



**Zemo
Partnership**
Accelerating Transport to Zero Emissions

Decarbonising the Cold Chain

Developing the Emissions Evidence Base for Auxiliary
Transport Refrigeration Units (AuxTRUs)

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9th October 2024

Cold Chain Hub

Welcome to Zemo Partnership

Accelerating transport to zero emissions

The Auxiliary Transport Refrigeration Unit (AuxTRU) Project

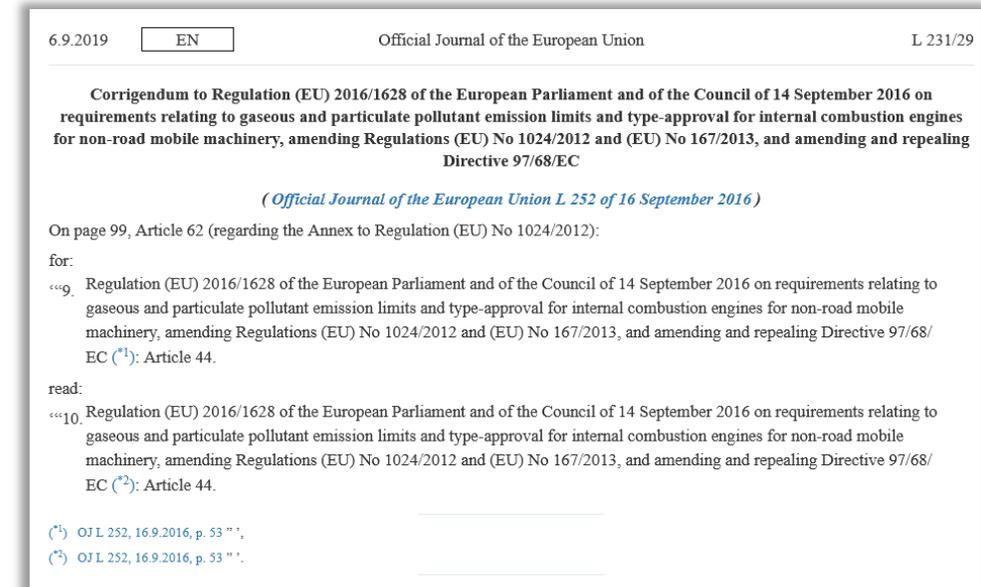
Context and Background



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Context – Regulatory Landscape

- ⌚ Powered by their own auxiliary engine, independent of the vehicle's propulsion engine.
- ⌚ Vehicle propulsion engines are regulated under EU emissions standards.
- ⌚ Auxiliary engines are regulated under the Non-Road Mobile Machinery (NRMM) Directive.
- ⌚ As auxTRUs are commonly attached to HGVs across the cold chain, these emissions are felt on the road in real terms.
- ⌚ The total emissions auxTRUs contribute to the transport sector remains largely unknown.



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Context – Greenhouse Gas Emissions & Air Pollutants

- Greenhouse Gases have a **global** impact and contribute to the climate crisis through the greenhouse gas effect.
- F (fluorinated) Gases have a Greenhouse effect and are **not** in scope for this project.
- Air pollutants have a far more **localised** effect and are linked to adverse human health impacts.

Examples of Greenhouse Gases	Examples of Air Pollutants
Carbon Dioxide (CO ₂)	Carbon Monoxide (CO)
Methane (CH ₄)	Sulphur Dioxide (SO ₂)
Nitrous Oxide (N ₂ O)	Nitrogen Oxides (NO _x)
Chlorofluorocarbons (CFCs)	Particulate Matter (PM _{10/2.5/1})
Hydrofluorocarbons (HFCs)	Ozone (O ₃)

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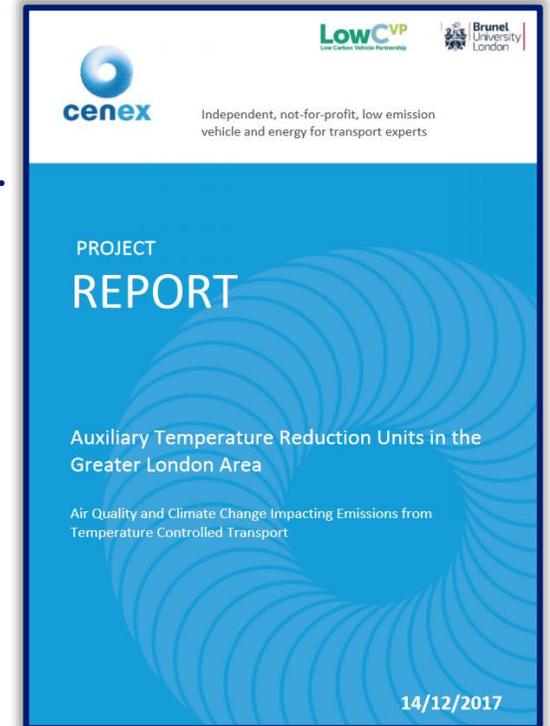
Cenex/TfL Report – Published 2018

CENEX, Zemo (then LowCVP) and Brunel University were commissioned by Transport for London via the LoCITY programme to conduct a desk-based study on auxTRUs in London.

5 Objectives:

- 🔗 Study & report on the nature of temperature-controlled transport in London.
- 🔗 **Estimate the emissions from the temperature-controlled fleet** (traction and auxiliary).
- 🔗 Review the alternative technologies available.
- 🔗 Review potential emission reductions when using best practices.
- 🔗 Suggest high-level policy measures & areas for further research.

Amongst the study's findings was a call to **develop the emissions evidence base** from real-world emissions testing for auxTRUs...



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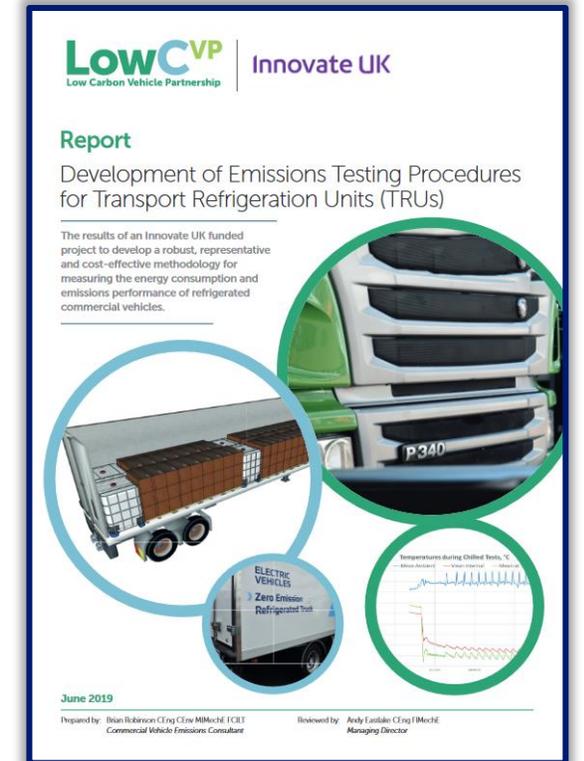
Innovate UK Report – Published 2019

Innovate UK tasked LowCVP to:

- ➊ Propose a robust, representative and cost-effective testing methodology from existing approaches.
- ➋ Trial and validate the methodology, through pilot testing of a single diesel auxTRU.
- ➌ Identify next steps for follow-up activity.

An initial test procedure was developed and validated via pilot testing.

Next step recommendations included **baseline testing of a wider range of existing TRU technologies**, develop procedures for multi-temp vehicles, and to **evaluate alternative TRU technologies** to assess emissions savings potential.



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Transport Scotland Report – Published 2021

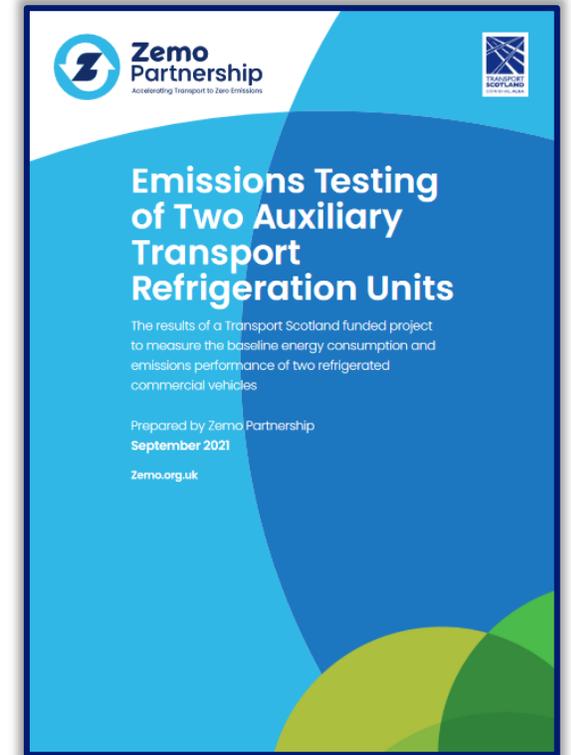
Zemo Partnership conducted research funded by Transport Scotland:

- 🔗 Expand on the evidence base for diesel auxTRUs.
- 🔗 Estimate real-world impacts on air quality.
- 🔗 Inform Transport Scotland on the potential policy interventions for TRU emission control.

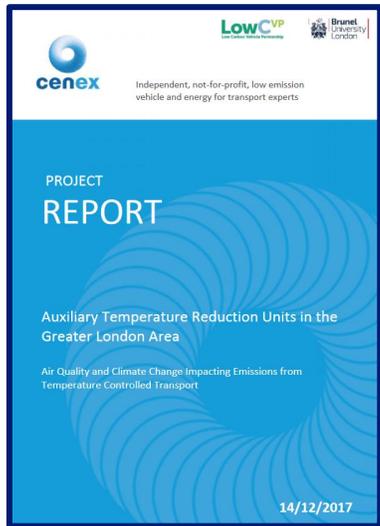
Two conventional diesel auxTRUs were tested under the programme of work:

- 🔗 One fitted to a full-sized semitrailer
- 🔗 One fitted to a (smaller) three-axle rigid HGV (26t GVW)

Both auxTRUs were from the same manufacturer.



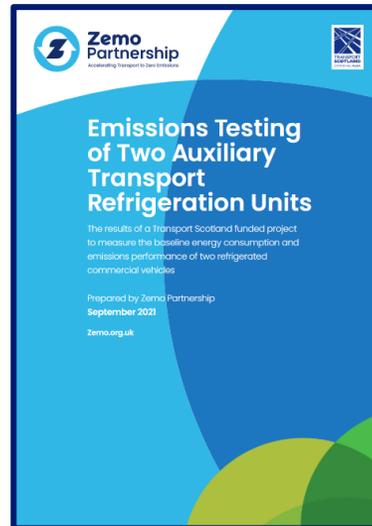
Timeline



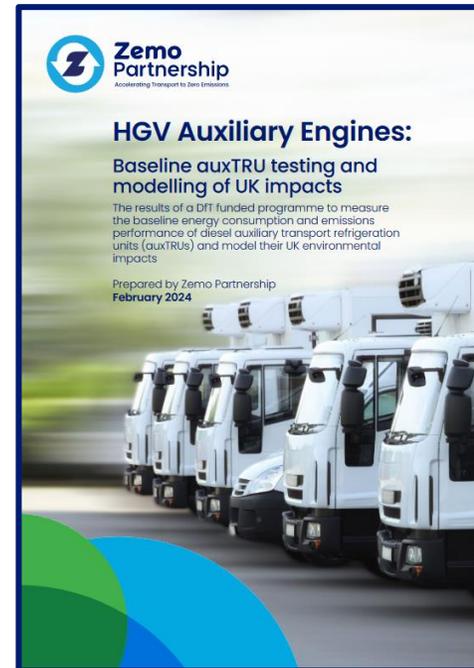
2018



2019



2021



2024

DfT auxTRU Project



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Project Details



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Overview

- ④ The Department for Transport commissioned Zemo Partnership to undertake further research, building on the Transport Scotland project.
- ④ The project started at the end of 2022 and is due to finish end 2024.
- ④ The scope was widened beyond TRUs to cover other forms of auxiliary HGV engines (e.g. road sweepers), that are also regulated as NRMM.
- ④ The project scope was expanded to include refrigerated vans in 2023.
- ④ Project has been steered by an Expert Group made up of key industry stakeholders.

Work Package 1

AuxTRU Baseline Testing

Work Package 2

Market Review

Work Package 3

Extend Baseline Testing

Work Package 4

Evaluate Alternative Technologies

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Work Packages 1 & 3 – AuxTRU Baseline Testing and Extending Baseline Testing

WP1: AuxTRU Baseline Testing

- ④ The testing was to include auxTRUs certified as being compliant with NRMM Stage V, as NRMM Regulations started to impose limits on some auxTRU emissions from January 2019.
- ④ The testing was also to include a greater range of manufacturers, as all three units tested to date were from the same supplier.

WP3: Extend Baseline Testing

- ④ The test procedures were to be developed to include multi-temperature operations, to ensure test protocols were more representative of in-service conditions.

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Testing Methodology



Layout of intermediate bulk containers (IBCs) and cardboard boxes

1. Empty trailer to be stabilised in test chamber at target ambient temperature.
2. Load vehicle/trailer with a mix of pre-conditioned water-filled IBCs & empty cardboard boxes.
3. Run the auxTRU to specified setpoint(s) (e.g. 2°C chilled, -20°C frozen)
4. Run the auxTRU in continuous mode (chilled) or start/stop mode (frozen and multi-temp) for 3 hours.
5. Simulate delivery stop via door openings (e.g. HGVs = 30-minute stop).
6. Close doors, auxTRU to pull down to set point (stage test ends).

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Testing Methodology

- ④ Six diesel auxTRUs tested from key market players, as provided by industry.
- ④ For all units, testing generally involved chilled and frozen testing at one ambient temperature (15°C).
- ④ One unit could only be tested in frozen mode, and an additional ambient test (5°C) was carried out for direct comparisons to the Transport Scotland work.
- ④ One unit also underwent a series of multi-temperature tests (50:50 split) under a suite of ambient temperatures (5°C, 15°C, and 30°C).
- ④ Note: The units were not tested against each other, but tested to **gain a representative emissions baseline** of the current cold chain sector.

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Test Results – HGV Report

In comparison to a Euro VI compliant propulsion engine, a single auxTRU fitted to a Euro VI HGV would (in a city/urban environment, in periods of reasonably average ambient temperatures):

	Manufactured Pre-2019	Manufactured Post-2019
Fuel Consumption (litres):	1/9 th	1/10 th
Greenhouse Gas Emissions (CO₂e):	1/9 th	1/10 th
Nitrogen Oxides (NO_x):	2x	1.5x
Particle Mass (PM_{2.5}):	5x	3x
Particle Number (PN):	400x	300x

An increase of ambient temperature was also found to increase both fuel consumption and emission rates.

The results for multi-temp operations typically came in between those of the chilled and frozen mode tests

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Work Package 2 – Market Review (HGV Report)

WP2: Market Review objectives:

- 🔗 To gather comprehensive and nationally/regionally representative data on aux engine operations and duty cycles via a market survey.
- 🔗 To establish findings to inform future test process development and provide overall fleet environmental impact estimates:

Diesel auxTRU UK Fleet Size:

Estimate

40,000–55,000

Fuel Consumption (litres):

235 million / year

Greenhouse Gas Emissions (CO₂e):

~590 kilotonnes / year

Nitrogen Oxides (NO_x):

~4.4 kilotonnes / year

Particle Mass (PM_{2.5}):

~126 tonnes / year

Particle Number (PN):

~353 x 10²¹ / year*

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Work Package 4 – Evaluate Alternative Technologies

🔄 Testing and reviewing of alternative technologies currently underway.

In Scope



Secures Emission Reductions



Zero Emission

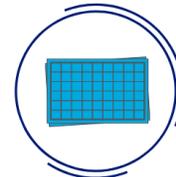


Near Zero Emission

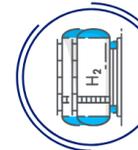


Commercially Available or Demo

Out of Scope



Non-Market Ready Technologies



Hydrogen Fuel Cell



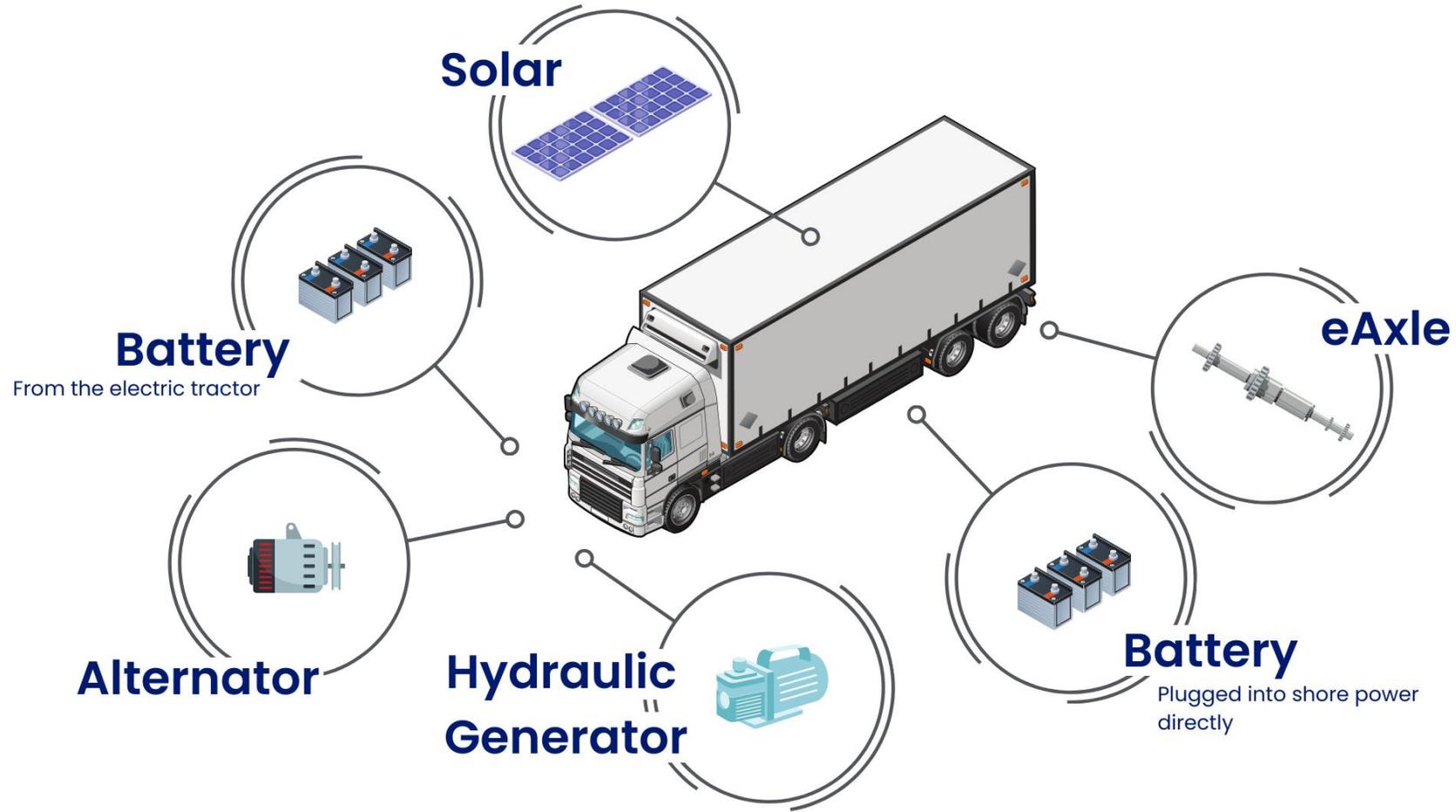
Eutectic Technologies



Low Carbon Renewable Fuels

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Work Package 4 – Evaluate Alternative Technologies



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Vans

- ④ Completed emissions testing of two 3.5t Euro 6 standard diesel-fuelled refrigerated vans (Spring 2024), plus testing of one 4.25t BEV.
- ④ Multi-temperature bodies, one PTO driven, one alternator driven.
- ④ Developed test procedures to be representative of van operational characteristics.
- ④ Report aims to characterise the environmental impacts of the full UK cold chain transport sector to date for HGVs and vans (excl. rigids and HGV TRUs from main propulsion).

- ④ Also includes additional particulates' analysis of all HGV testing from DfT and Transport Scotland test programmes (8 TRUs), to further understand emissions from ultrafine particulates, a public health impact concern.

Next Steps

Deliverable	Detail	Timeline
Report	Van testing reporting and additional particulates' analysis from vehicles tested in DfT and Transport Scotland research.	October 2024
Project Completion	Project due to be completed with no further testing to take place.	November 2024
Report	Results from the testing of alternative HGV auxTRU technologies, and battery electric refrigerated van tests.	Winter 2024/25

Thank you

Any questions? Please get in touch

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