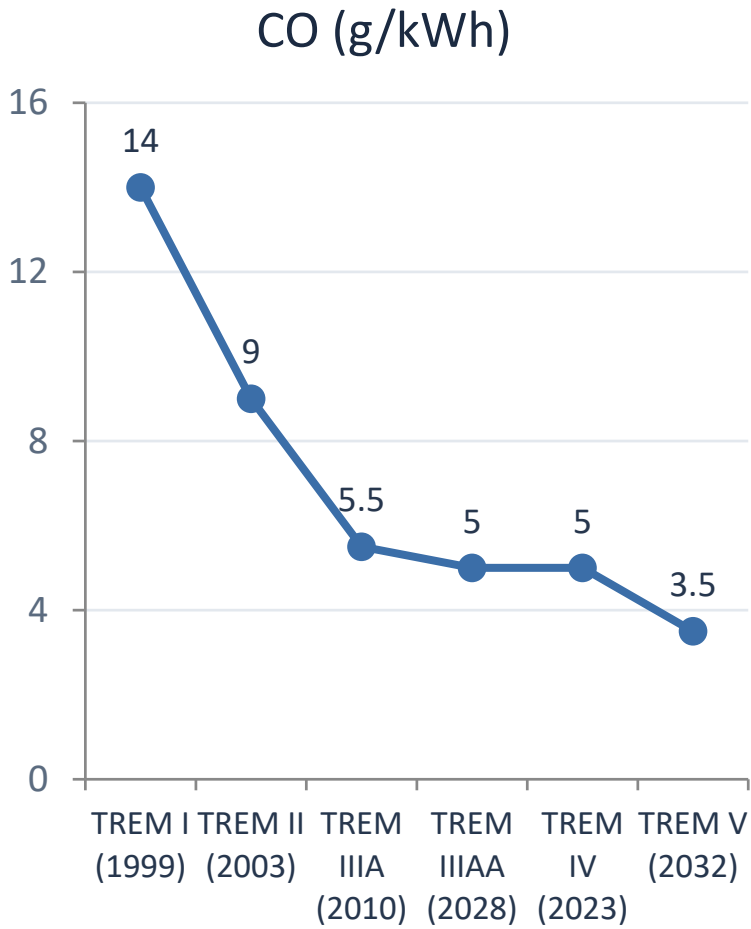
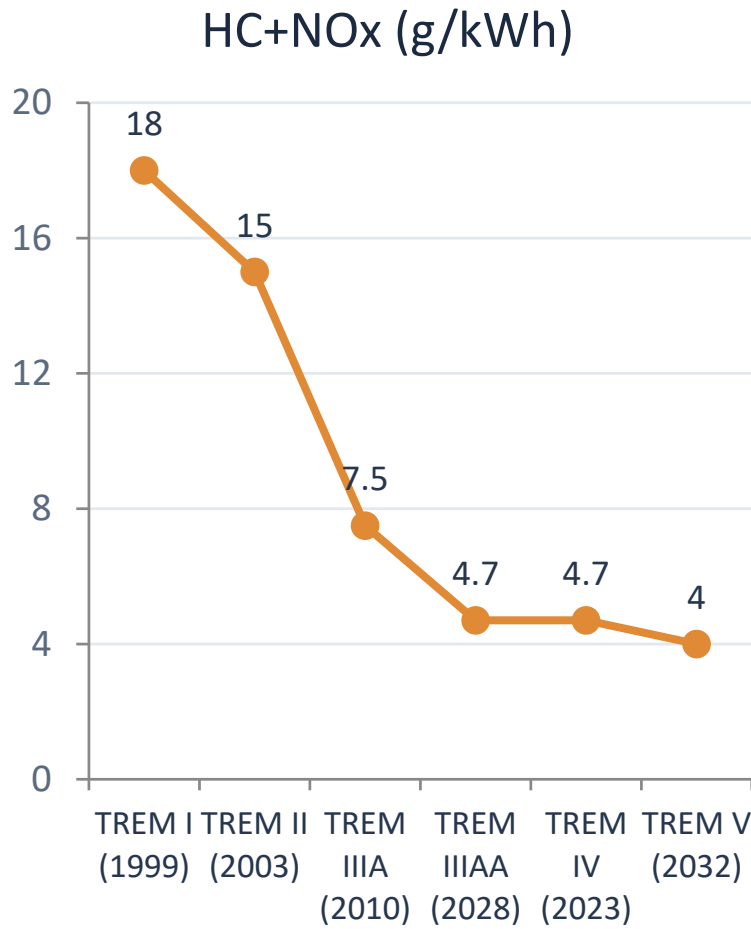
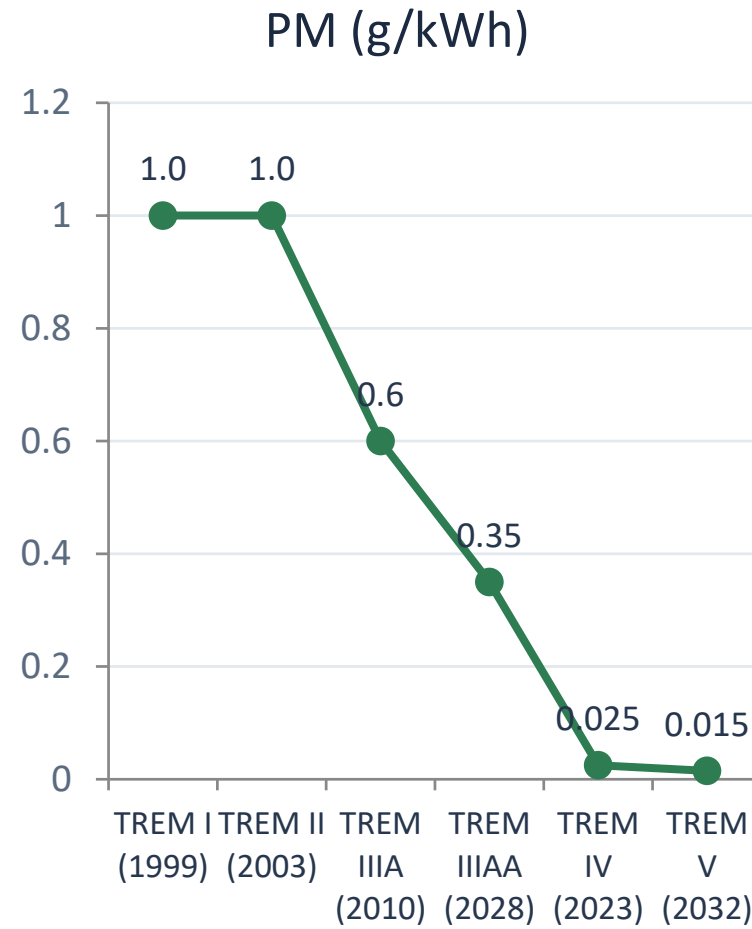
TREM Evolution

India's tractor emission norms, 1999 to 2032



TREM Emission Norm Evolution

India tractor emission standards: limits by stage (g/kWh)



TREM V Emission Limits by Power Category

Limits in g/kWh; PN in #/kWh

Category (kW)	CO	HC	NOx	PM	PN (#/kWh)	Test Cycle
P < 8	8	7.5 (HC+NOx)		0.4	—	NRSC
8 ≤ P < 19	6.6	7.5 (HC+NOx)		0.4	—	NRSC
19 ≤ P < 37	5	4.7 (HC+NOx)		0.015	1×10 ¹²	NRSC and NRTC
37 ≤ P < 56	5	4.7 (HC+NOx)		0.015	1×10 ¹²	NRSC and NRTC
56 ≤ P < 130	5	0.19	0.4	0.015	1×10 ¹²	NRSC and NRTC
130 ≤ P < 560	3.5	0.19	0.4	0.015	1×10 ¹²	NRSC and NRTC
P ≥ 560	3.5	0.19	3.5	0.045	—	NRSC

NRSC: Non-Road Steady Cycle • NRTC: Non-Road Transient Cycle

Impact on ATS

After-treatment system required at each emission stage

1999 TREM I	2003 TREM II	2005–10 TREM III / IIIA	Jan 2023 TREM IV	Oct 2026* TREM V < 25 HP & > 75 HP	Apr 2028 TREM IIIAA	Apr 2032* TREM V
						
NA	NA	NA	DOC + SCR	DOC	DOC	DOC + DPF + SCR*

Emission Norms Compared

TREM IV, TREM IIIAA and TREM V limits

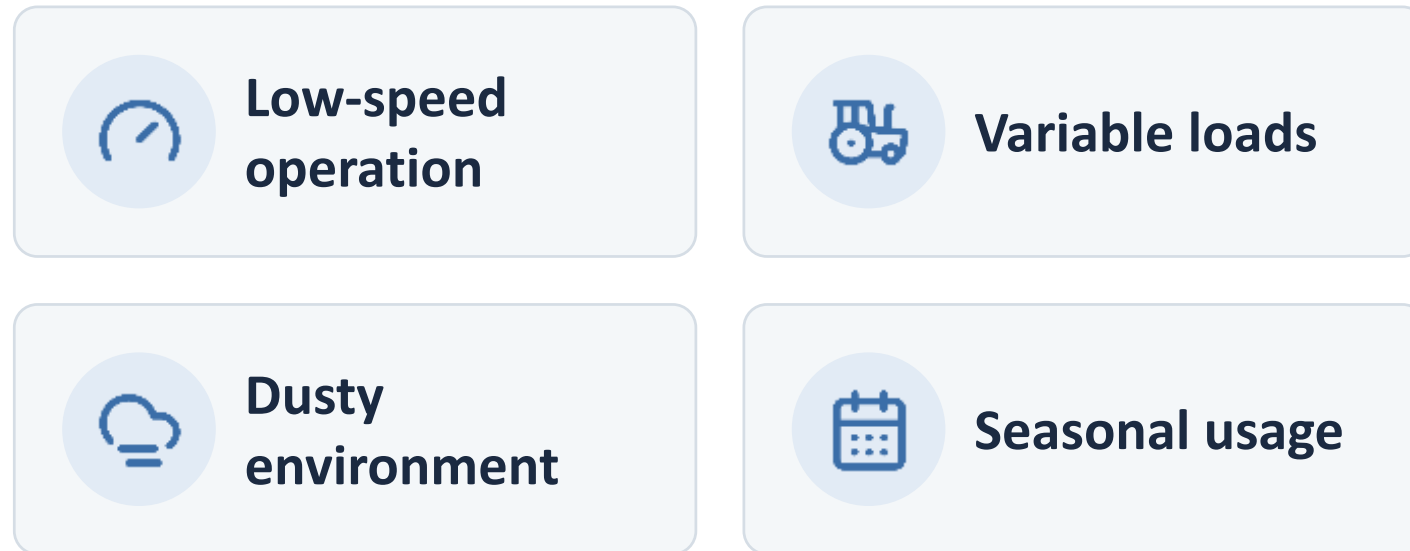
Emission Norm	CO (g/kWh)	HC (g/kWh)	NOx (g/kWh)	PM (g/kWh)	PN (#/kWh)	Test Cycle
TREM IV	5	0.19	3.3	0.025	—	NRSC + NRTC
TREM IIIAA	5.5	4.7 (HC+NOx)		0.35	—	8-Mode Cycle (ISO 8178 C1)
TREM V	5	0.19	0.4	0.015	1×10^{12}	NRSC + NRTC

NRSC: Non-Road Steady Cycle • NRTC: Non-Road Transient Cycle

Why Agriculture Is Different

Agricultural operating conditions drive the resulting system challenges

AGRICULTURAL OPERATING CONDITIONS



RESULTING SYSTEM CHALLENGES

-  DPF regeneration challenges
-  Sensor reliability concerns
-  Overall system durability

TREM V SUCCESS = TECHNOLOGY + COST OPTIMIZATION + INFRASTRUCTURE + USER EDUCATION

Technical Challenges

Tractor duty cycles make temperature, soot and control strategy difficult to balance



Low Exhaust Temperature

- DOC / DPF / SCR efficiency
- Passive regeneration can suffer



DPF Regeneration

- Soot accumulation
- Rising exhaust back pressure



Variable Load Cycle

- Rapid temperature changes
- Complex engine calibration



Dust & Contamination

- Sensor fouling
- Connector contamination



Sensor Reliability

- NOx & temperature sensors
- Durability under vibration



Thermal Management

- Heat shielding
- Catalyst temperature control

Engineering focus: optimize the complete engine + after-treatment system, not components in isolation.

Infrastructure Challenges

Field support must be ready before advanced after-treatment reaches customers



DEF Distribution

- Rural availability
- Supply continuity



DEF Storage & Quality

- Prevent contamination
- Monitor fluid quality



Service Network

- Technician capability
- Dealer readiness



Diagnostics

- Scan tools & ECU access
- Remote diagnostics



Localization

- Sensors & catalysts
- Resilient supply chain



Training & Certification

- Technician and farmer awareness
- Consistent service practices

Implementation needs coordinated investment in logistics, service capability and technical training.

Farmer / End-User Challenges

Adoption will depend on affordability, simple maintenance and confidence in field reliability



Cost Impact

- Higher tractor cost
- DOC, DPF & SCR hardware



DEF Management

- Availability & storage
- Contamination control



Awareness & Training

- Understand warning indicators
- Build technology confidence



DPF Regeneration

- Filter maintenance
- Potential operating impact



Maintenance Complexity

- ATS servicing
- Sensor diagnostics



Reliability & Acceptance

- Field durability
- User confidence

Customer readiness is as important as technical compliance.

TREM V Implementation

Six connected workstreams for a practical transition to cleaner agricultural machinery



OEM Integration

- Package DOC / DPF / SCR
- Protect visibility & service access



Thermal Strategy

- Regeneration performance
- Heat shielding & airflow



Controls & Calibration

- ECU strategy
- NOx, fuel and drivability



Validation

- Dust, vibration, thermal
- Emission & durability testing



Supplier Readiness

- Localization & quality
- Secure component capacity



Customer Support

- DEF access & diagnostics
- Dealer training

A coordinated OEM–supplier–service ecosystem turns compliance into a reliable field solution.

Make DPF Regeneration Work in Real Duty Cycles

In agricultural work, low-load and intermittent jobs can keep exhaust temperatures below the range needed for reliable passive regeneration

03 DPF regeneration

THE CHALLENGE

Soot can accumulate when a tractor spends long periods at low load or moves between short tasks.

DESIGN FOR THE WAY TRACTORS WORK

- Map real duty cycles—not only certification cycles
- Validate active regeneration for safe temperatures and fuel penalty
- Give clear actions for interrupted or repeated incomplete cycles



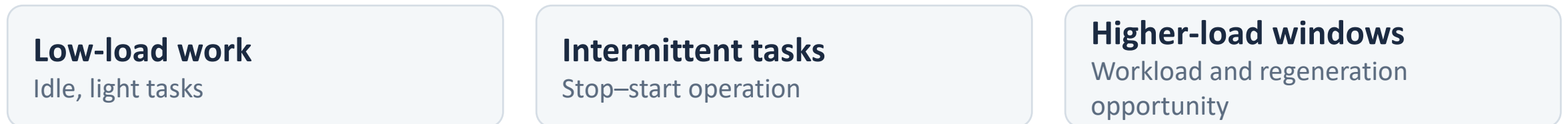
DPF Regeneration: Control Loop and Validation

Calibrate regeneration for the duty cycle, then verify it in the field

REGENERATION CONTROL LOOP



FIELD DUTY CYCLE TO COVER



VALIDATION CHECKS: Soot load • Exhaust temp • Fuel penalty • **Thermal safety** • Recovery logic

Success metric: reliable completion with acceptable fuel use, safe temperatures and clear operator actions.

Make Ownership Costs and Service Complexity Acceptable

The customer experiences the whole product lifecycle—not just the purchase price or a compliance certificate

06

Cost + acceptance

THE CHALLENGE

Higher acquisition and maintenance costs, unfamiliar warnings and service complexity can undermine acceptance.

DESIGN FOR CUSTOMER CONFIDENCE

- Use whole-life cost analysis—not component price alone
- Make access, diagnosis and routine maintenance straightforward
- Prepare dealers and operators before the first machine is delivered

TOTAL COST OF OWNERSHIP



*Include DEF only where the selected architecture requires it.

Practical Readiness Actions

Prepare product, network and operators before launch



Design for access

Routine service points, filter access and repair clearance



Simple diagnostics

Clear fault messages, guided checks and service procedures



Train the network

Dealer technicians, diagnostic tools and parts readiness



Educate operators

Regeneration, DEF handling where applicable and maintenance

LAUNCH KIT: Service manual • Diagnostic workflow • Operator guide • Parts plan • Field-feedback channel

Opp. | Build a Localized, Service-Ready Ecosystem

Supplier readiness and customer support must mature alongside the hardware



Critical parts

Map sensors, catalyst, DPF, mounts, harnesses; qualify alternate sources



Quality at source

Specifications, incoming checks, traceability and change control



Capacity & lead time

Launch volumes, buffers for critical parts, supplier escalation routes



Service network

Diagnostic access, scan tools, trained technicians, clear repair procedures



DEF readiness*

Availability, storage quality and operator handling guidance



Operator confidence

Explain warnings, regeneration, maintenance intervals and escalation

Launch kit: service manual • diagnostic workflow • operator guide • parts plan • feedback channel

*Only for architectures that require DEF.

Way Forward | A Simple Readiness Control Tower

A compact dashboard connects engineering, suppliers and service teams before and after launch

EMISSIONS MARGIN

Worst-case margin to applicable limits

GREEN / AMBER / RED

REGENERATION

Completion rate and frequency by duty cycle

Trend + exceptions

THERMAL SAFETY

Peak temperatures vs component limits

Hot spots + margin

DURABILITY

Failure / drift rate for sensors, mounts and harness

Issue ageing

SUPPLIER READINESS

Localization, capacity, quality and lead time

Open risks

SERVICE READINESS

Dealer coverage, trained technicians, tools and DEF access*

Coverage gaps

EVERY RED KPI → OWNER → CONTAINMENT → DUE DATE → EVIDENCE-BASED CLOSURE

Review cadence: weekly during development; continue field feedback and corrective action after launch

Outcome: compliant technology that is robust in the field, supportable at scale and credible to the customer.

*Where required by the selected architecture.

A photograph of two hands, palms facing each other, forming a heart shape. The hands are positioned in the foreground, with a green field and a single tree in the background under a cloudy sky. The text "Together We Can..." is overlaid on the top part of the image.

Together We Can...

Thank You