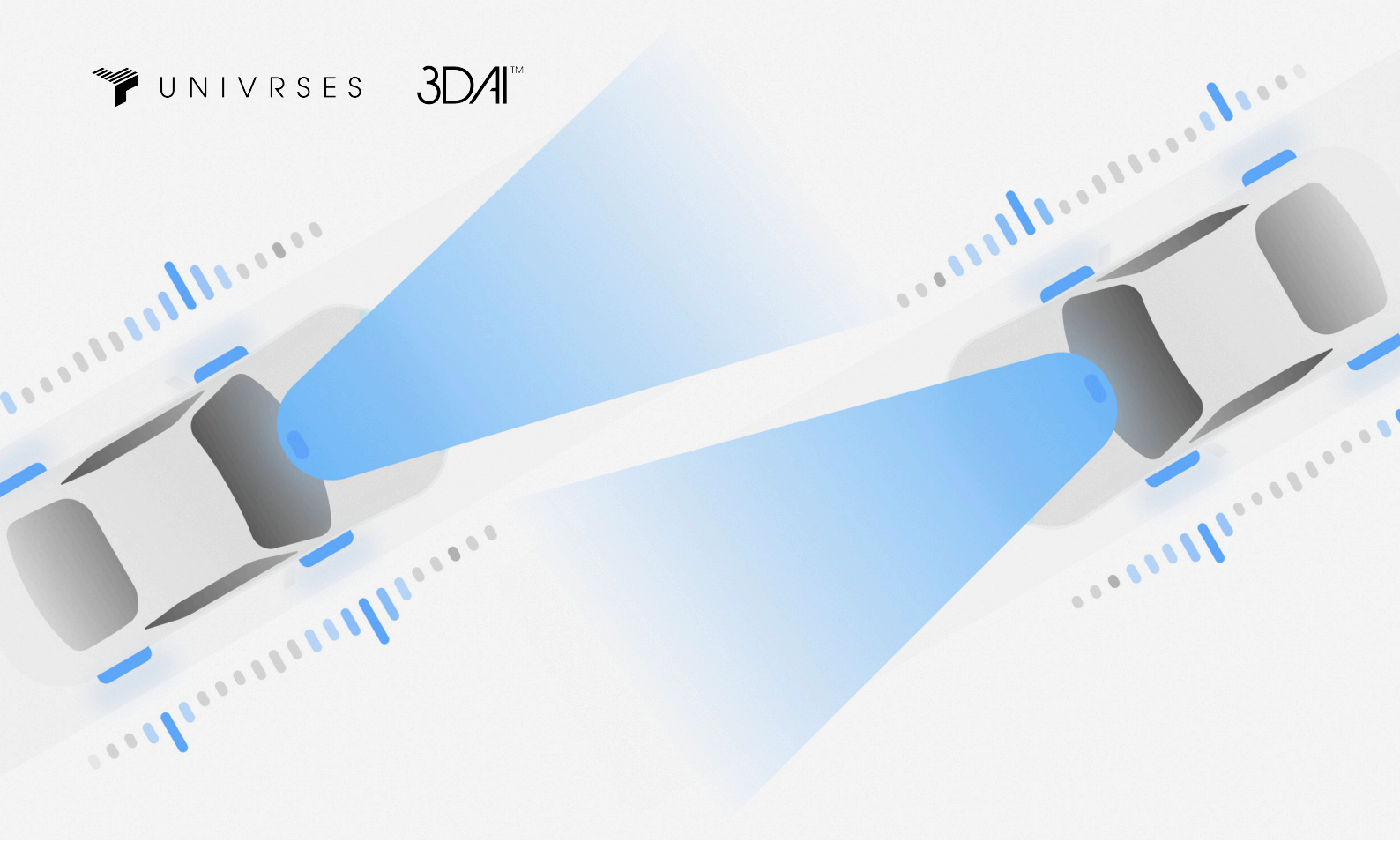




# Cracks in the system: How rough roads accelerate pollution — and what AI can do to help



Vehicle emissions are falling across Europe — a promising sign for the EU's ambitious climate goals. In particular, exhaust emissions are down thanks to cleaner engines, better fuel efficiency, smarter mobility planning, and the rapid adoption of electric vehicles. But look closer, and the picture gets less clear.

While combustion-related emissions are dropping, air pollution from traffic hasn't gone away — it's just coming from different sources. Non-exhaust emissions (NEEs) — tiny airborne particles produced by tyre wear, brake abrasion, and the breakdown of road surfaces — now account for the

majority of traffic-related particulate matter in many cities. And the worse the road, the worse the pollution. This article explores the often overlooked link between road quality and air quality — and how real-time, AI-powered infrastructure monitoring can help close the gap.



## The invisible emissions problem

NEEs come from brake wear, tyre wear, road surface degradation, and the resuspension of dust particles as vehicles pass over the road. These emissions contribute to particulate matter — a mix of solid and liquid particles suspended in the air — that can enter the lungs and bloodstream. According to the World Health Organization, exposure increases the risk of asthma, cardiovascular disease, lung cancer, stroke, and premature death.

A 2020 OECD report states that particulate matter from passenger cars is projected to rise 53% by 2030 due to increased traffic volumes. EIT Urban Mobility's 2025 study confirms the trend: in cities like London and Milan, non-exhaust sources

already account for up to 88% of traffic-related particulate matter. Once released, these particles don't just pollute the air. They carry microplastics, heavy metals, and chemical additives that settle into soil and water, disrupting ecosystems. According to the U.S. Environmental Protection Agency, particulate matter can acidify lakes and streams, alter nutrient balances, and damage crops and forests.

In sum, the dominant source of traffic pollution is shifting from exhaust emissions to those created by the friction between contacting surfaces. Tyres, brakes, and worn-out roads are becoming today's biggest sources of particulate pollution.

## Why electrification isn't enough

Electrification is transforming mobility, cutting CO<sub>2</sub> emissions and helping countries meet their climate targets. But when it comes to NEEs, it's no silver bullet.

EVs are typically heavier than combustion-engine vehicles — often by 20% or more due to battery weight. This added mass increases both tyre wear and road abrasion, especially on surfaces already in decline. So while EVs are great at cutting exhaust

pollution, they still contribute to — and in some cases worsen — particulate pollution. This issue is starting to gain attention from policymakers. The upcoming Euro 7 standard will, for the first time, include limits on brake and tyre wear. But those regulations only apply to new vehicles, not the millions already on the road. And it doesn't address the condition of the roads themselves, even though that's a major part of the problem.



## How poor road conditions accelerate emissions

Potholes, cracks, and uneven road surfaces intensify every form of non-exhaust pollution. Here's how that plays out on the road:

- Tyre wear increases as friction and abrasion rise on coarse or broken surfaces — causing significantly more wear - and emissions - than when driving on smooth asphalt.
- Road surface wear accelerates, contributing to loose aggregate that vehicles stir up, sending particles back into the air.
- Vehicle suspension is activated, increasing vertical load on tyres — which accelerates tyre wear and increases emissions.
- Driving behaviour shifts, as drivers brake, accelerate, or swerve to avoid damage — leading to more aggressive mechanical stress on tyres and brakes, thereby increasing emissions.

According to the OECD, vehicles driving on poorly maintained roads can emit up to 30% more particulate matter from tyres and surfaces than those on smooth asphalt. And the effect is even worse in wet conditions.

This creates a feedback loop: degraded surfaces increase tyre wear, which accelerates further breakdown. That, in turn, drives up emissions — and left unaddressed, the problem quickly spirals.

While the link between road quality and NEEs is increasingly clear, many cities and authorities still lack up-to-date insight into which surfaces are wearing down, or how quickly. This makes it hard to intervene in time, before the damage worsens and emissions rise. And even when the data exists, non-exhaust pollution is rarely part of the equation when deciding where and when to resurface. As a result, the environmental cost of rough roads continues to be overlooked.

Fortunately, a new generation of tools is stepping in to fill the blind spots.





## Real-time road intelligence

Univrse's AI-powered monitoring system, 3DAI™, provides the real-time visibility that traditional road surveys can't. Mounted on standard vehicles, it uses computer vision and machine learning to scan road surfaces continuously, identifying cracks, potholes, and surface wear as they appear.

With this stream of structured, geo-positioned data, transport authorities can:

- Spot hotspots and deterioration trends early
- Factor in environmental impact when prioritising resurfacing — not just safety
- Track how maintenance interventions affect emissions over time



By shifting from infrequent road surveys to continuous, data-driven insights, they can move from reactive fixes to targeted, proactive maintenance — saving money, improving infrastructure, and helping cut pollution at its source.

## How 3DAI™ works

**1 Smartphone-based scanning.** Vehicles equipped with 3DAI™ continuously scan road surfaces using smartphone cameras and motion sensors.

**2 AI-powered detection.** Computer vision algorithms identify cracks, potholes, surface wear and other defects — automatically and in real time.

**3 Edge processing.** Key data is processed on the device, keeping file sizes small and enabling immediate filtering of useful insights.

**4 Cloud refinement.** Detections are uploaded and structured in the cloud, where they're validated and organised for action.

**5 Geo-positioned mapping.** Every issue is mapped to its exact GPS location, enabling precise localisation within road inventories.

**6 Trend analysis.** Over time, 3DAI™ tracks deterioration rates — supporting proactive maintenance and better budgeting.



3DAI™ isn't just a promising idea — it's already helping authorities act earlier and smarter. Faster interventions mean less surface breakdown — and fewer emissions from tyre wear and loose particles, and It's already delivering measurable results across Europe:

- In 2024 alone, 3DAI™ scanned nearly 950,000 km of roads across six countries and processed over 94 million images — helping authorities monitor their assets and improve maintenance planning.
- In Helsingborg, Sweden, the shift to data-driven maintenance helped cut the number of potholes by 70% in just five months — from 3,000 to 900 — while reducing manual inspection from 2.5 days a week to just one hour. The municipality estimates this has already saved €17–25 million.
- At the national level, Trafikverket (the Swedish Transport Administration) is now using 3DAI™ to receive weekly or even daily updates on high-traffic routes. This marks a major improvement over previous methods, which relied on manual surveys — often conducted just once a year.

Univrses has also started working with leading tyre manufacturers to explore how road condition data from 3DAI™ can support better tyre design and usage — helping reduce wear and extend tyre life. These collaborations also aim to investigate how smart tyres could contribute to road monitoring by directly measuring NEEs.



## The road to cleaner air

Reducing NEEs starts with a shift in mindset: road quality isn't just a mobility concern — it's about public health. To act, decision-makers should:

- **Recognise road degradation as a contributor to air pollution** — and integrate it into climate and clean mobility strategies
  - **Adopt real-time monitoring tools** to move from reactive to proactive asset management
  - **Use smart data to prioritise resurfacing where it counts most** — increase the focus on high-friction roads that produce the most emissions
- **Push for broader regulatory frameworks** that include NEEs and infrastructure quality — not just vehicles and fuels

By tackling surface degradation head-on, and giving authorities the intelligence to act earlier and smarter, we can significantly cut pollution from tyre and road wear. 3DAI™ offers a scalable way to make that shift.

It's time we stop treating rough roads as a minor inconvenience — and start recognising them as a preventable source of pollution, hiding in plain sight.

## About Univrses

Univrses is a leading computer vision and AI company specialising in software that provides autonomous systems with advanced perception capabilities. The company has collaborated with major automotive manufacturers to develop software components that are now deployed in production vehicles, including flagship models such as the Polestar 3 and Volvo EX90.

Leveraging its strong foothold in the automotive sector, Univrses has expanded into the trillion-dollar asset management market by harnessing data from regular passenger vehicles. Through its proprietary algorithms, the company transforms raw sensor data into actionable insights that are critical for efficient asset management.

This data enables a detailed, real-time understanding of road infrastructure, including road conditions,

traffic signs, lane markings, and street lighting. The AI system can also be used to monitor and analyse ongoing projects, such as roadworks and construction sites. By leveraging these insights, cities and road authorities can make better decisions, allocate resources more efficiently, reduce CO<sub>2</sub> emissions, lower costs, and improve road safety.

With a well-established market presence, Univrses helps cities, road transport authorities, and contractors achieve significant annual cost savings—potentially hundreds of millions of euros per country. The company's proprietary 3DAI™ solution has already been deployed by national road network authorities in six European countries, including Sweden, Denmark, Norway, the Netherlands, the UK, and Italy.

## Want to explore how 3DAI™ can transform your asset management?

[Book a demo today](#)