#H2020RTR21

MODALES
Modify Drivers' behaviour to Adapt for Lower Emissions

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ERTICO – ITS Europe

modales

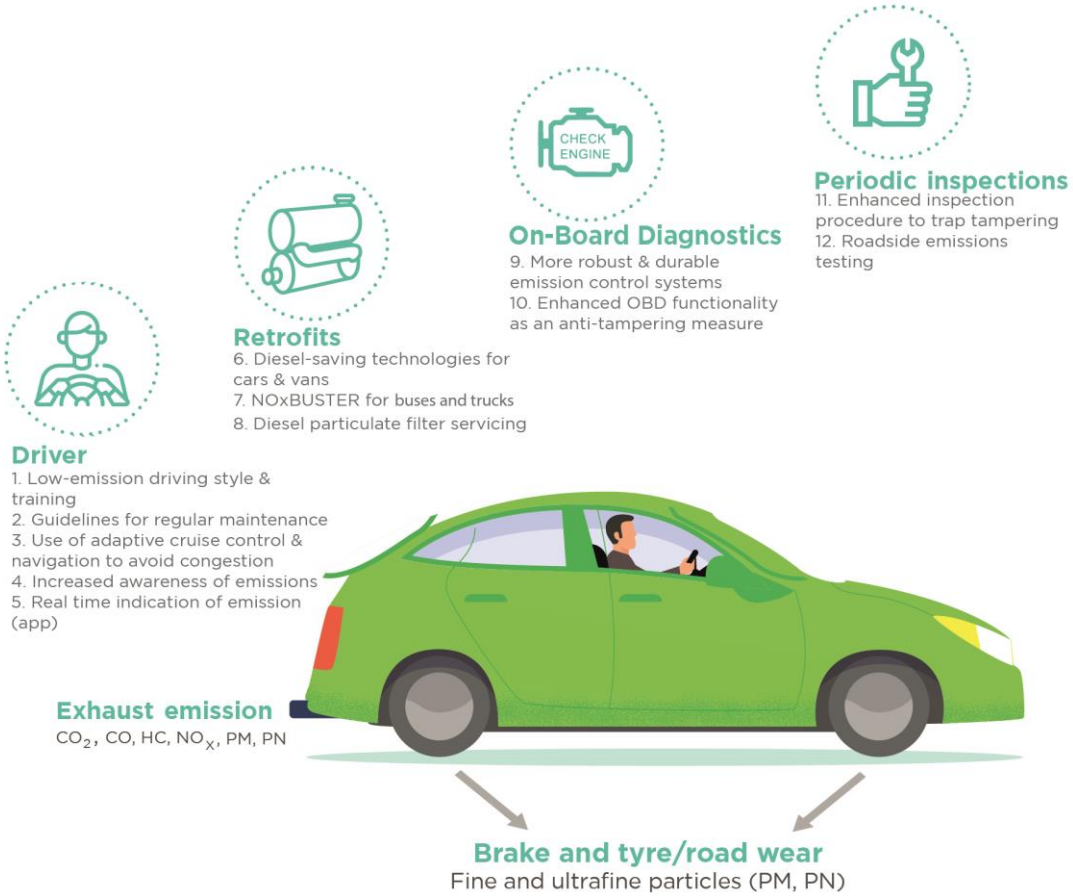
Adapting driver behaviour for lower emissions

2ZERO CCAM ERTRAC European Commission

Introduction: the MODALES 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 advances the understanding of the co-variability between user behaviour and vehicle emissions from powertrain, brakes and tyres, in order to modify user behaviour, via training and awareness



Project data overview

modales
Adapting driver behaviour for lower emissions

Dates: 1 Sep 2019 to 31 Aug 2022 (expected extension to 28 Feb 2023)
EC H2020 Call: MG-1.1: "Reduction of transport impact on air quality" (INCO Flagship)
Budget: € 4.72 million
Consortium: 16 EU-funded partners (coordinated by ERTICO) + 2 International partners in China

- Associations
- Universities
- Research institutes
- Industry and technology
- Legal experts

MODALES receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815189.

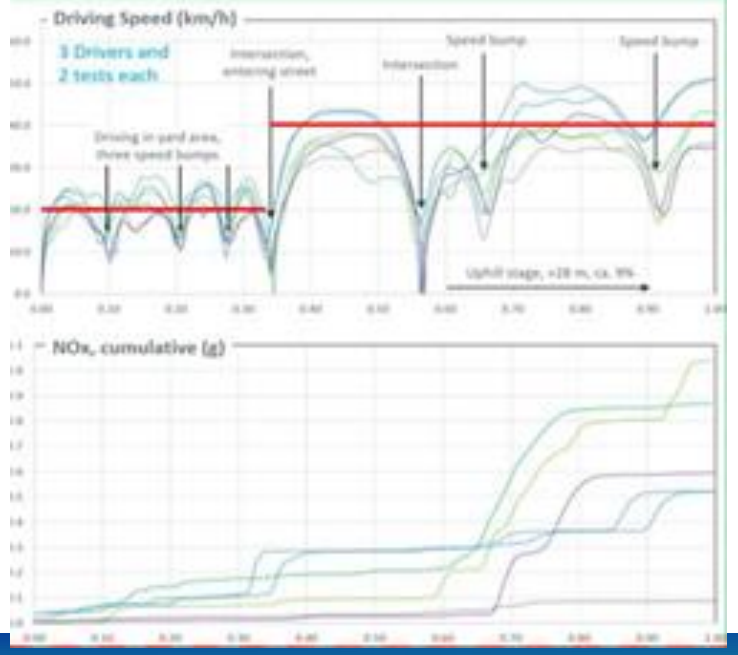
Objectives of MODALES

Key objectives	Targets
Understand the **nature of driving behaviour** with respect to vehicle emissions	Variables for driver behaviour and their variability (e.g. speed, road condition, etc.) validated with data
Correlate **driving behaviour variability** with real **powertrain, brake and tyre emissions**	Mathematical equations defining powertrain, brake and tyre emissions as a function of driving behaviour
Propose and validate a real-time driver assistance **smartphone app** for low emission driving	App available for demonstration and testing, to be opened for further exploitation post-project
Promote low-emission oriented driving via **training courses and an awareness campaign**	Courses set up for various user groups, and feedback used to assess user acceptance and awareness
Assess the real effectiveness of **on-board diagnostics (OBD)** and **technical inspections** and investigate the legal situation of **tampering** in Europe	Analysis for OBD and inspections to detect high emissions due to different causes; Study report on legal aspects of vehicle tampering
Assessment of the potential impact of diesel **retrofits**	Diesel retrofit to a van and emissions tests. Monitoring and data analysis for retrofitted HDVs and review of technologies/performance for car retrofits

Activities and results (1)
Emission monitoring (Powertrain, brakes, tyres)

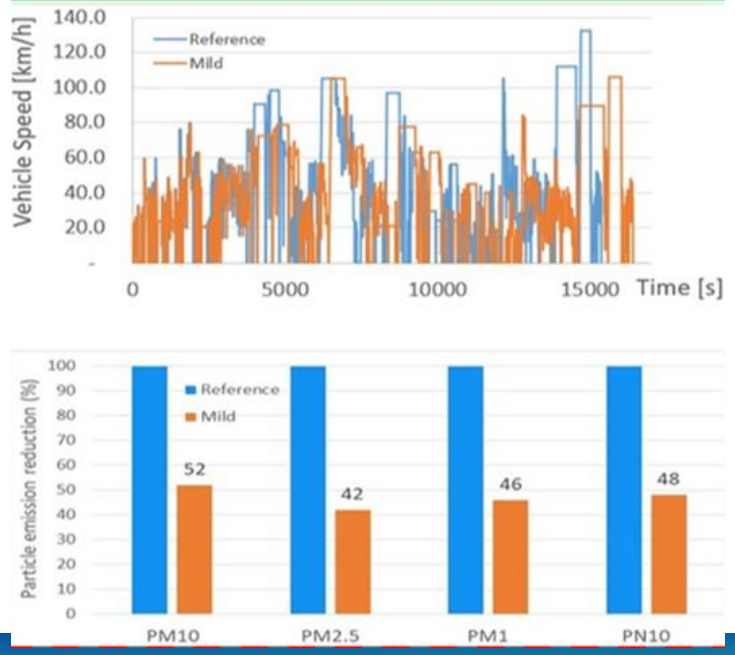
Powertrain (exhaust) emissions

Real-world driving, 15 drivers and 6 cars



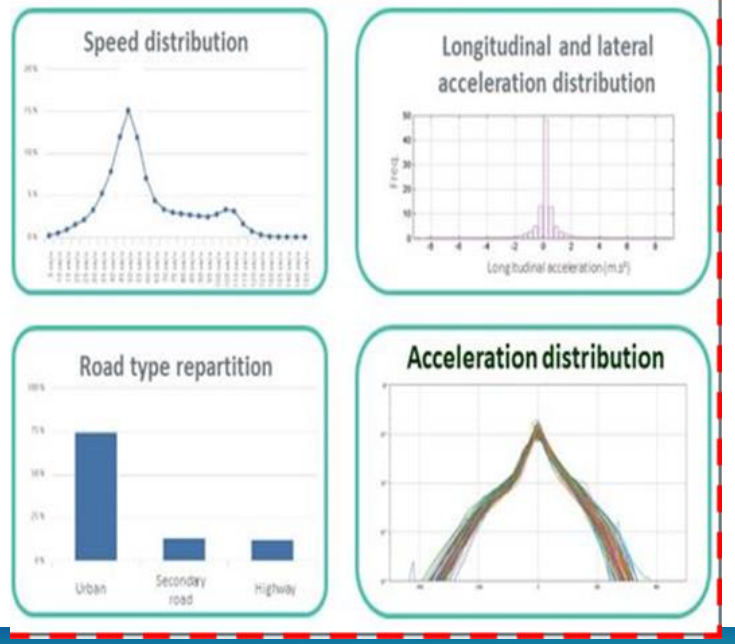
Brake wear emissions

In-lab driving cycle tests



Tyre wear emissions

Real-world driving and measurements



Activities and results (2)
Driving behaviour factors

Powertrain

Driving behaviour KPIs for exhaust emissions	Ranking (1: most important)
Aggressiveness (% of time in acceleration > 0.9 m/s$^{2)}$	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

Activities and results (3)
Retrofits for diesel vehicles

Potential NOx retrofit technologies

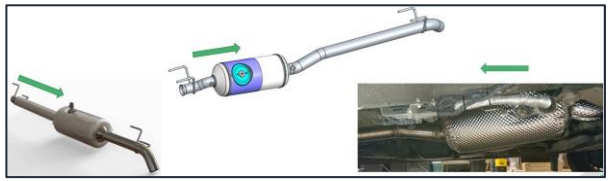
- Based on ammonia generation (1-3), heat loss prevention (4), exhaust temperature increase (5-6), NOx adsorber (7)

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

Real-world retrofit tests

HDV (Proventia NOxBUSTER)

LDV (experimental fitment of NOxBUSTER to Mercedes van)

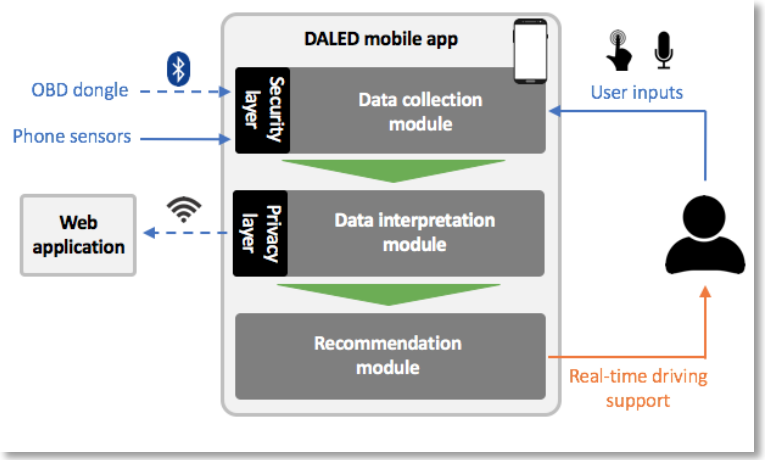


Activities and results (4)
Low-emission driving app

Currently published on Published on Google Play and Apple App Store (both for private access only so far)

The app will create two types of recommendations:

- Active recommendations (when the user is driving):
  - Research prototype: simplified recommendations & HMI, using only the phone sensors
- Passive recommendations (after a trip):
  - Complete report, using phone sensors, OBD data & external web services



OBD dongle

Activities and results (5)
Training, awareness and ongoing trials

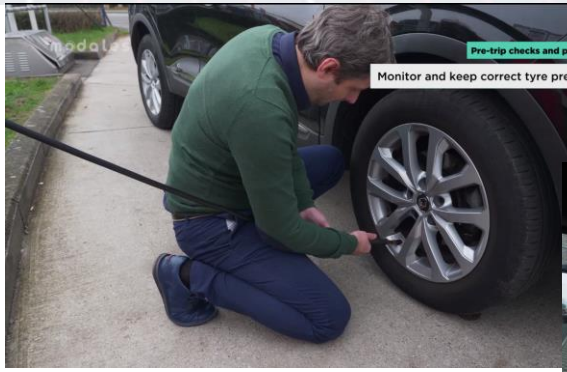
Training videos recently developed by MODALES to cover:

- Pre-trip checks and planning
- Driving
- Maintenance

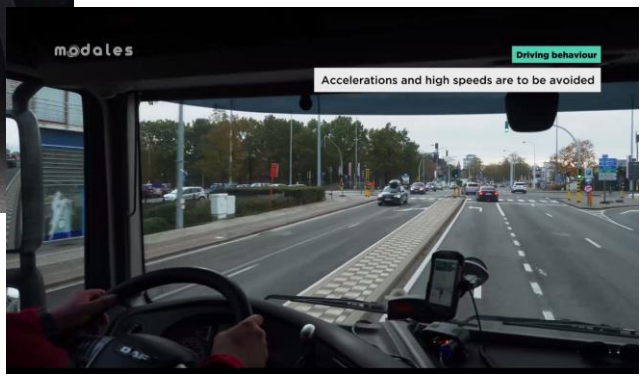
These will be trialled on volunteers in in April 2022

Supported by a multilingual **awareness campaign** supported by automobile clubs on social media

See https://modales-project.eu/campaign



MODALES training video



Trial sites

App and training to be tested with ~200 volunteer drivers in 8 countries

- Baseline drives have started

Mid to long term expected impact of the project (1)

Contribute to reduction of emissions from the existing combustion-engined car fleet:

- Average 20-35% reduction in pollutant emissions expected (might differ depending on the types of emission: NOx, PM, CO and engine characteristics) for tampered/poorly maintained vehicles.
- Retrofitted vehicles reaching Euro VI standards will have a reduction of >60% in PMs & NOx.
- Target of a 20% reduction in non-engine PMs.

Contribute to reduction of unnecessary driver-induced emissions though a better awareness by the public of their role in controlling polluting emissions

- 5-10% reduction of emissions (depending on vehicle type and Euro technology) by applying the MODALES low emission driving guidelines.

Provide technical evidence to assess gaps in current regulation of vehicles

- The adeptness of current EOBD and technical inspection procedures to detect elevated emissions levels are improved by 30%.

Mid to long term expected impact of the project (2)
Next steps to evaluating the potential impact

- Finalisation of the recommendations module of the MODALES app
- Validation of the capacity of MODALES app and training to change driving behaviour and testing user acceptance
  - trials in 8 countries with approx. 200 drivers
- Identification of user groups in which MODALES had most of the impact
  - age, gender, driving experience, types of roads used, type and age of vehicle
- Quantify the effects of reducing vehicle induced emissions by the MODALES app and training
  - Trial data evaluation, scaling-up and impact assessment
- Quantify potential reductions in emissions through OBD optimisation, retrofits, enhanced periodic inspections and legal measures

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Thank you

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