Welcome to SIS 94:

Intelligent systems to help drivers and road authorities reduce pollutant emissions: Beyond eco-driving

Session Moderator:
Jean-Charles Pandazis
ERTICO – ITS Europe

12th October 2021, Hamburg, Germany

Organised by ERTICO
Co - Organised by ITS America, ITS Asia-Pacific
Supported by Federal Ministry of Transport and Digital Infrastructure
Hosted by Hamburg
HAMBURG ITS World Congress 11 - 15 Oct 2021
Experience Future Mobility Now

AGENDA

14:00 Jean-Charles Pandazis – ERTICO (Introduction)

14:05 Norbert Ligterink – TNO (uCARe Project)

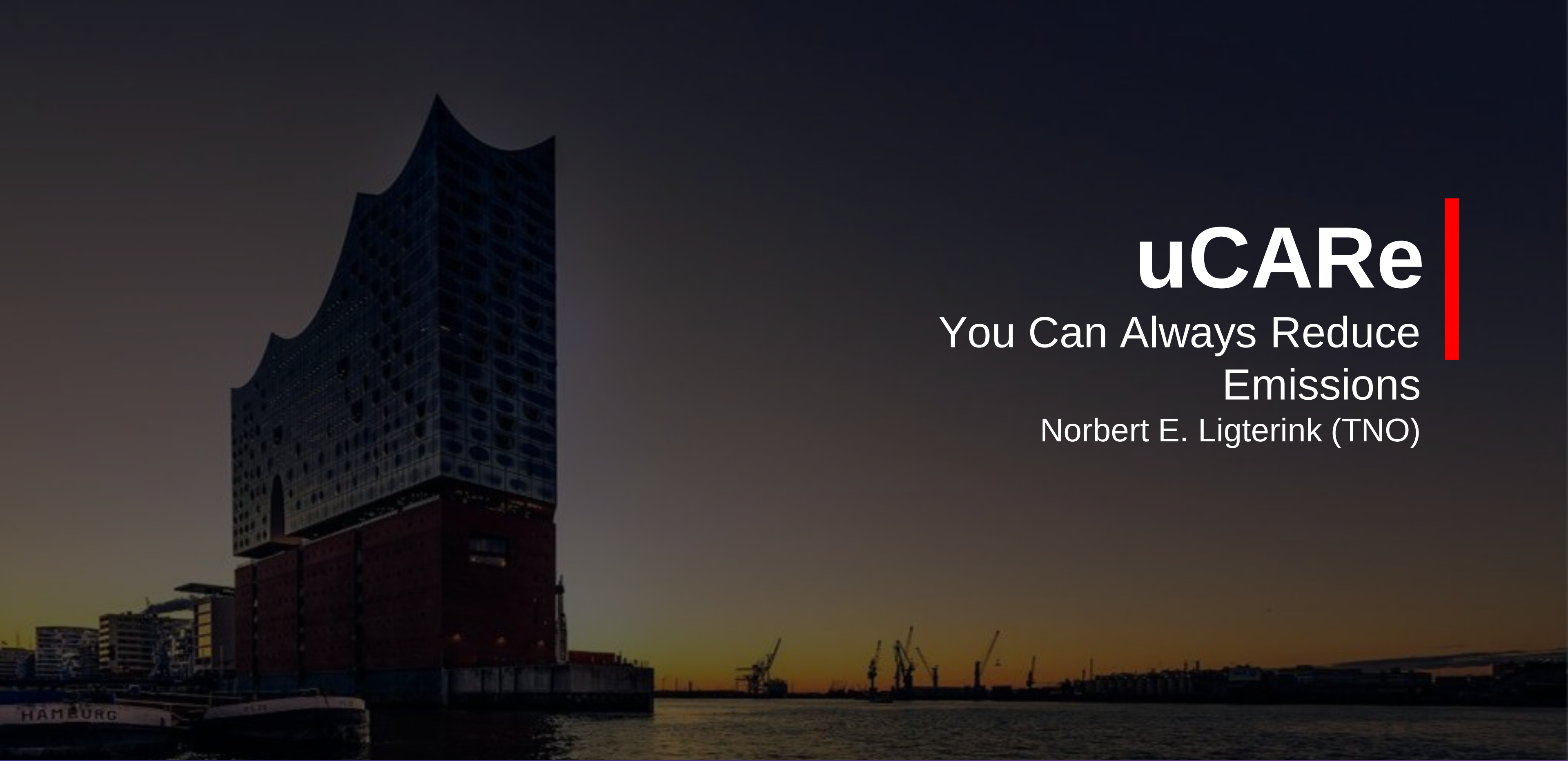
14:15 Andrew Winder – ERTICO (MODALES Project)

14:20 Haibo Chen – University of Leeds (MODALES Project)

14:30 Åke Sjödin – IVL, Swedish Environmental Research Institute (CARES Project)

14:50 Matthias Mann – HERE Technologies

15:10 Discussion and wrap-up



uCARe

You Can Always Reduce Emissions

Norbert E. Ligterink (TNO)

Organised by ERTICO
Co - Organised by ITS AMERICA ITS ASIA-PACIFIC
Supported by Federal Ministry of Transport and Digital Infrastructure
Hosted by Hamburg
HAMBURG ITS World Congress 11 - 15 Oct 2021 Experience Future Mobility Now

CONTENTS

Ambition

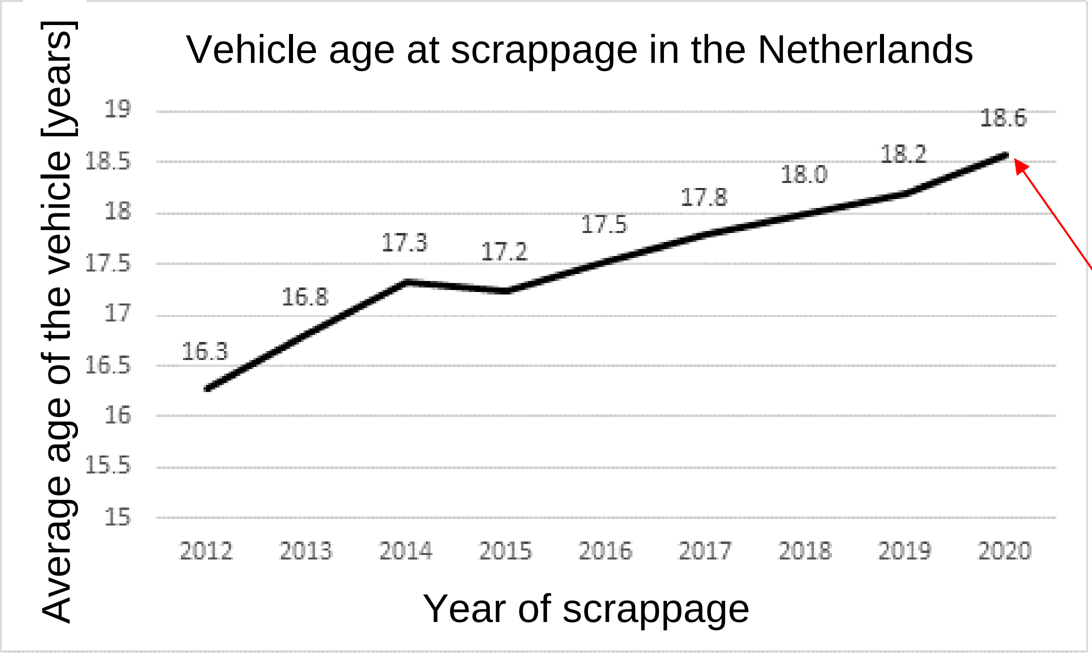
To reduce the **overall pollutant emissions** of the **existing vehicle fleet** by providing **vehicle users** with **simple, insightful, and effective tools** to decrease their individual emissions *and* to support **stakeholders** with an interest in local air quality in selecting feasible **intervention strategies** that lead to the desired user behaviour.

Current fleet will have effect on air-quality up to 2040

Emissions vary with:

- Certain technologies and emission classes.
- Specific driving behaviour.
- Certain vehicle usages.
- Certain defects and tampering.

→ Roughly 80% of the emissions by 20% of the vehicles/driving/ maintenance



Vehicles from 2002 (Euro-3) are scrapped now

The step-by-step plan

uCARe
You Can Always Reduce Emissions
because you care

1. Disclose the pollutant emissions information for specific vehicles
2. Determine the emission reduction potential by individual car users
3. Provide the instructions and tools to achieve the reductions
4. Make the material appealing for different user groups
5. Test the approaches in practice in pilots with stakeholders
6. Collect feedback and determine the achieved emission reductions
7. Assess the possible impact on air quality and vehicle emissions
8. Make the information data, and material available for general use

Completed

Finalizing

Current

Ongoing

The general objectives and routes

- Dissemination of relevant vehicle emission information
  - Completeness, clarity, relevance, suitability, and fun
  - Full spectrum of information, tuned towards specific vehicles and user actions

    → The basis is laid, examples exists, more interaction with users may help to focus

- Car users and owners were never easily to involve and convince
  - Central role for local stakeholders is foreseen as essential
  - COVID-19 pandemic makes this “double” or “linked” outreach difficult

    → Some concerns on progress and effectiveness

Consolidation and dissemination

- ERMES, HBEFA, COPERT, VERSIT+, non-exhaust, etc.
  - All experts in the same room to combine the knowledge.
- Individual vehicles, specific emission behaviour
  - A shift from averaging and modelling has proven difficult.

    → Some additional analyses and reporting may be needed
- Mitigation measures available to users
  - A new view on vehicle emissions, with the tendency to divert to eco-driving.
- Solid evidence
  - “dynamic correction”, or the statistical uncertainty, from variation in the data
  - Modelling and averaging may limit the “evidence” part of emission behaviour

Hearts and minds

- Passionate vehicle emission researchers and the dispassionate vehicle users: a match to be made.
- The role of psychologists is to translate the raw material in effective campaigns.
- More interaction is needed to make the worlds meet.
- Testing user material allows uCARe to take steps beyond the obvious.

Interview sessions with focus groups provides information on:

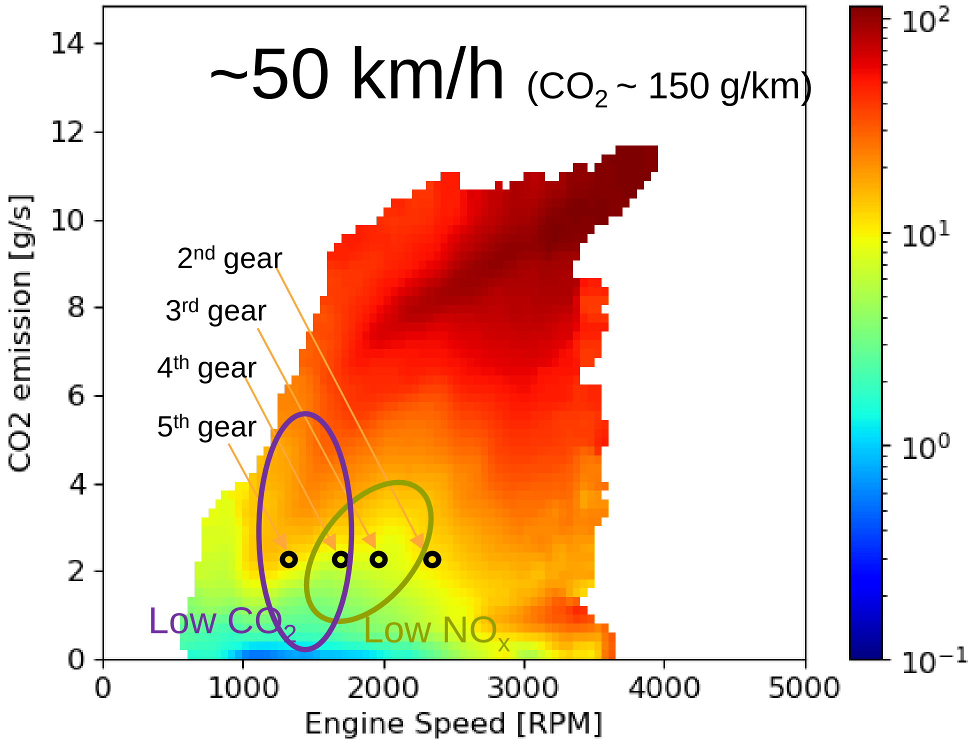
1. Level of public understanding on pollutant emissions
2. Material to use to achieve a change in behaviour

An example: gear choice

Euro-5 diesel vehicles have high NO_x emissions.

CO_2 eco-driving instruction: high gear driving at low engine speeds (~1500 RPM).

Low NO_x instructions is to retain a slightly lower gear, in particular when accelerating.



uCARe highlights

- ~100 AEM (augmented emission maps): uniform representation of emission data for modelling and analyses, and more coming.
- Standardized vehicle model and engine classification scheme, already used too in other H2020 and LIFE projects.
- Beta version of AEM-based driving behavior assessment tool.
- Focus groups formed and interviews held.
- Pilot and mitigation measures assessment methodology ready.
- YouTube movie to explain the AEM and how it can be used.
- Delays limited and the risks for project progress mitigated.

Identifying vehicle technology groups

A method of categorising vehicles, dependent on the main (technical) properties.

Allows for cross-organisation and cross-project comparison and communication

- CARES, MILE21, GVI

Consists of

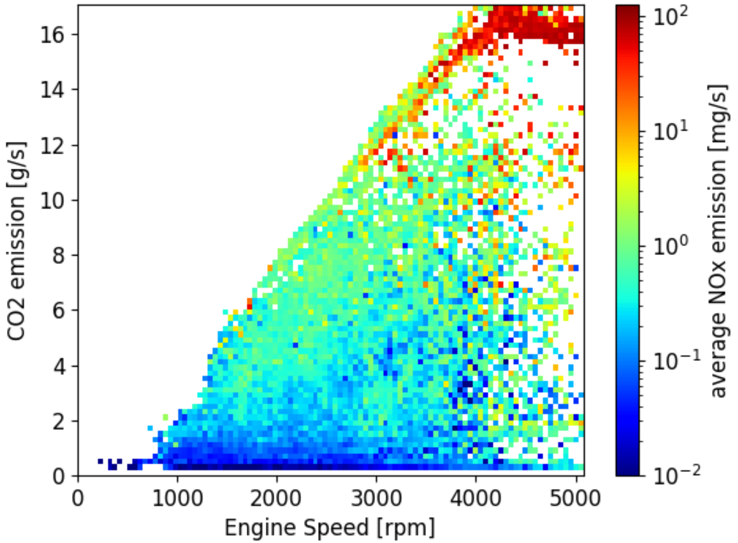
- A vehicle code, and
- An engine code

Especially useful in cases where a base vehicle and engine are used by different manufacturers

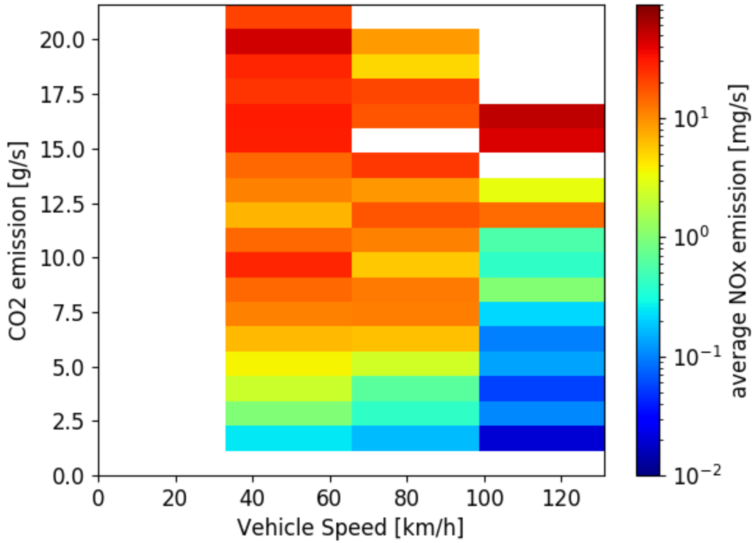
- E.g. Peugeot 107, Citroen C1, and Toyota Aygo

Base emission maps

P_6dT_998_74_FORD – 18.4 hours



P_6b_999_70_VAG – 4.6 hours



- Flexible bin sizes dependent on data availability
- Pollutant map dependent on either RPM or vehicle speed, and CO_2
- Python script circulated amongst partners, to determine maps from data

Augmentations

Cold start	Deterioration	Non-tailpipe particulate emissions
• Formula finalised • Vehicle-dependent and fallback parameters	• Dependent on scaling factors • CONOX/CARES (Remote Sensing)	• Simulator tests • Literature • Qualitative advice

Cheap and simple monitoring

- NO_x direct feedback device
  - still needs testing with respect to driver impact
- NO_x emissions along with trip data
  - OBD NO_x signal has been logged by CROSSYN
- Particle sensor based on smoke detector
  - Can detect damaged DPFs, as well as when they have been removed
- Mini-PEMS (Simplified PEMS)
  - ~10 kg, for small engines (mopeds, motorcycles, tools/equipment)
- Portable FTIR
  - Portable
  - Larger range of gaseous pollutants

Citizen Science

- Six DIY tests
  - Five videos published on the uCARe website
  - App in iStore and Google Play

CO meter

Exhaust PM filter test

Exhaust PM swipe test

Brake dust PM test

Driving style test

DPF inspection

Pilots starting (with the end of lockdown)

- Information material
- Driving schools instructions
- App with emission prediction linked to driving behaviour

Preparing assessments

- Scaling up to city and national levels
- Feasibility and experiences
- Examples of linking to air-quality

Thank you for your attention

See project uCARe website: www.project-ucare.eu for details and material

uCARe
You Can Always Reduce Emissions
because you care

TNO
LAT
LABORATORY OF APPLIED THERMODYNAMICS
ARISTOTLE UNIVERSITY THESSALONIKI
ivl
vti
icct
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION
TU Graz
Empa
Materials Science and Technology
mobi
INFRAS
UNIVERSITY OF LEEDS
HSDAC

Overview of the MODALES project: Adapting driver behaviour for lower emissions

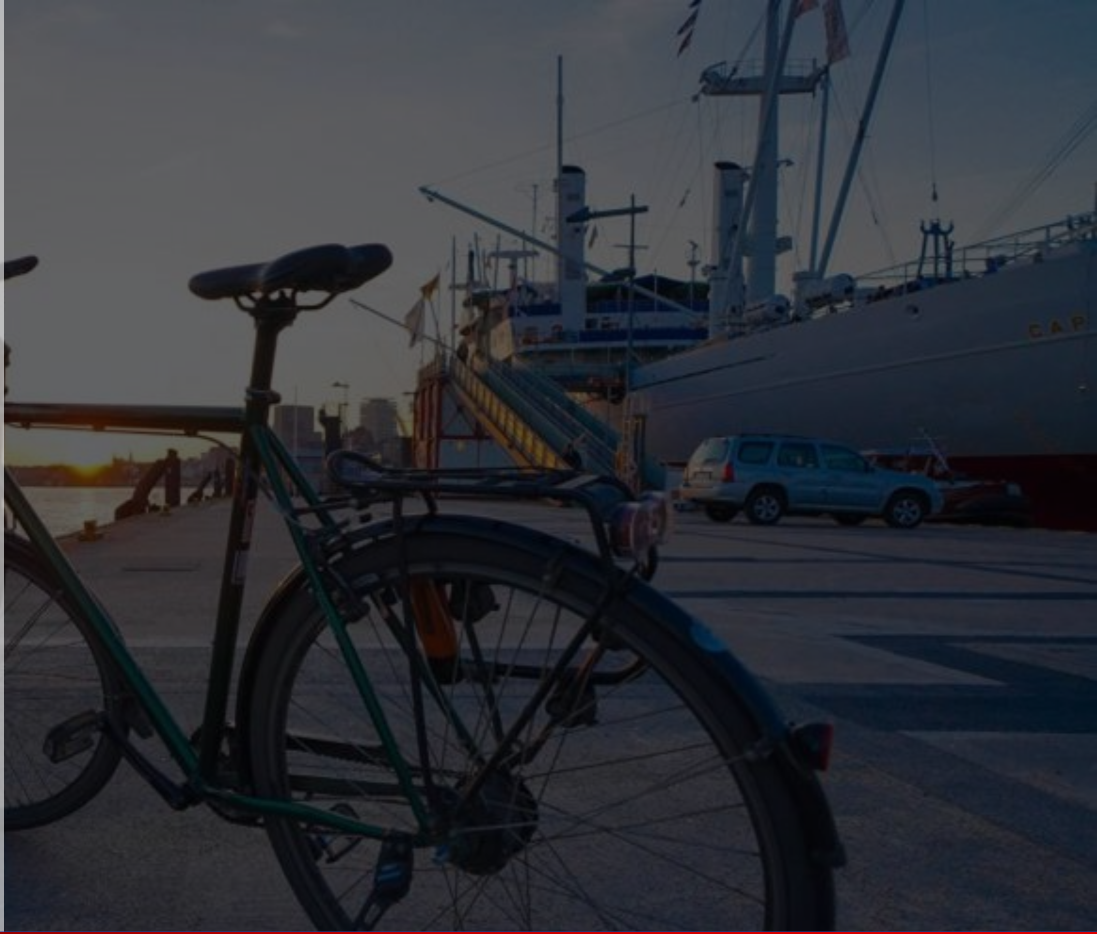
Andrew Winder
MODALES Project Coordinator
ERTICO – ITS Europe

12th October 2021, Hamburg, Germany

Organised by ERTICO
Co - Organised by ITS AMERICA, ASIA-PACIFIC ITS
Supported by Federal Ministry of Transport and Digital Infrastructure
Hosted by Hamburg
HAMBURG ITS World Congress 11 - 15 Oct 2021
Experience Future Mobility Now

CONTENTS

[redacted]



1

MODALES project overview and expected impact

MODALES – Adapting driver behaviour for lower emissions

Project Vision:

- To **reduce air pollution** from all types of road vehicles (but especially older vehicles) by encouraging adoption of **low-emission driving behaviour** and **proper maintenance choice**

MODALES focuses on emissions from:

- Powertrain (exhaust)
- Brakes
- Tyres

Expected impacts of MODALES

Contribute to **reduction in emissions** from the existing combustion-engine car fleet

Contribute to **reduction in unnecessary driver-induced emissions** though a better awareness by the public of their role in controlling polluting emissions through a driver assistance app and an awareness campaign

Provide **technical evidence to assess gaps in current regulation** vehicles

Low-emission driving versus eco-driving

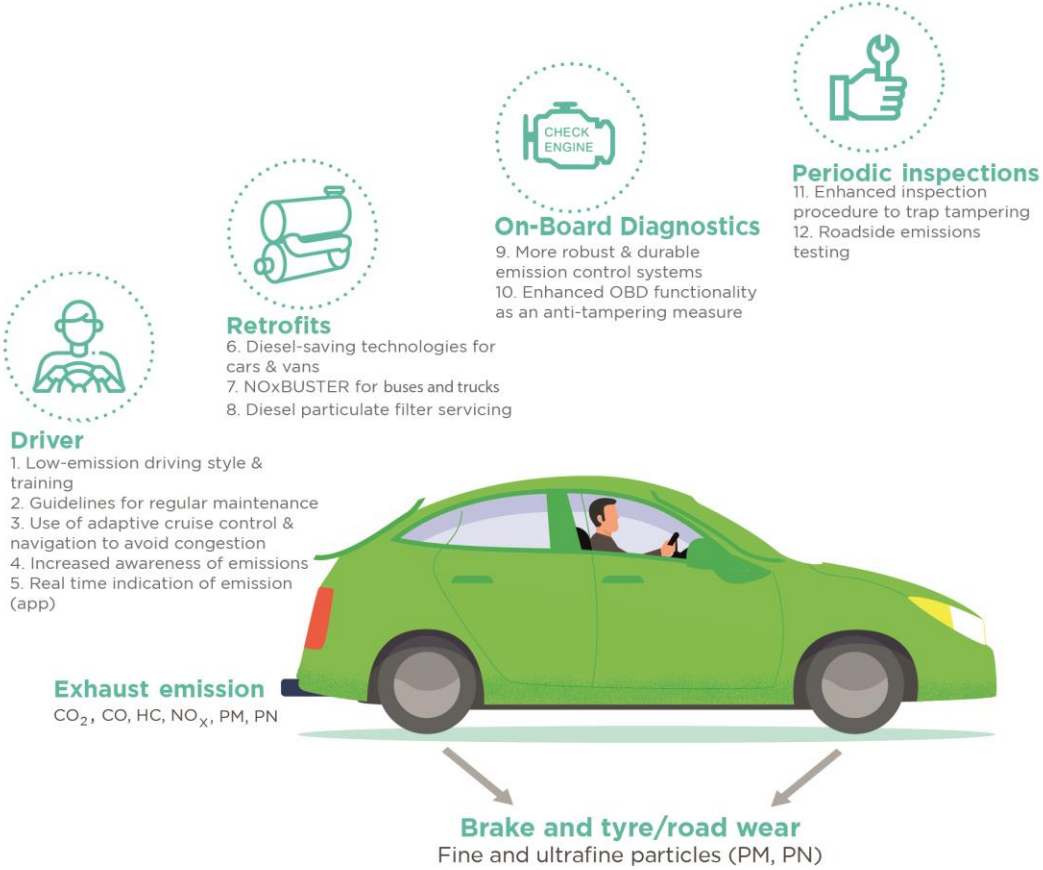
Eco-driving targets a reduction in CO_2 emissions and fuel consumption by encouraging green driving behaviour.

MODALES focuses on other **air pollutants** (not always correlated with CO2), e.g.:

- NO_X – Nitrogen oxides
- O3 – Ground-level ozone
- PM – Particle matter
- PN – Ultrafine particles

MODALES also measures **particle emission from brake and tyre wear**

Project innovation areas



MODALES partners

Associations

Universities

Research institutes

Industry and technology providers

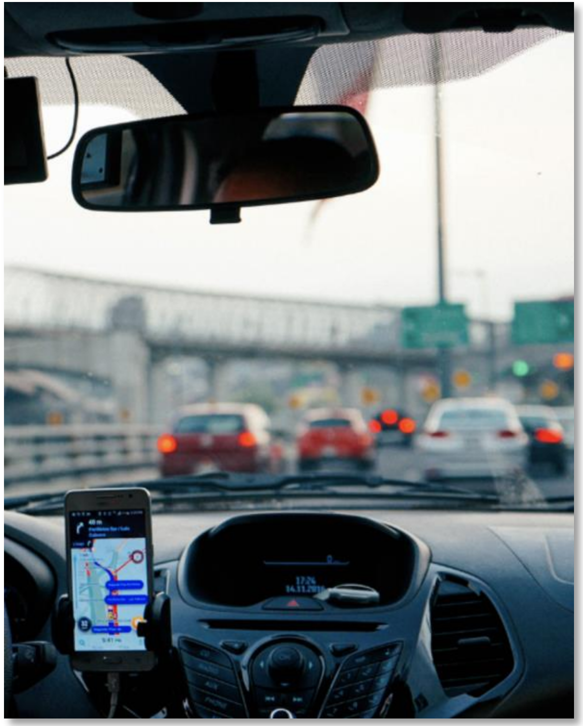
Legal experts

2 Mobile app and training

MODALES low-emission driving app

The app will create two types of recommendations:

- **Active recommendations**:
  - When the user is driving
  - Research prototype → simplified recommendations and HMI, using only the phone sensors
- **Passive recommendations**:
  - After a trip
  - Complete report, using the phone sensors, OBD data and external web services



Training videos being developed by MODALES to cover…

+ Pre-trip checks and planning

Driving behaviour

Training will be delivered on emissions savings by changing behaviour (idling, gears, breaking, accelerating etc.)

Proper maintenance

By maintaining the vehicle properly, emissions savings can be achieved

Use of the MODALES app

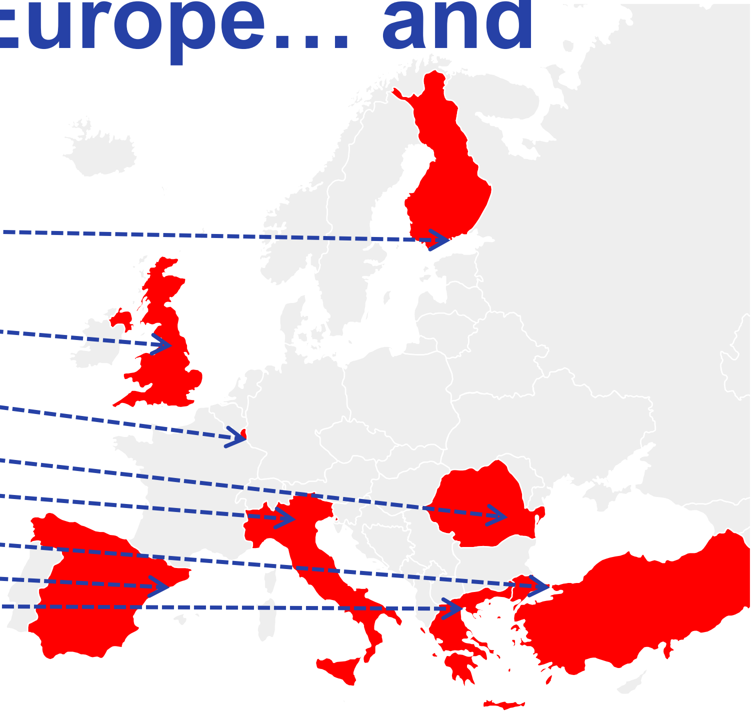
The MODALES app will assist drivers consulting them to drive environmentally friendly

3

On-road trials

The training and driving app will be tested in pilots across Europe… and beyond

- Helsinki, FI
- Leeds, UK
- Luxembourg, LU
- Bucharest, RO
- Bergamo, IT
- Istanbul, TR
- Barcelona, ES
- Thessaloniki, GR
- Nanjing, CN



The on-road trials in brief

Purpose:

- To validate capacity of MODALES app and training to change driving behaviour
- Identify user groups in which MODALES had most of the impact
- Test user acceptance of the MODALES app and training
- Quantify the MODALES impact on reducing vehicle induced emissions from driving

Users:

- Private car drivers (20-30 per site, aim for balance between age, different levels of experience and driving routines). Euro 3, 4 and 5 cars preferred (Euro 6 accepted)
- Commercial drivers (van, truck, taxi, possibly bus)

Method:

- 1-2 month baseline, then training, then at least 2 months using the app
- Consent forms and anonymised data, including questionnaires
- MODALES App as data collection module
- OBD Dongles provided to users + MODALES app as data collection module

GET IN TOUCH

Andrew Winder — Project Manager

Jean-Charles Pandazis — Senior Manager

ERTICO – ITS Europe

	Andrew Winder	Jean-Charles Pandazis
Email:	a.winder@mail.ertico.com	jc.pandazis@mail.ertico.com
Mobile:	+32 477 032 782	+32 474 106 368

ertico.com
modales-project.eu

modales

Adapting driver behaviour for lower emissions

modales

Adapting driver behaviour
for lower emissions

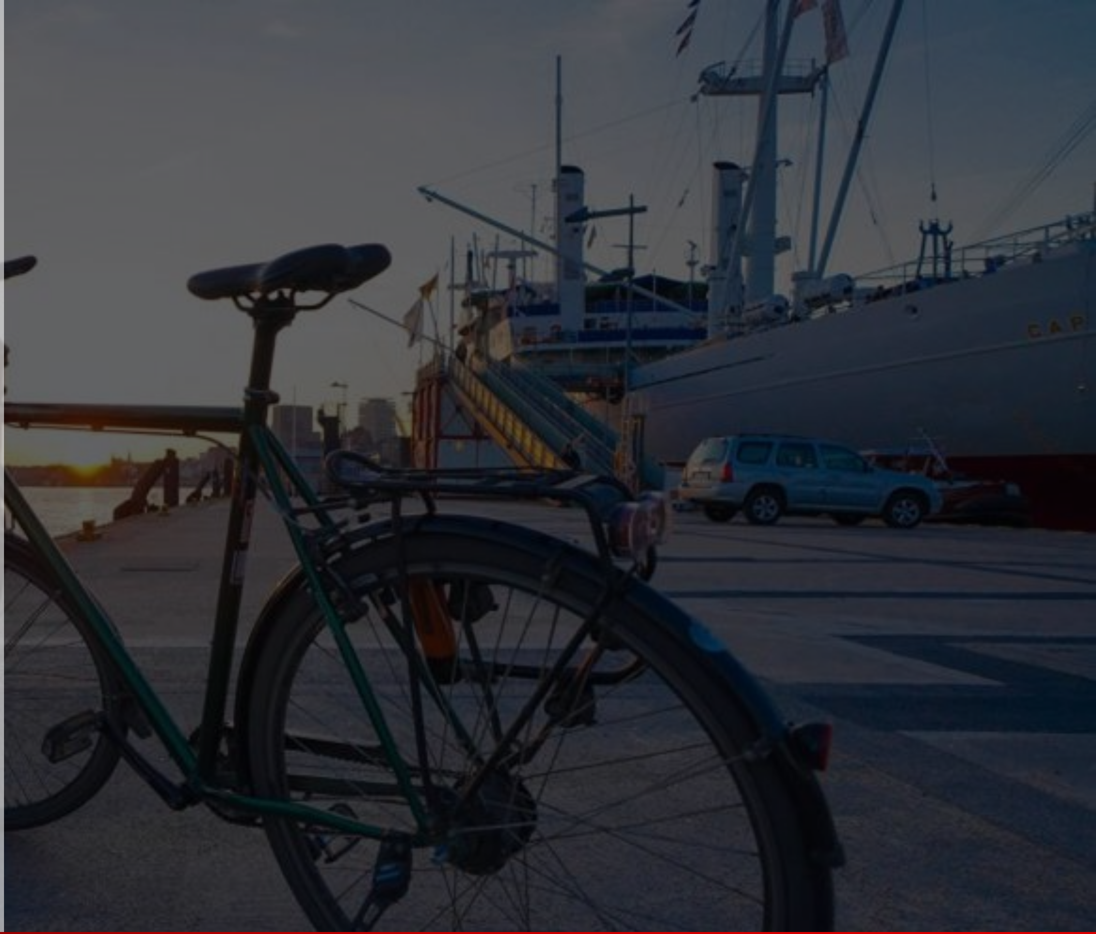
The MODALES approach for Emission reduction & clean mobility

Dr Haibo Chen, Institute for Transport Studies, University of Leeds
Group leader for Spatial Modelling and Dynamics,
Research theme leader for Connected and Shared Mobility

12th October 2021, Hamburg, Germany

Organised by ERTICO
Co - Organised by ITS AMERICA, ITS Asia-Pacific
Supported by Federal Ministry of Transport and Digital Infrastructure
Hosted by Hamburg
HAMBURG ITS World Congress 11 - 15 Oct 2021 Experience Future Mobility Now

CONTENTS

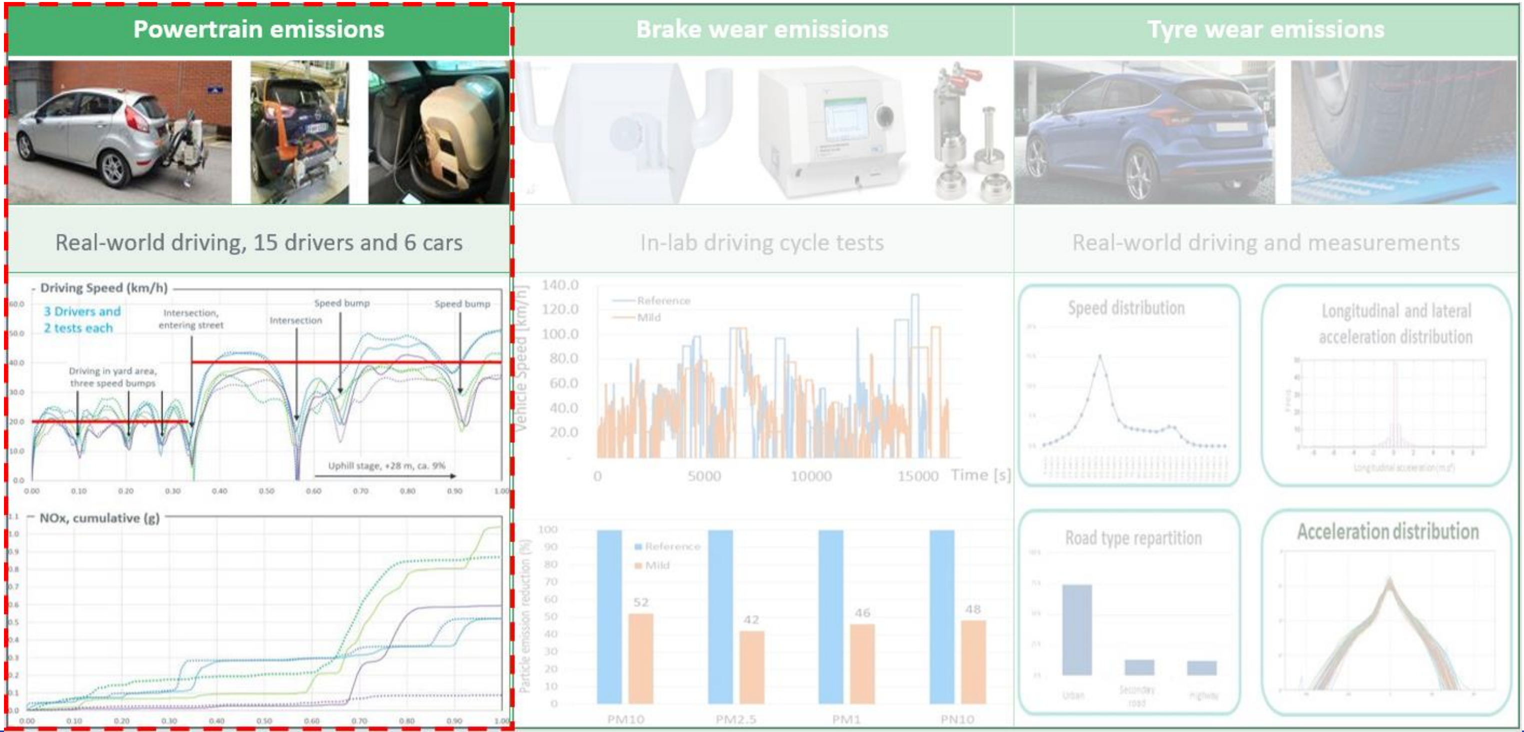


1

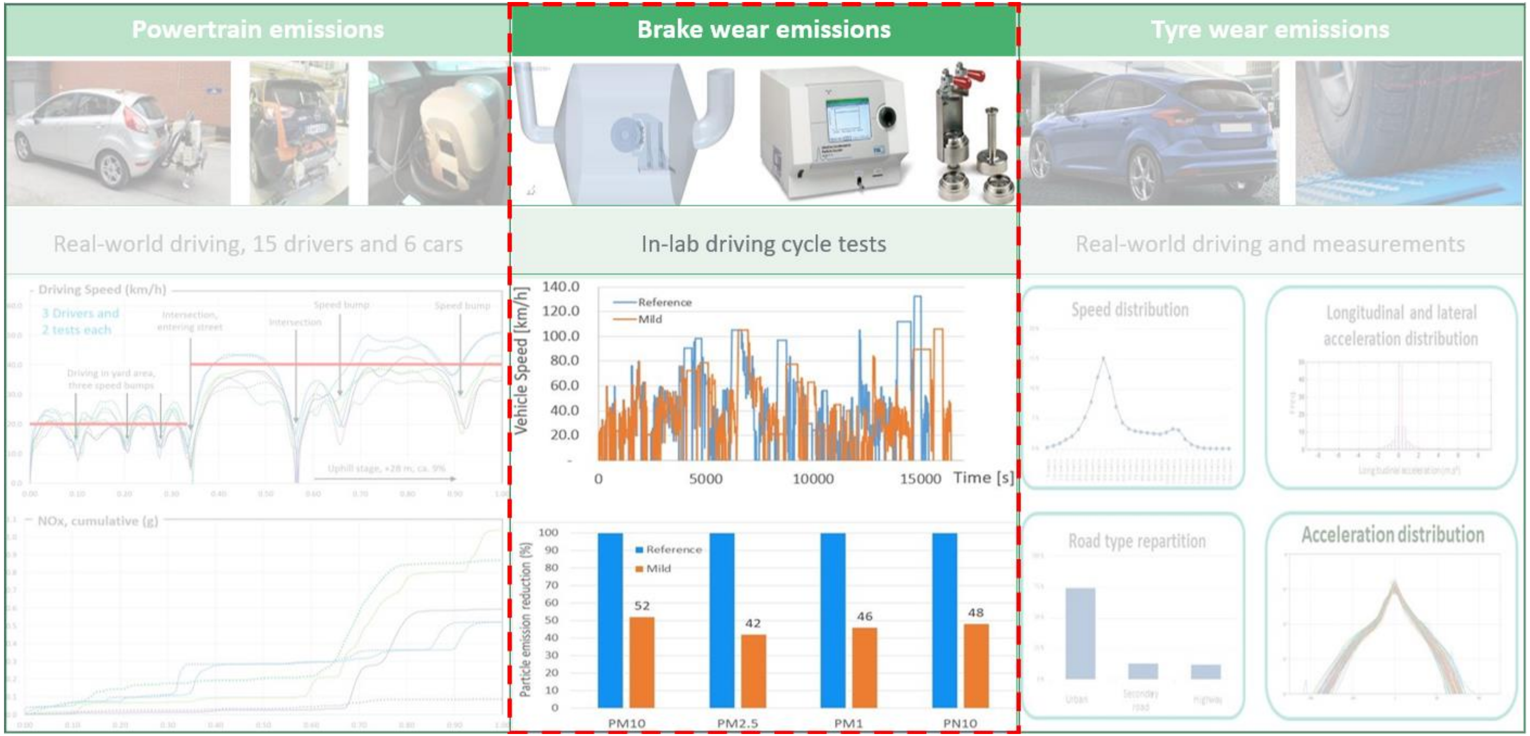
Emission Monitoring

Powertrain, brakes & tyres

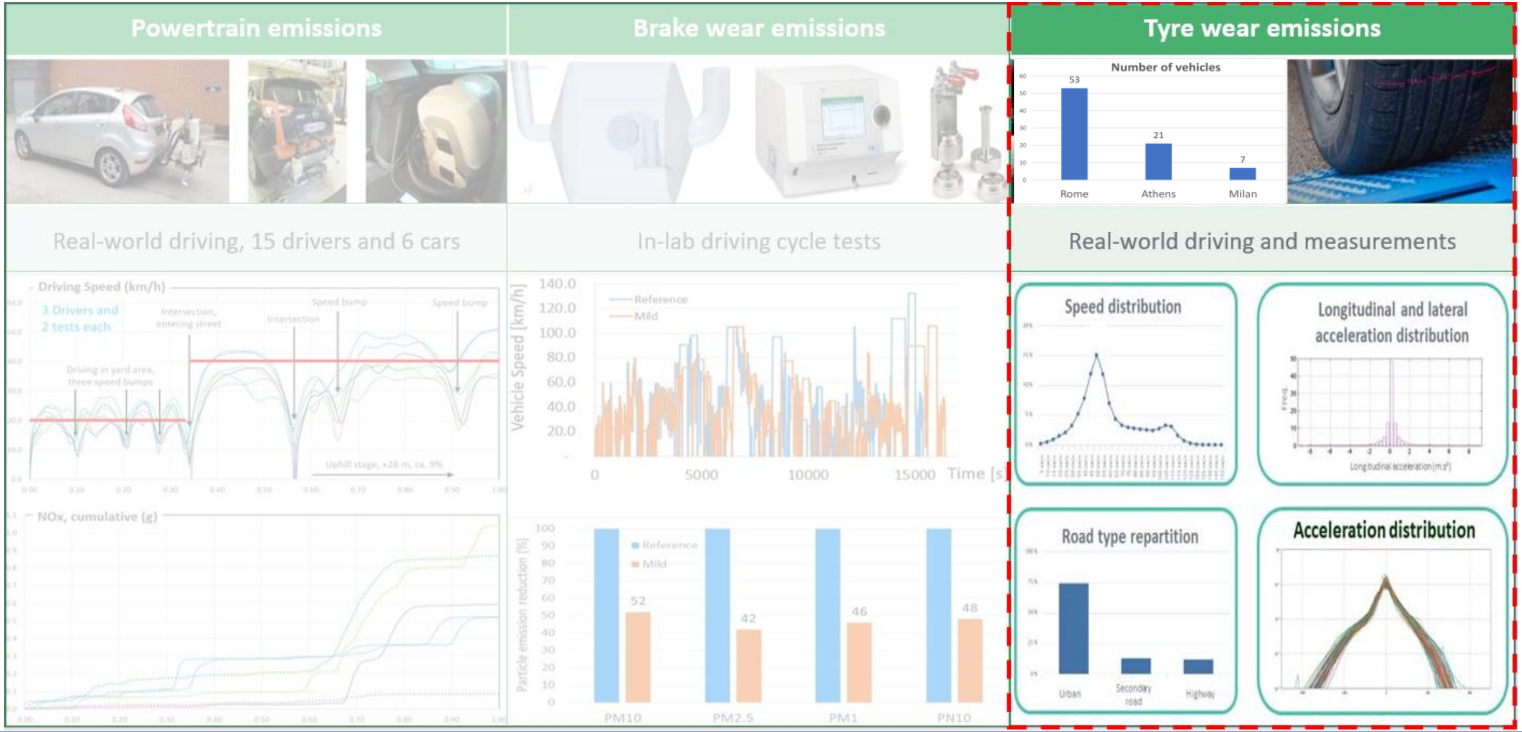
Monitoring: exhaust emissions



Monitoring: brake wear



Monitoring: tyre wear



2

Emission Modelling

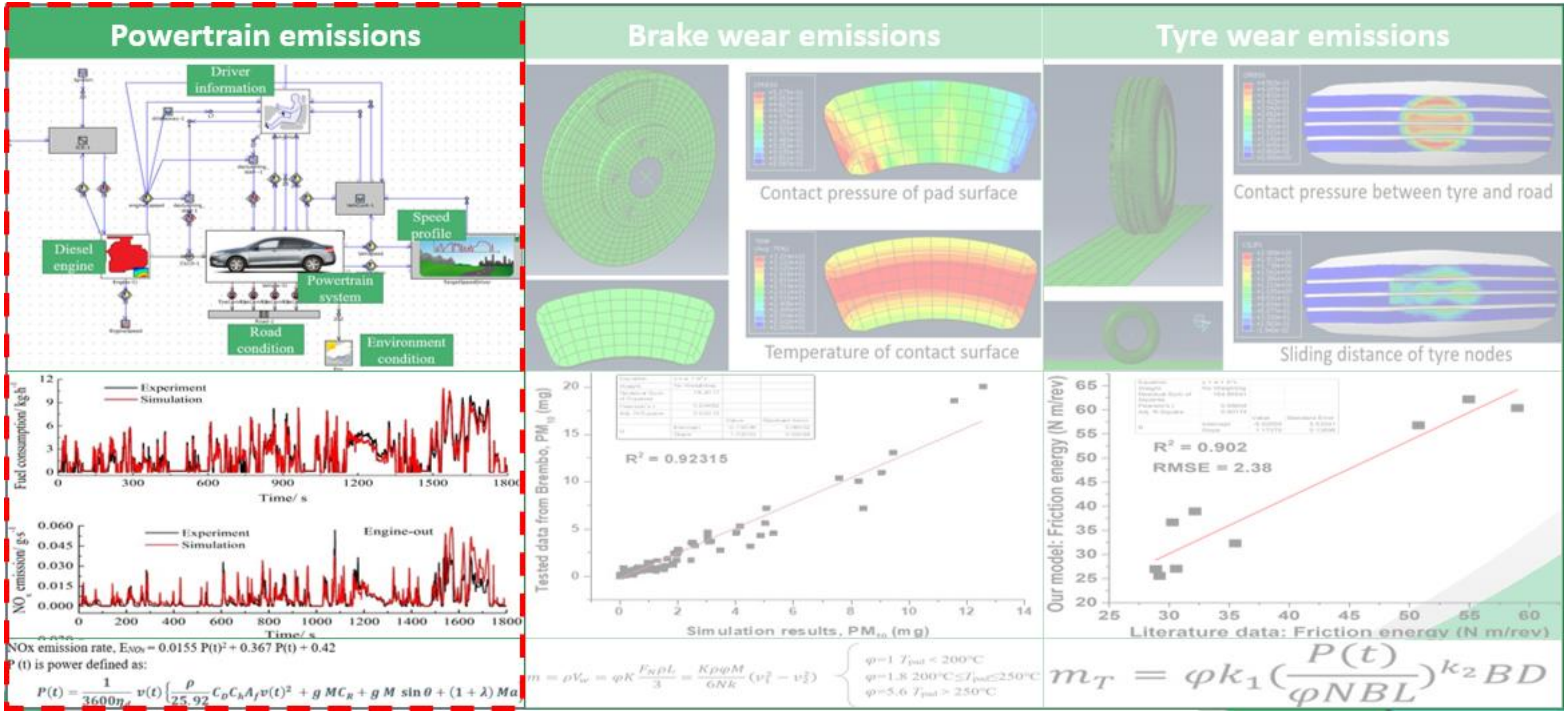
Powertrain, brakes & tyres

Modelling: exhaust emissions

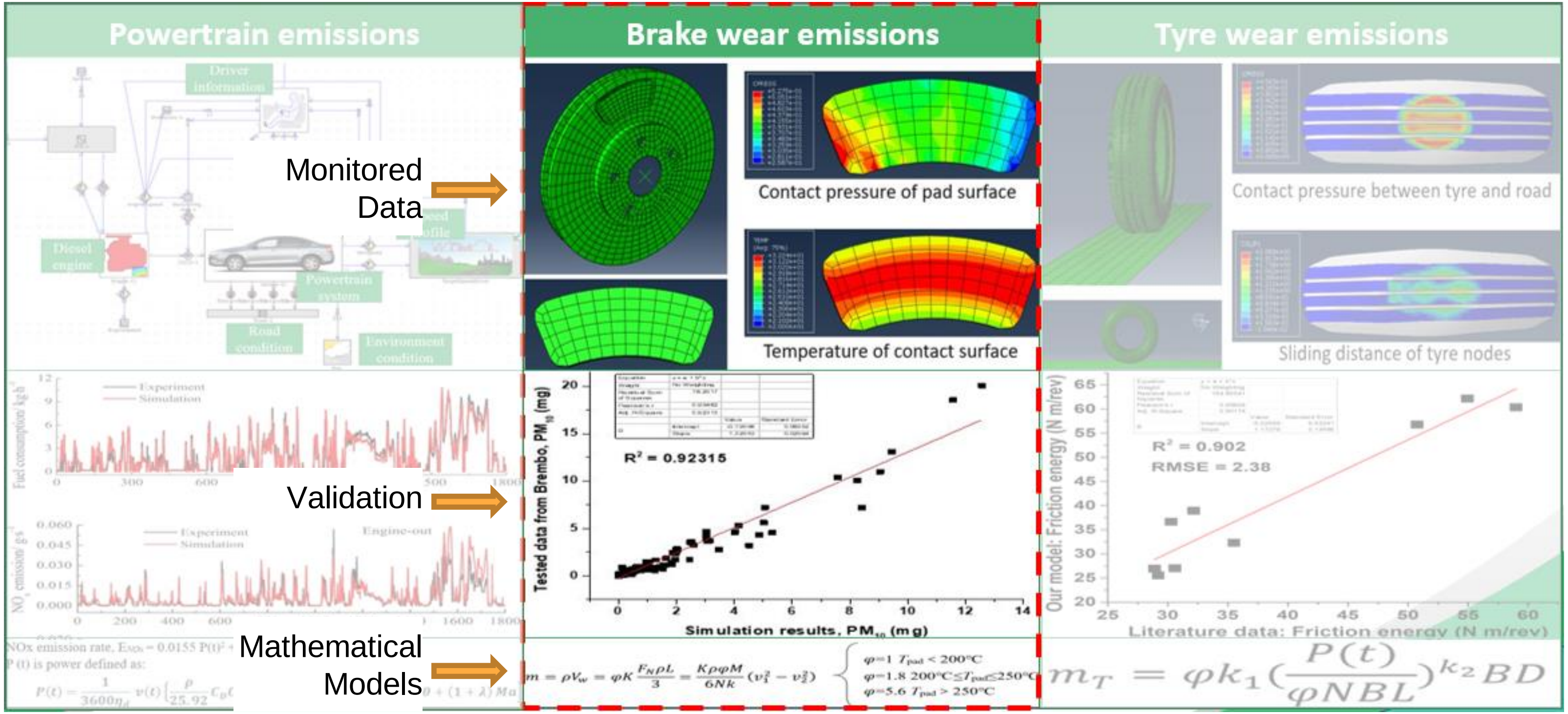
Monitored Data

Validation

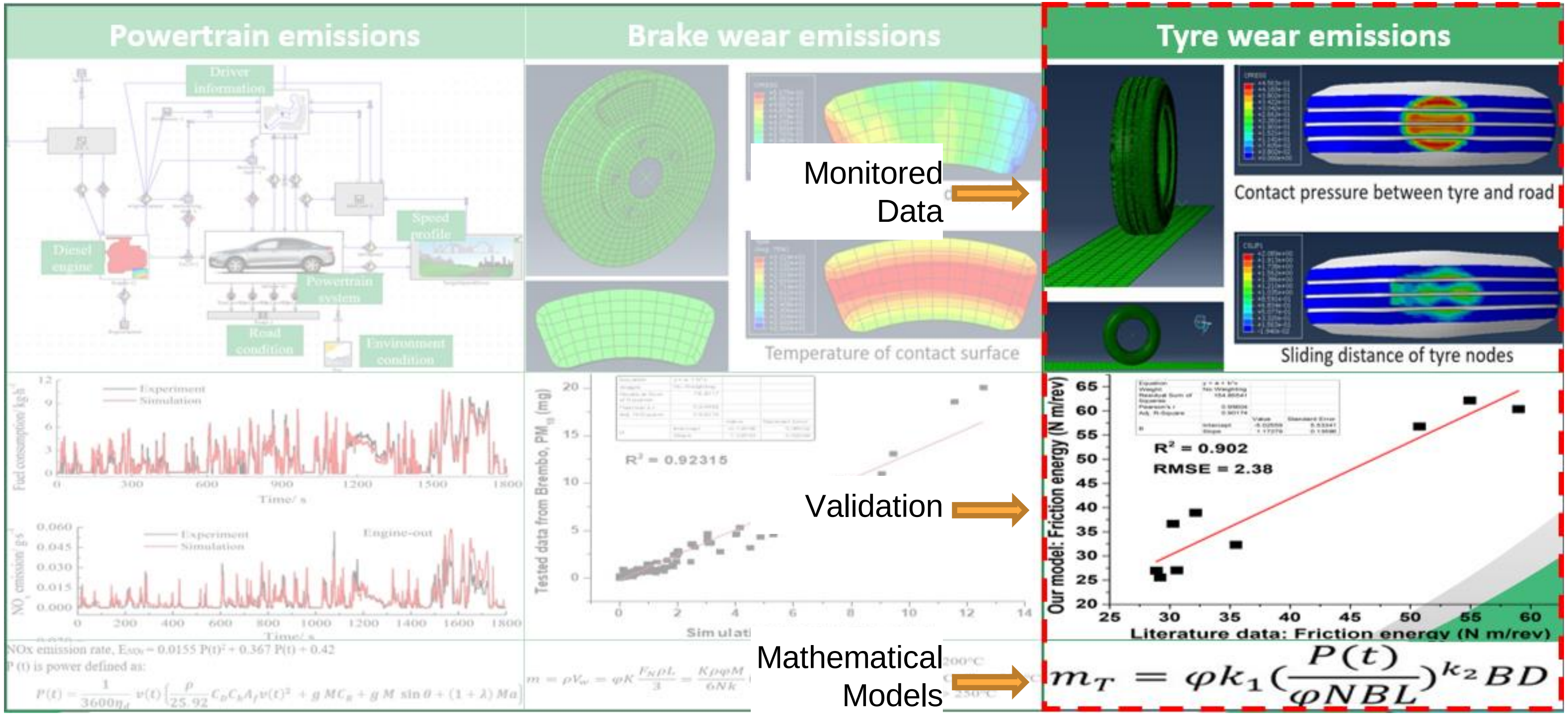
Mathematical Models



Modelling: brake wear



Modelling: tyre wear



Driving behaviour factors

Powertrain

Driving behaviour KPIs for exhaust emissions	Ranking (1: most important)
Aggressiveness (% of time in acceleration > 0.9 m/s2))	1
Average acceleration	2
% of time in speed interval of 20~50 km/h	3
Average speed	4
Average driving speed without stops	5
% of time in deceleration interval of -0.9~0 m/s^2	6
Average deceleration	7
% of time in acceleration	8
% of distance in acceleration	9
% of time in deceleration	10
% of distance in deceleration	11
% of distance in speed interval 50~70 km/h	12
Gear upshift speed	13
Gear downshift speed	14

Brakes

Driving behaviour KPIs for brake emissions	Unit	Ranking (1: most important)
Deceleration rate of braking	$m\ s^{-2}$	1
Average deceleration rate of braking	$m\ s^{-2}$	2
Braking distance	m	3
Braking time	s	4
Initial speed when braking	km/h	5
Average initial speed when braking	km/h	6

Tyres

Driving behaviour KPIs for tyre emissions	Wear amount (m^3/rev)	Wear mass (g/rev)	Ranking (1: most important)
Deceleration rate when right braking	5.43E-10	6.30E-04	1
Acceleration rate when right accelerating	4.13E-10	4.80E-04	2
Initial speed when right braking	3.14E-10	3.64E-04	3
Initial speed when right accelerating	2.82E-10	3.27E-04	4
Deceleration rate when straight braking	2.51E-10	2.91E-04	5
Acceleration rate when straight accelerating	1.78E-10	2.07E-04	6
Initial speed when straight braking	1.49E-10	1.73E-04	7
Initial speed when right cruising	1.27E-10	1.47E-04	8
Initial speed when straight accelerating	1.07E-10	1.24E-04	9
Driving speed when straight cruising	4.73E-11	5.49E-05	10
Deceleration rate when left braking	4.14E-11	4.80E-05	11
Acceleration rate when left accelerating	3.79E-11	4.40E-05	12
Initial speed when left braking	2.65E-11	3.07E-05	13
Driving speed when left cruising	2.59E-11	3.00E-05	14

3 Retrofits

Potential NOx retrofit technologies

Based on ammonia generation (1-3), heat loss prevention (4), exhaust temperature increase (5-6), NOx adsorber (7)

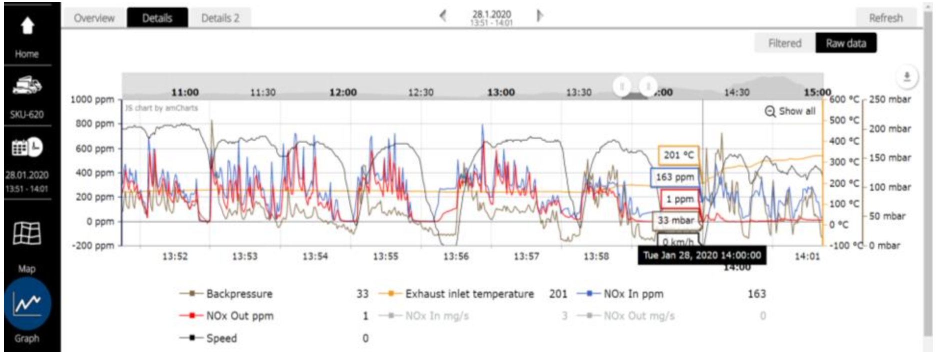
No	Technology	Efficiency	Response	Energy Penalty	Complexity/Affordability/Adaptability
1	**SCR*** (Selective Catalytic Reduction)	Medium	Medium	Low	Medium/Medium/Medium
2	**ACCT** (Ammonia Creation and Conversion Technology)	High	Fast	Medium/High	Complex/Low/Low
3	**ASDS** (Ammonia Storage and Delivery System)	High	Fast	Medium	Complex/Low/Low
4	**Thermal Insulation Technology** (Insulation materials covering SCR system)	Low	Slow	Low	Simple/High/High
5	**EHC** (Electrically Heated Catalyst)	High	Fast	High	Simple/High/High
6	**External burner**	High	Fast	High	Simple/High/High
7	**LNT** (Lean NOx Trap)	Low	Fast	Medium	Medium/Medium/Medium

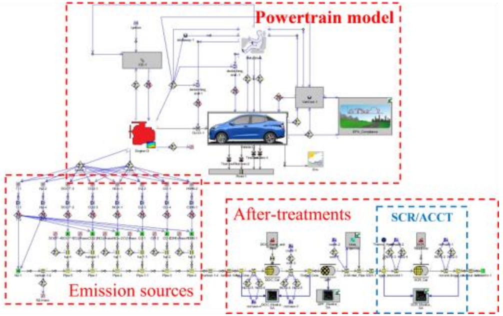
Retrofits for NOx

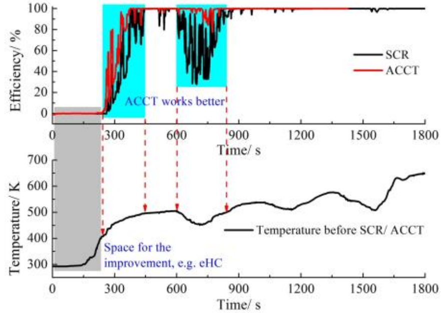
"Real-world test" *vs* "Modelling & Simulation"

LDV

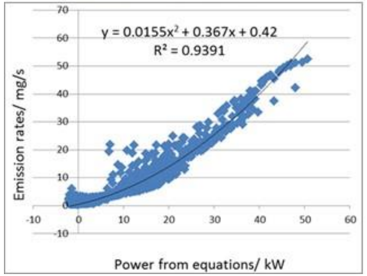
HDV



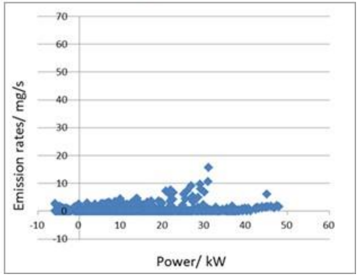




Engine-out NOx



Pipe-out NOx



4 Conclusions

Conclusions

- *Correlation* of driving behaviour variability with emissions from powertrain, brakes and tyres can be *quantified with high accuracy*.
- *Inspection* and *auto-tampering measures* as well as *maintenance* are important but difficult to quantify.
- NOx *after-treatment* systems or retrofits are *highly effective* when exhaust temperature is high.

GET IN TOUCH

Dr Haibo Chen (Speaker)
University of Leeds
Email: h.chen@its.leeds.ac.uk

Mr Andrew Winder (MODALES Coordinator)
ERTICO - ITS Europe
Email: a.winder@mail.ertico.com

modales

Adapting driver behaviour for lower emissions