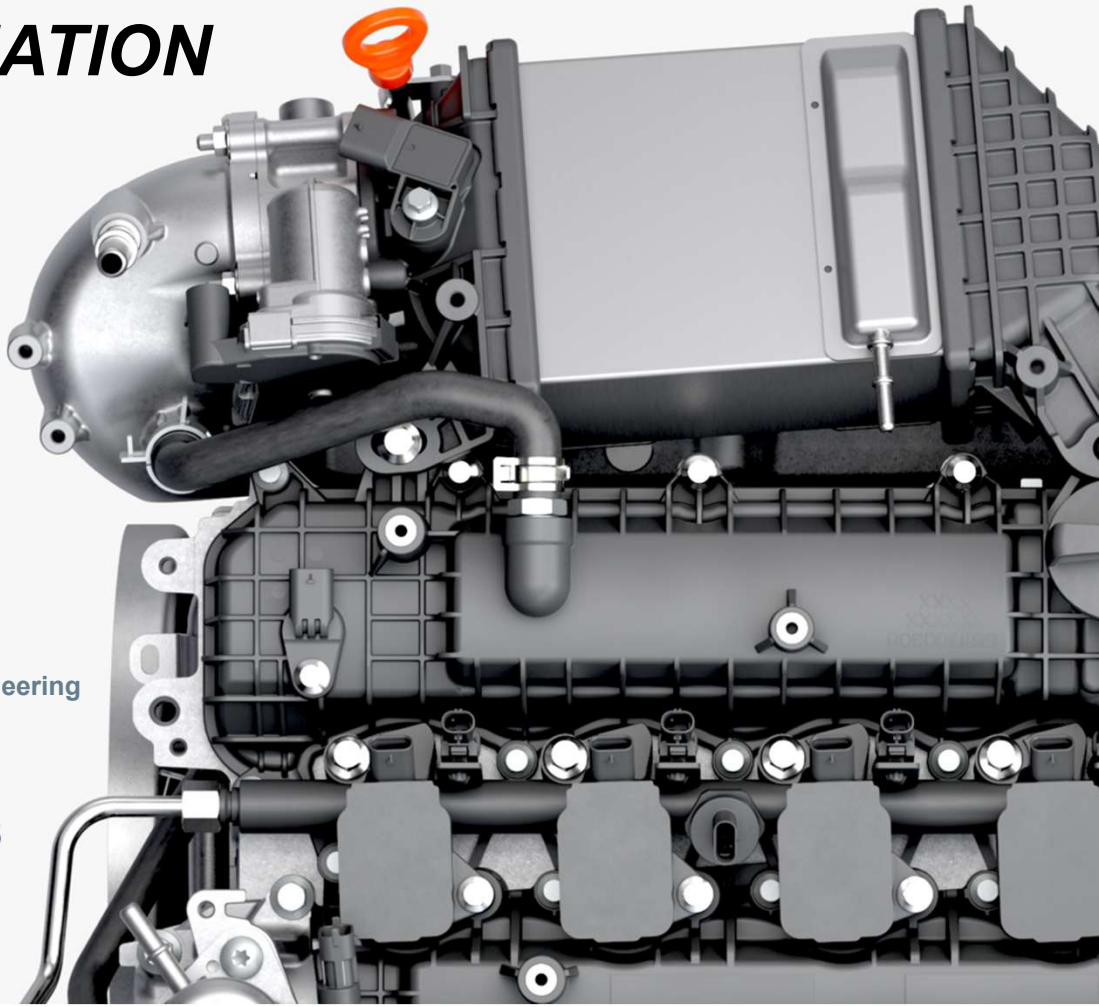
ULTRA LOW EMISSIONS ENGINE

OPTIMIZING DECARBONIZATION AND AIR QUALITY

OLTEANU Marius

Powertrain Innovation Project Manager



The 36th SIAR International Congress of Automotive and Transport Engineering
MOBILITY ENGINEERING AND SUSTAINABILITY

HORSE aramco CAR 2026

Thursday, November 5th, 2026

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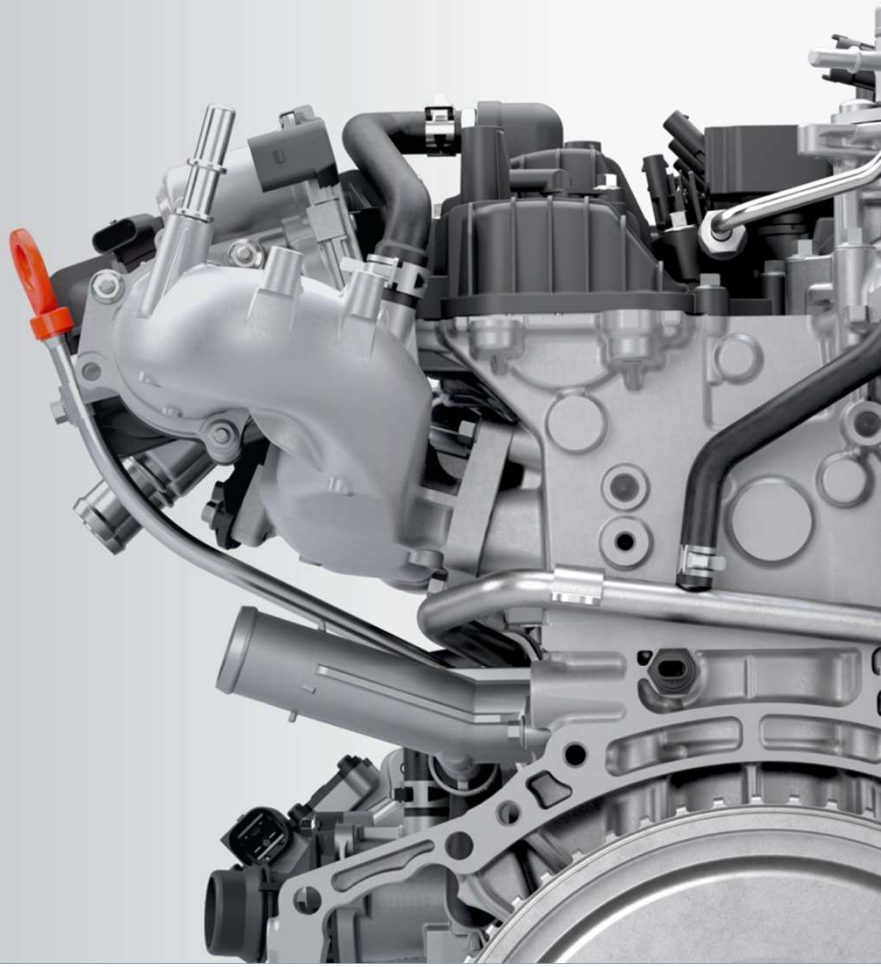
LCA & FUELS

EXPERIMENTAL VALIDATION

AIR QUALITY IMPACT ASSESSMENT

STRATEGIC CONCLUSIONS

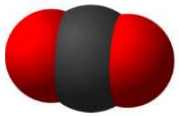


Transport sector emission challenges

Global impact

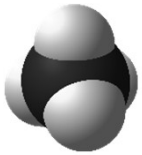
Green House Gases

CO_2



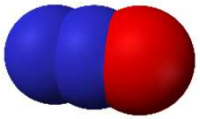
- GHGs contribute to Global Warming Potential

- Mainly from anthropogenic activities: fossil energy, deforestation, and agriculture



CH_4

- Low-carbon fuels to reduce transport sector contribution

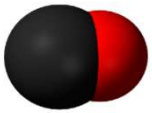


N_2O

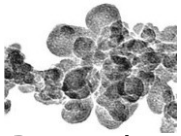
Local impact

Air pollution

CO



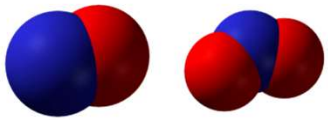
- Gaseous and particulates emissions are impacting local Air Quality



Particulates



- Both biogenic and anthropogenic sources: agricultural, transport sector, industries …

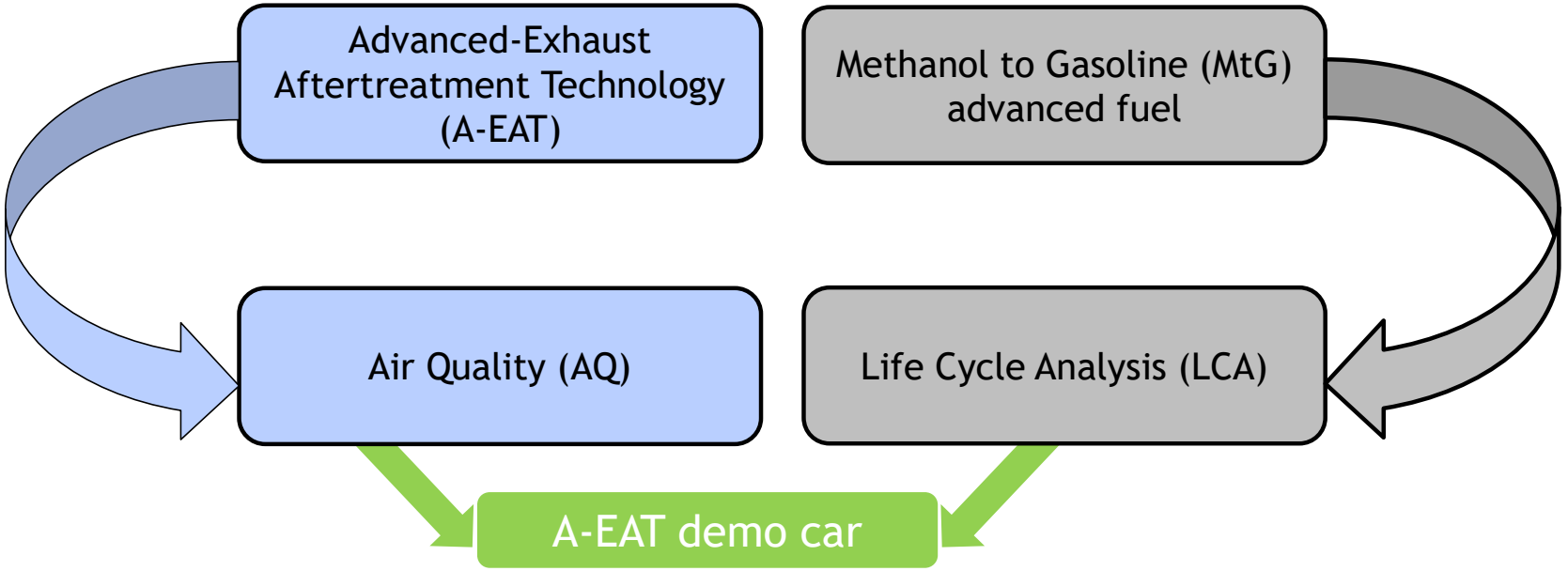


NO_X

- Innovative after-treatment technologies to reduce tailpipe emissions

Public

Integrated development of advanced vehicle technologies







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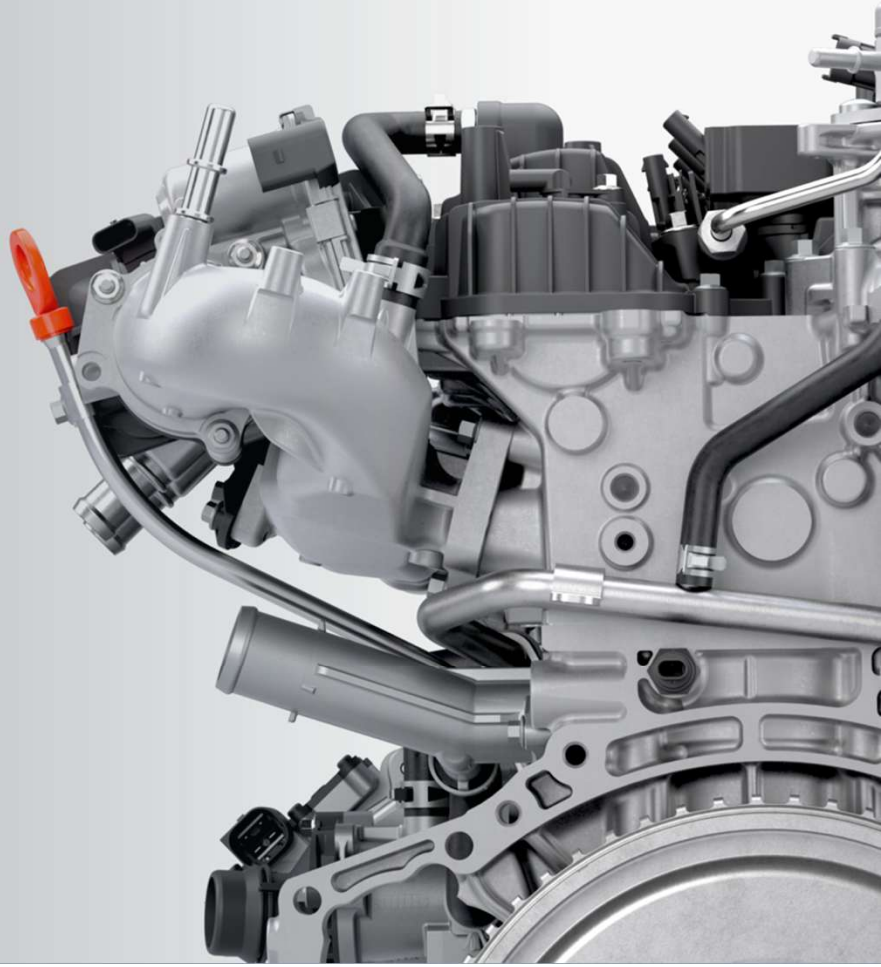


LCA motivation & setup

Evaluate both global and local impacts of different powertrains and energy production pathways

General methodology

- Software: Sphera LCA For Experts
- Foreground data: published/industry sources + BatPaC for battery manufacturing
- Background data: Sphera LCA For Experts database
- Well-to-Wheel (WtW) approach for fuels, following JEC v5
- Cradle-to-Grave (CtG) approach for vehicles



Impact categories

- Primary focus on climate change, using IPCC AR5 characterization factors over a 100-year horizon

Vehicle powertrains

- Battery Electric Vehicle (BEV)
- Fuel Cell Electric Vehicle (FCEV)
- Internal Combustion Engine (ICE)
- Hydrogen ICE (H_2-ICE)

Energy production pathways

- Conventional/fossil route: conventional gasoline, grey H_2 for FCEV and 788 gCO_2-eq/kWh for electricity
- Renewable/low-carbon route: e-gasoline with CO_2 capture, green H_2 for FCEV and 13.6 gCO_2-eq/kWh for electricity

Public

Low-carbon gasoline focus

Two reference fuels for calibration and validation test campaigns

- **Certification**
- **High-particulate:** designed to generate higher particulate emissions than standard market fuels

Development of a MtG mock-up advanced fuel for test campaigns

- E10 equivalent and EN228 compliant
- Lower aromatics content

Property	Unit	Certification	High-particulate	MtG
RON	-	97.2	97.3	96.9
MON	-	86.2	86.9	88.1
Density at 15°C	kg/m3	0.747	0.746	0.726
DVPE at 37.8°C	kPa	58.5	63.7	58.2
E70	%/v/v	38.4	35.9	40.9
E100	%v/v	56.3	47.8	73.4
E130	%v/v	88.7	76.5	84.3
E150	%v/v	92.2	85	88.7
E170	%v/v	95.7	93.7	95.9
LHV	MJ/kg	41.41	41.57	41.87
Total aromatics	%v/v	26.8	26.3	17.9
Total olefins	%v/v	6.6	6.2	7
Ethanol	%v/v	9.2	9.1	0.3
ETBE	%v/v	0	0	19.2
sPMI v1	-	0.86	1.38	0.99

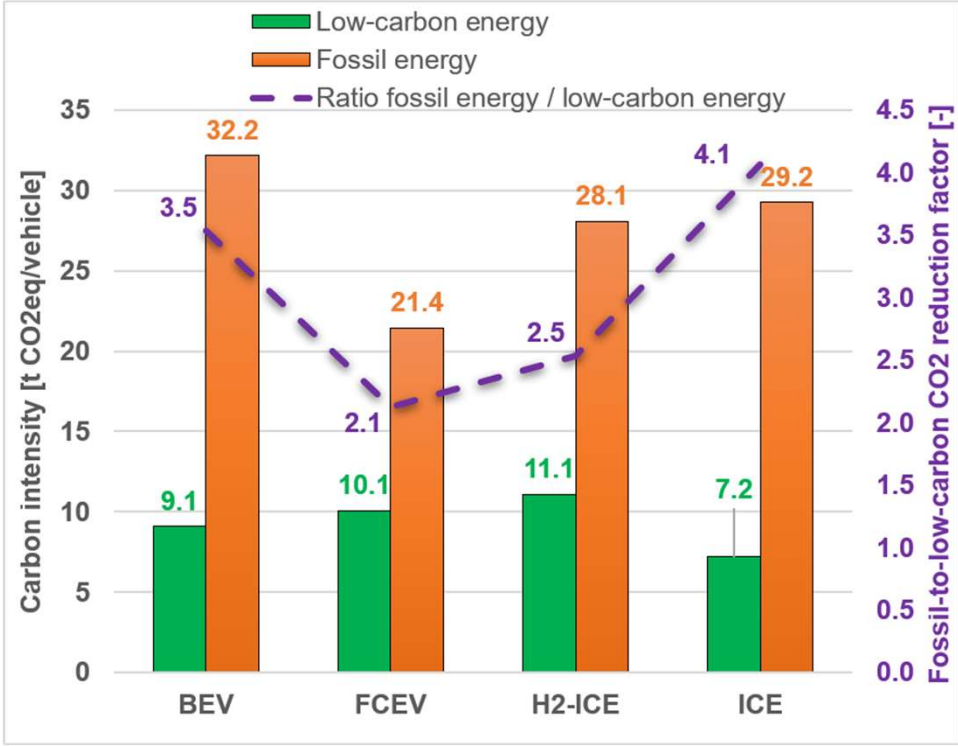
Development of a MtG mock-up advanced fuel to reduce global impact

LCA Results

Homogeneity of the carbon intensity among powertrains within the same energy category

H_2-ICE powertrain displays the highest carbon intensity using low-carbon energy due to low electrolysis and engine efficiencies, and logistics

On average, carbon intensity is three times lower using low-carbon energy than with fossil energy



Carbon intensity is more sensitive to energy source than powertrain technology

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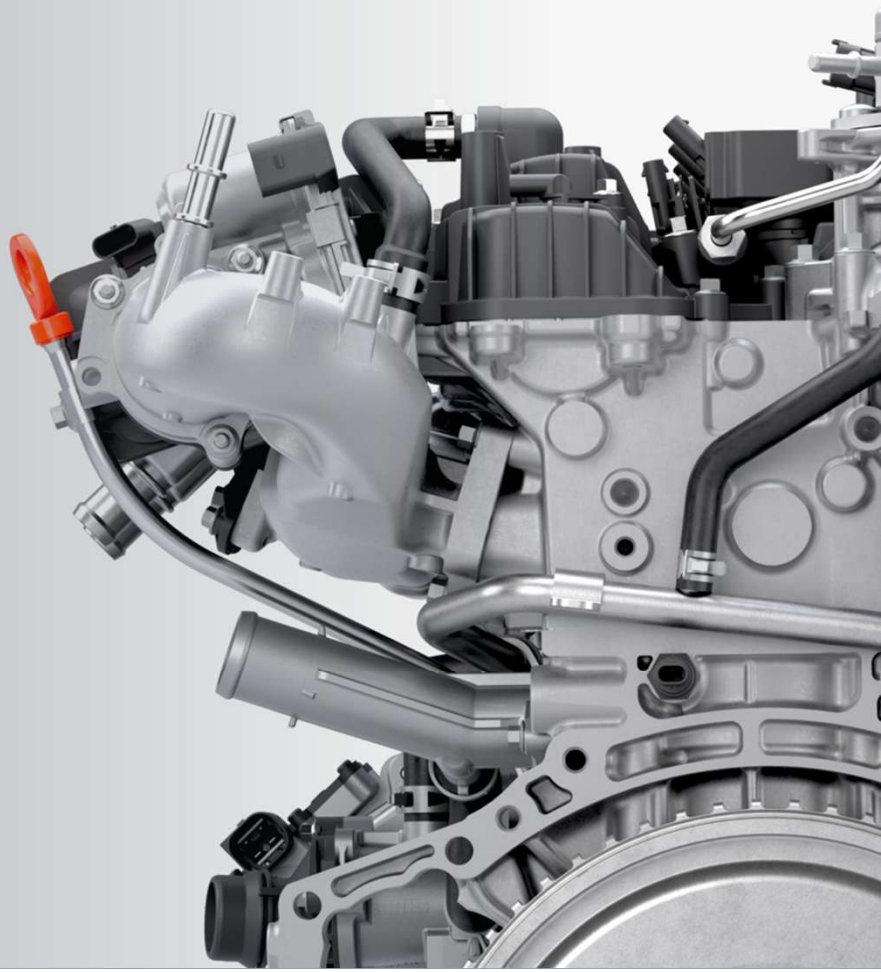
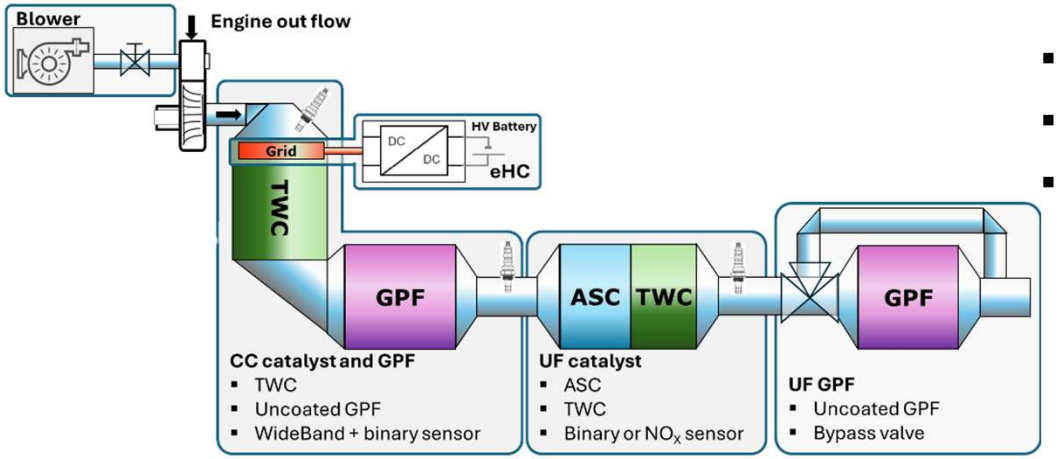


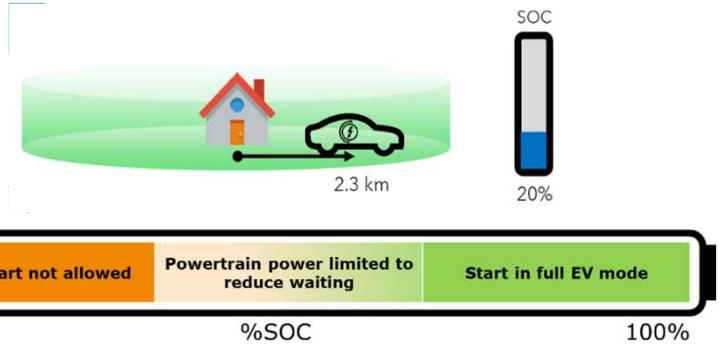
Hardware & software vehicle setup







- Vehicle : Renault Austral E-Tech
- Powertrain : 1.2L TGDI engine Euro 6 Full hybrid
- ATS modifications
  - Blower + 3 kW electrical Heated Catalyst (eHC)
  - Upgraded Close Coupled (CC) TWC + GPF
  - Under Floor (UF) catalysts : Ammonia Slip Catalyst (ASC) + TWC
  - Patented double GPF (dGPF) with bypass



- Battery State Of Charge (SOC) optimization = charge zone
  - GPS based strategy to load battery before reaching destination
- Pre-heating starting with vehicle key detection
- Priority for low emissions strategies in powertrain management
- Cold start instantaneous limitation of the ICE pollutant exhaust flow to match the first TWC treatment capacity

Dedicated ATS architecture & control strategies for lowering emissions

Advanced **E**xhaust
Aftertreatment **T**echnology

Test matrix and conditions

Cycle	Temperature (°C)	Fuel
CBR	-10	High particulate
RDE95	0	High particulate
WLTC	14	Certification
Beaune	35	High particulate

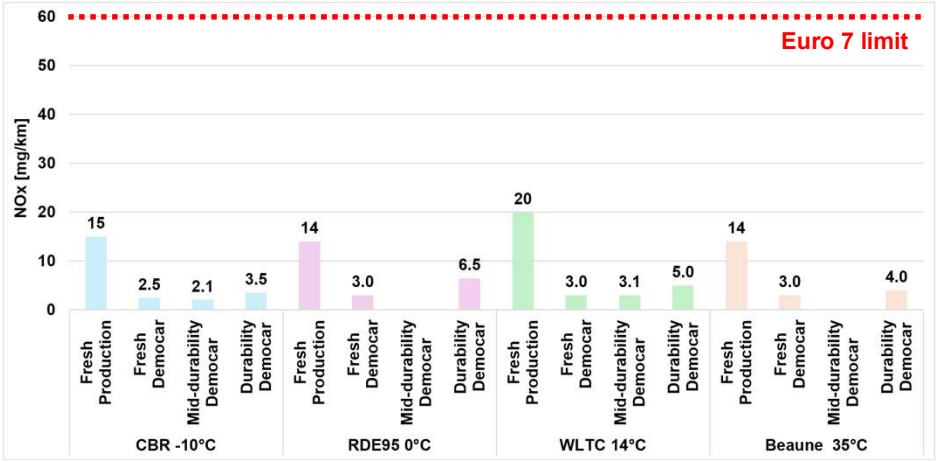
	Validation test matrix	Extended test matrix	Road testing
Cycles	WLTC, CBR, RDE95, Beaune	WLTC, RTS95, TfL, Artemis urban, Artemis road, N184-Poissy, FTP75	RDE
ATS ageing	Fresh and durability	Fresh, mid and durability	Durability
Ambient temperature	-10, 0, 14 & 35°C	-10, 0 & 23°C	~ 10-20°C
Initial SOC	Min	Min & max	-
Road load	Mid, high	Low, mid & high	-
Fuel	Certification and high particulate	MtG advanced fuel	MtG advanced fuel
Status	Finalized and presented	Tests performed and on-going analysis	Q4 2026

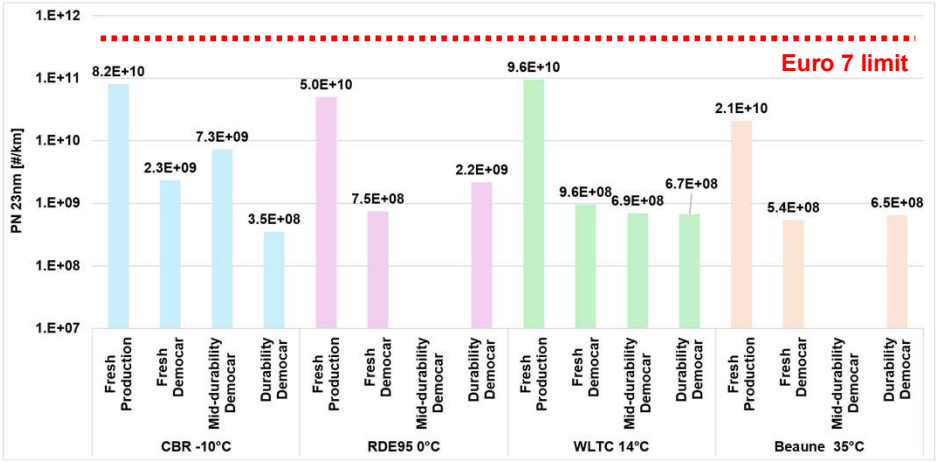
Vehicle tested in standard and severe conditions

Validation test matrix results

Emissions results over all cycles (CBR -10°C, RDE95 0°C, WLTC 14 °C, Beaune 35 °C)

Pollutant	Emission [mg/km]	Reduction NAQIV fresh / production fresh ATS	Reduction Euro 7 to NAQIV (fresh / durability ATS)
NO_X	3.6	82%	20 / 10
CO	62	92%	25 / 10
HC	3.7	94%	60 / 20
NH_3	1.1	95%	-
N_2O	0	-	-
PN_{23}	1.60E+09	98%	525 / 350





From 82 to 98% reduction compared to the serial vehicle

From 10 to 525 times lower emissions compared to Euro 7

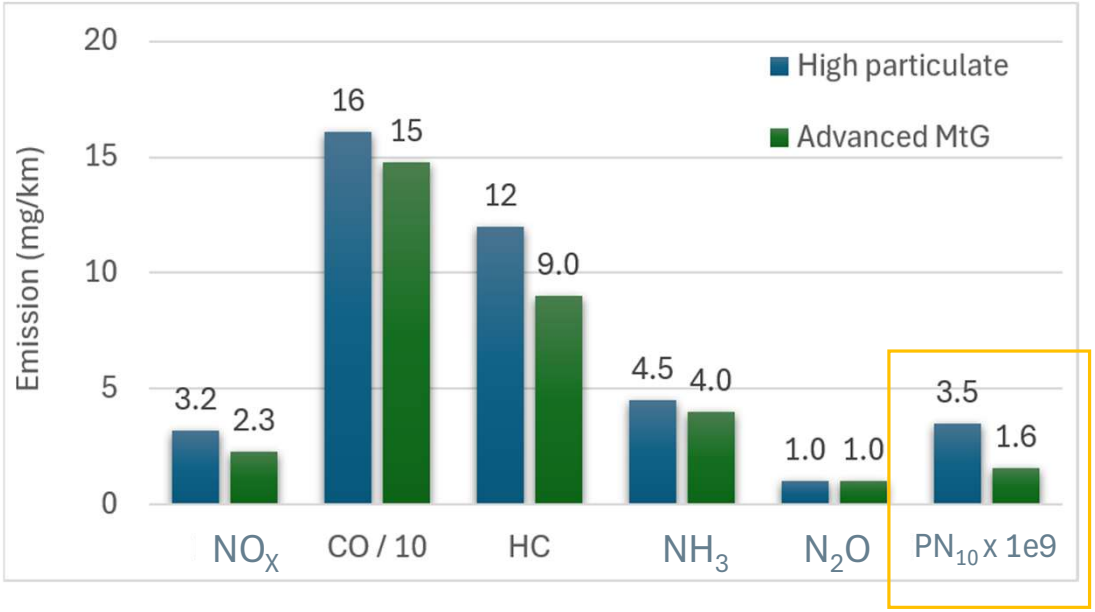
On average, more than 90% lower emissions than the production vehicle, with emission levels at least 10 times below Euro 7 limit

Advanced MtG fuel emission validation

Validation by comparison with the high particulate fuel

Gaseous pollutants present similar to lower emission levels

Particulates emissions are halved



Emissions validated with advanced MtG fuel

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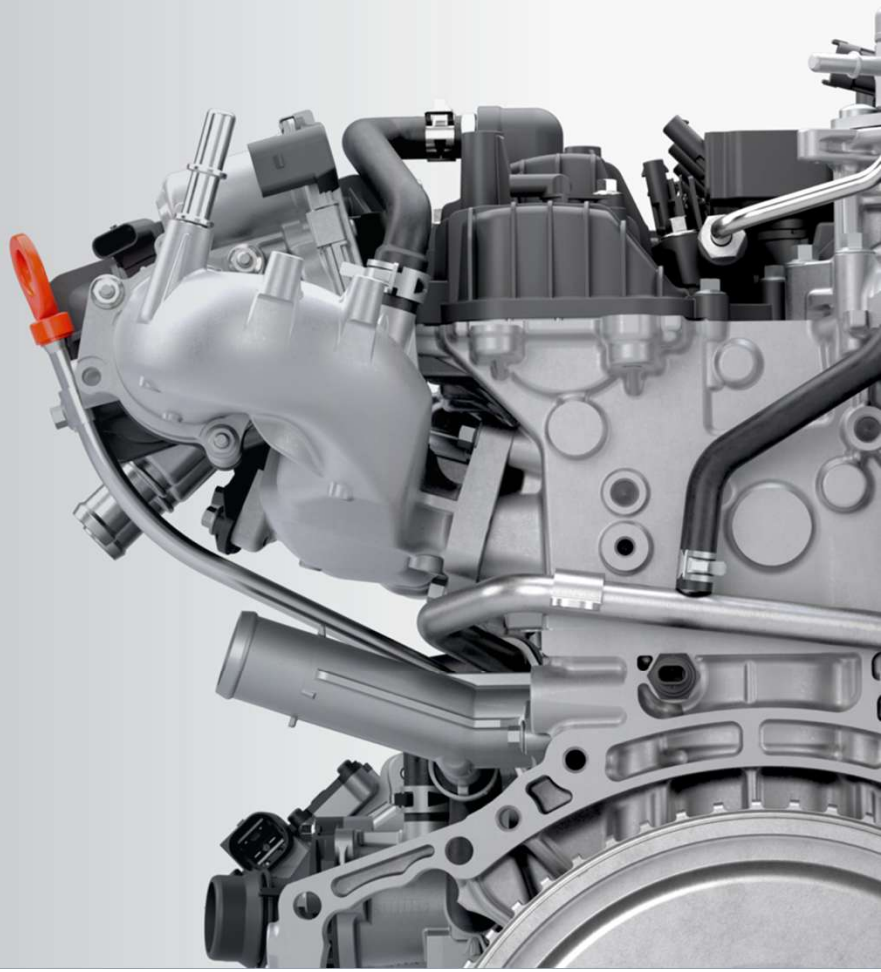


Air quality targets

International definition

European Union (EU) and World Health Organization (WHO)

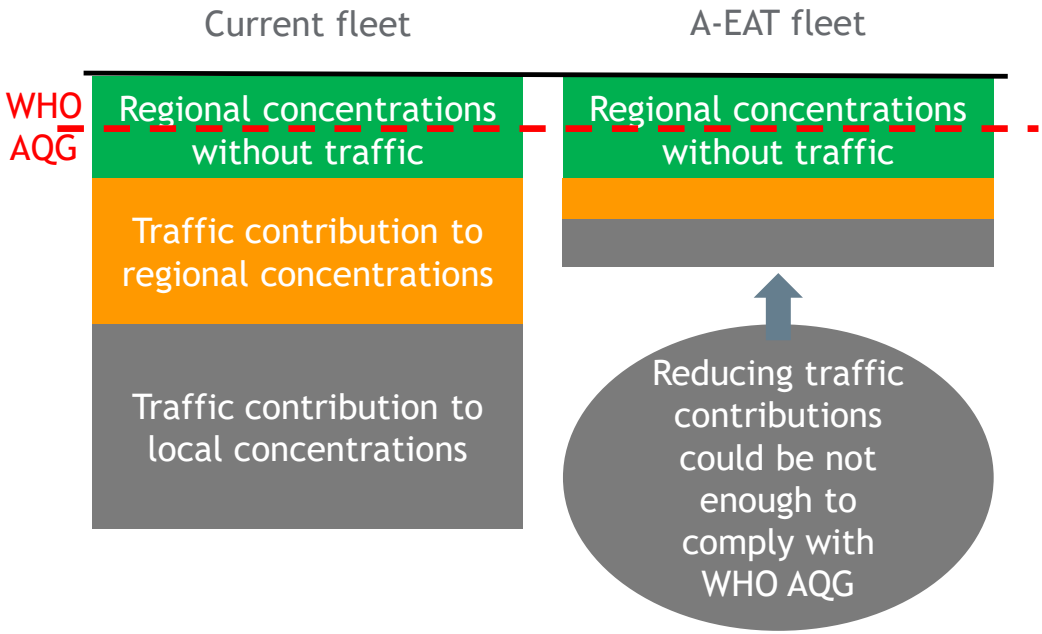
Based on the current scientific knowledge with “at least moderate certainty evidence for adverse health effects” (WHO)

AQ standards to reach by 2030

Concentration [µg/m³]		EU AQ Directives (last updated in 2015)	WHO AQ Guidelines (last updated in 2021)
Pollutant	Averaging period		
NO_2	Hourly	200	200
	Annual	20	10
CO	24 hours	4 000	4 000

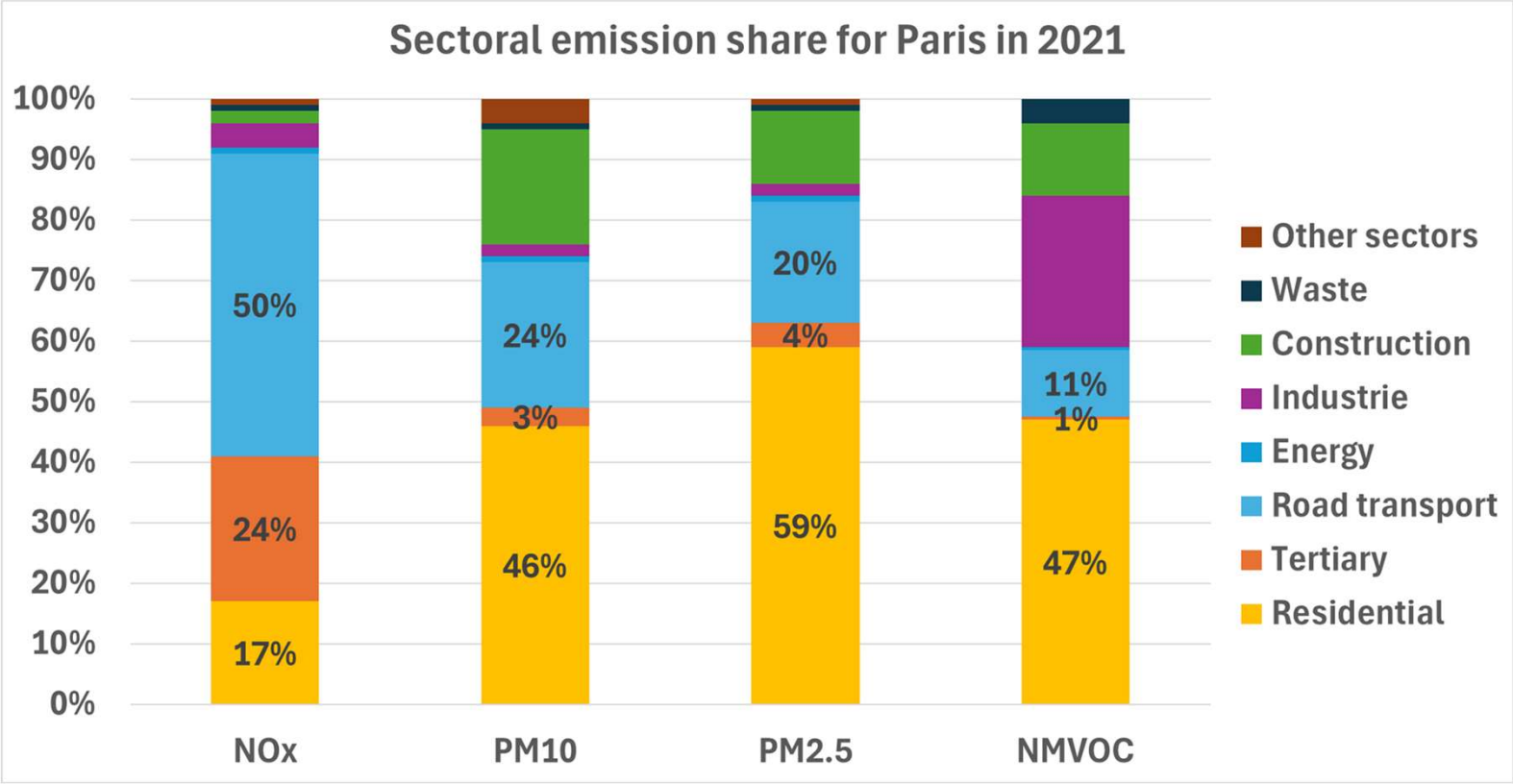
Multi-sectoral origins

- Emission reduction efforts across all activity sectors to comply with AQ targets



Efforts across all activity sectors needed to reach the more stringent WHO AQG

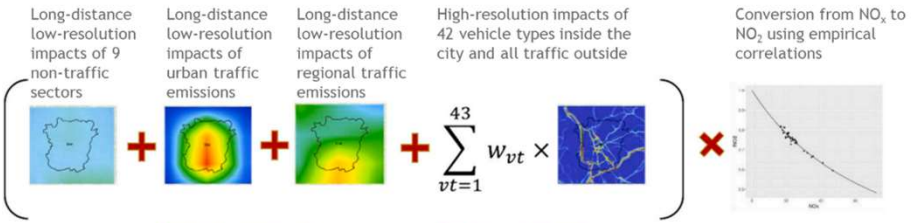
Emission per sector for Paris city



Reducing air pollution requires action across several sectors

Air Quality impact assessment tools

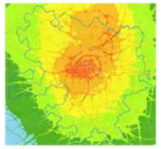
CONCAWE ,a rapid decision-making tool for estimating future NO2 concentration across Europe





NO2 compliance at monitoring stations

or

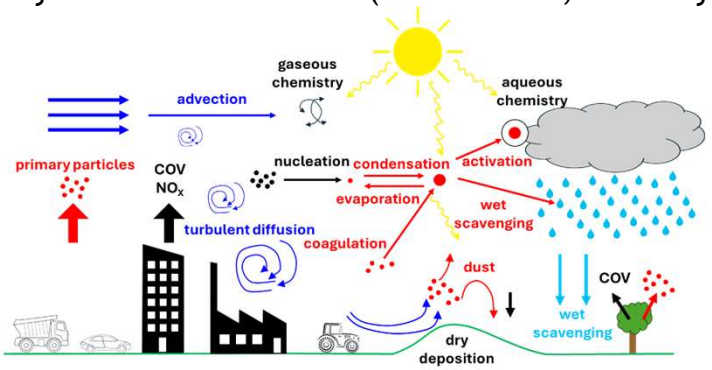


NO2 concentration maps over cities



Regional scale (Polair3D)

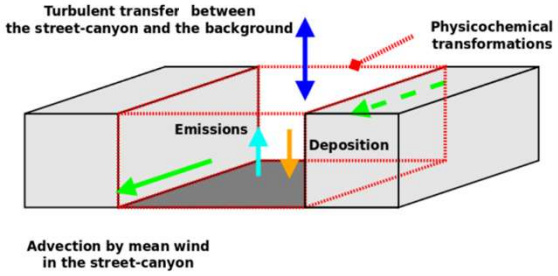
All activity sectors considered (road traffic, industry …)



Provide background concentrations for the local scale

Local scale (MUNICH)

Model of Urban Network of Intersecting Canyons and Highways



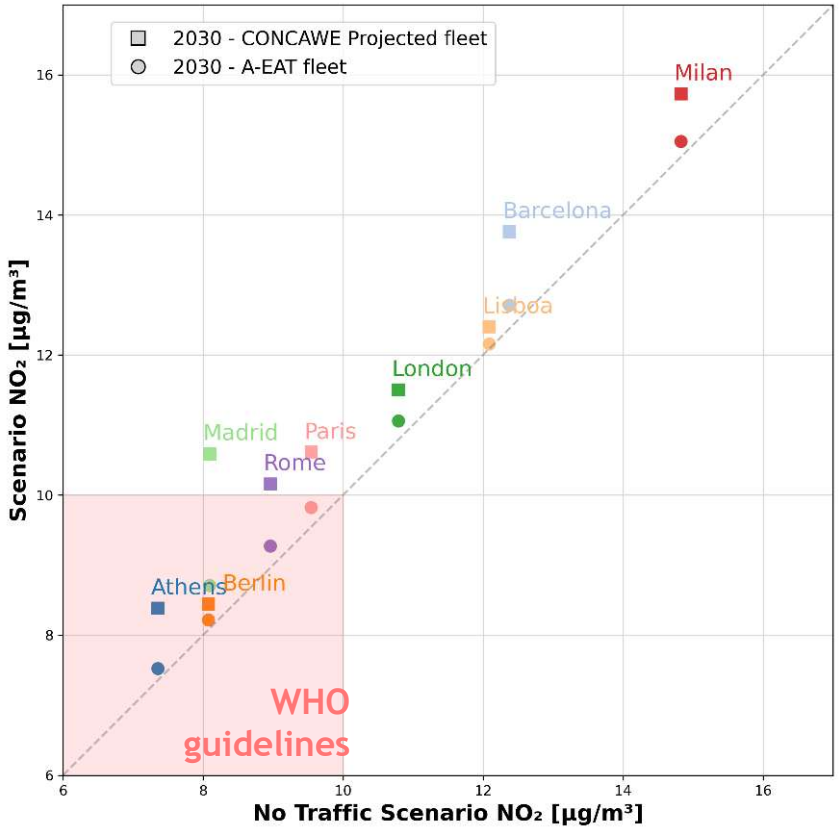
Provide concentrations in streets

Public

A-EAT AQ impact on major European cities using CONCAWE

Comparison of 2030 scenarios and WHO guidelines

- For some cities, further air quality improvements require actions beyond the transport sector
- NO_2 reductions from widespread A-EAT adoption bring some cities into compliance with WHO guidelines
- NO_2 concentrations with the A-EAT fleet are close to no traffic scenario



Overall benefits of A-EAT across European urban areas / cities

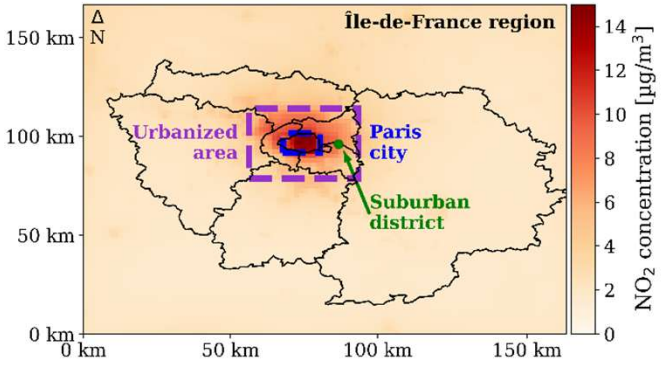
Public

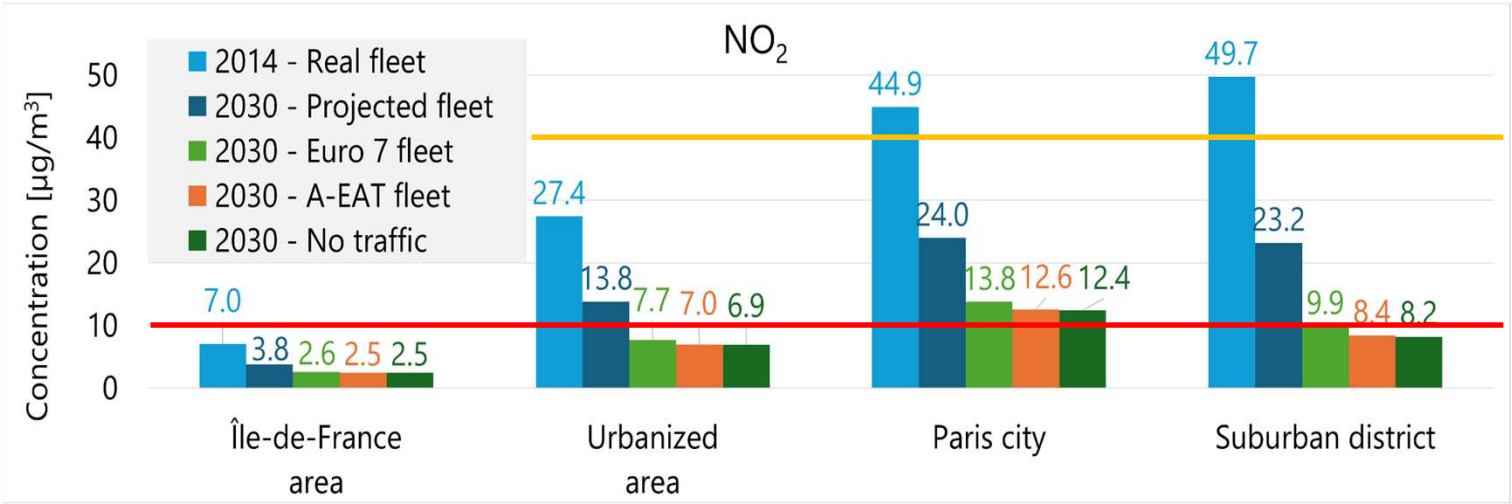
Spatial domain comparison

Impact of the considered domain size and location

Limited impact of the A-EAT fleet compared to no-traffic scenario

Importance of the domain of interest to check compliance with WHO AQG



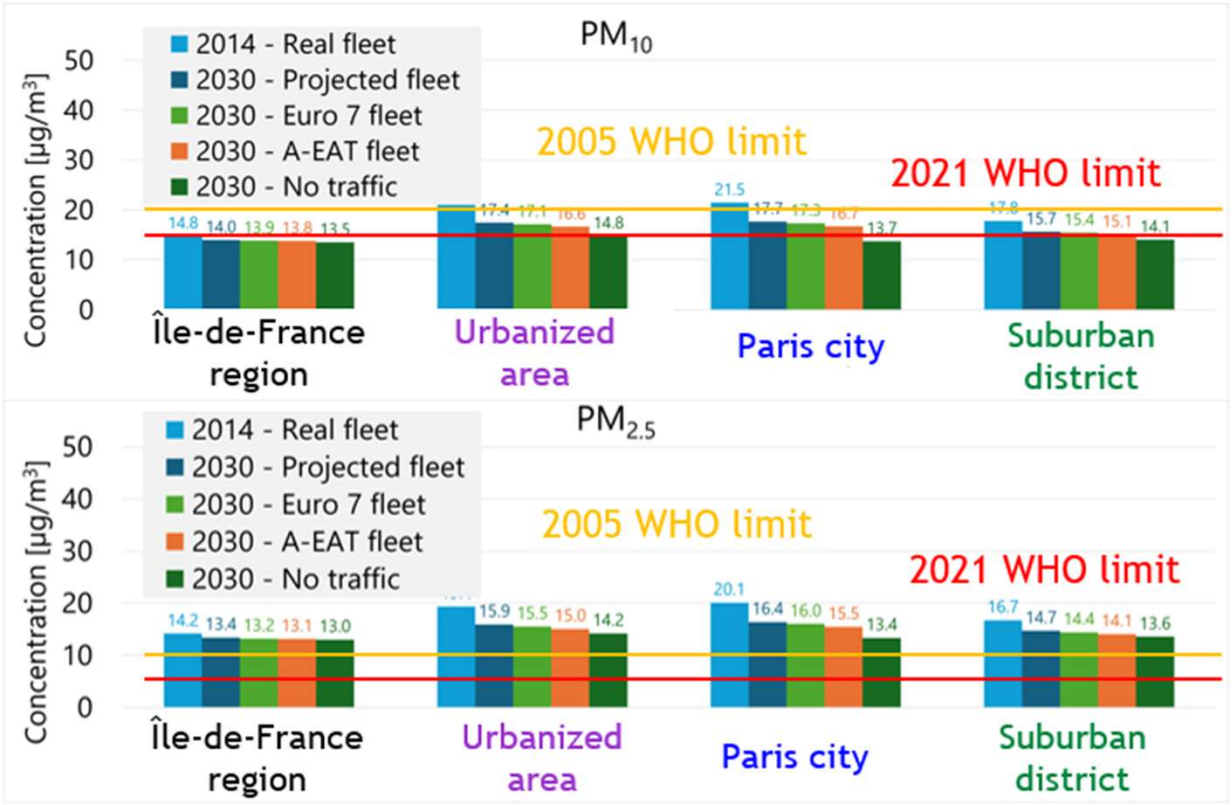


2005 WHO limit

2021 WHO limit

Even in the absence of traffic, some locations are exceeding WHO AQG

Particulate Matter (PM) simulation results



Impact of the A-EAT technology

PM concentrations approach No traffic levels

WHO PM_{10} guideline levels are within reach

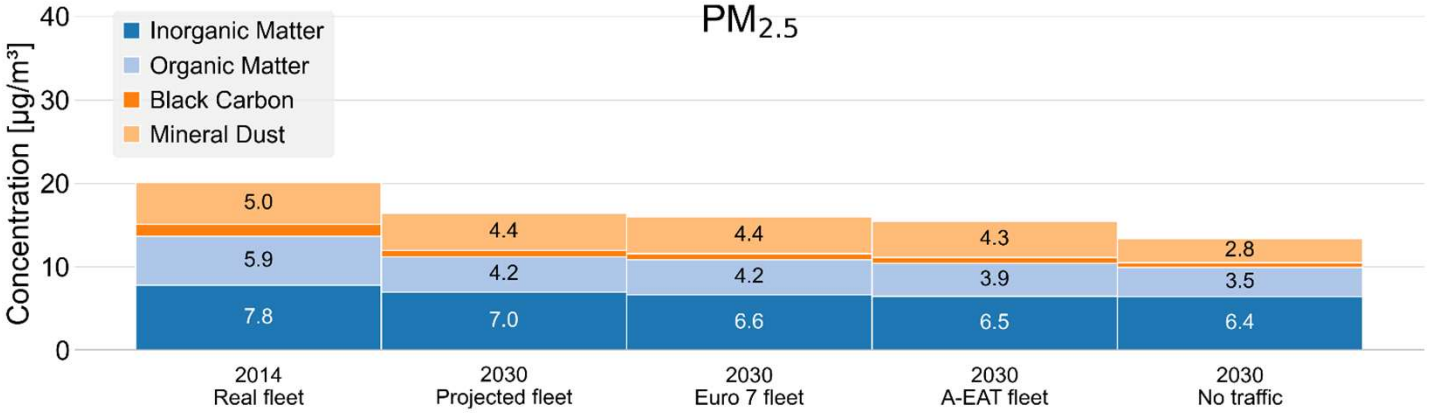
Even with no road transport, the WHO $PM_{2.5}$ guideline levels remain unattainable

Strong influences of non-traffic sectors on PM concentrations

$PM_{2.5}$ composition analysis

Impact of A-EAT on $PM_{2.5}$ composition

- Inorganic and black carbon exhaust particulates are reduced to near No traffic levels
- Organic aerosol concentrations also decrease
  - Lower exhaust emissions reduce primary organic aerosol (POA)
  - Lower precursor emissions reduce secondary organic aerosol (SOA) formation
- Non-exhaust mineral dust becomes the dominant traffic-related PM source



In 2030, non-exhaust sources dominate traffic PM emissions

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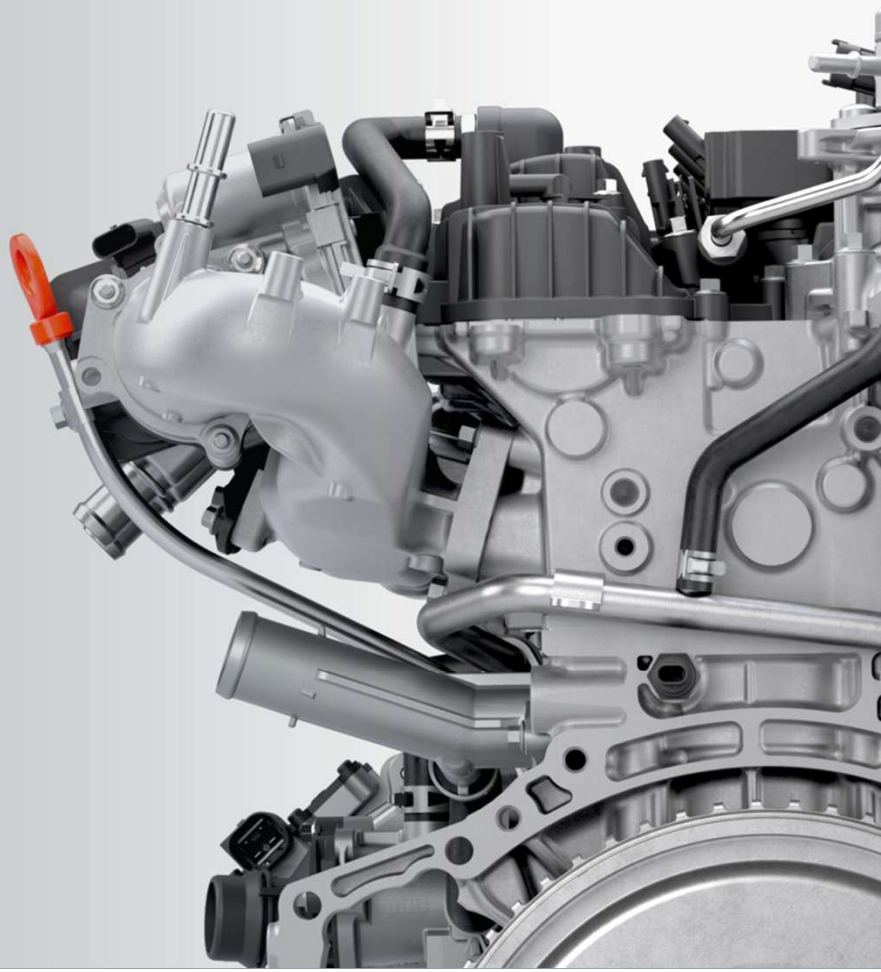

Conclusions:

1st reducing greenhouse gases and improving air quality requires an integrated approach combining fuels, vehicles and environmental assessment

2nd LCA shows that low-carbon energy pathways have a greater influence on climate impact than the choice of powertrain technology alone

3rd A-EAT demonstrator achieved more than 90% pollutant reduction compared with the production vehicle while maintaining robust performance under severe conditions

4th AQ modelling indicates that a fleet equipped with A-EAT technology would have an impact very close to a no-traffic scenario for NO_2 and CO concentrations

Internal Use

Innovation becomes reality through the combined power of expertise, collaboration and determination.

Thank you for your attention .



