OPUS REMOTE SENSING

Real-World Vehicle Emissions Control

Supporting the Roadworthiness Package with Remote Sensing Technology

Position Paper – July 2025

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Executive Summary

The European Commission's Roadworthiness Package (the Proposal), published in April 2025, includes a groundbreaking measure: **the mandatory use of remote sensing technology to detect high-emitting vehicles on public roads**. OPUS RSE, the global leader in this field, fully supports the Commission's proposal and contributes this Positioning Paper to reinforce its technical, economic and societal viability.

Remote Sensing Devices (RSD) are instruments that enable large-scale, real-time measurement of vehicle emissions in real-world, real-driving conditions. It is already used operationally in many countries worldwide, with exceptional results. It is **scientifically validated**, **ISO-accredited** and proven to detect the small fraction of vehicles responsible for most of the traffic-related pollution (~40% of road transport emissions): the so-called "**high-emitters**". EU-funded studies and the European Commission's JRC evaluations confirm that the technology is **mature**, **scalable** and **cost-effective**. In addition to the Commission's regulatory proposal, other EU countries, such as Spain and Lithuania, are moving forward with a process of national standardization.

The Commission's proposed **30% fleet coverage target is both feasible and necessary**. RSD systems are capable of screening thousands of vehicles per day, automatically and non-intrusively. OPUS RSE's technical-economic model shows that deploying a remote sensing program across the EU, mainly thanks to unmanned fixed stations, would require **modest investment**, be **self-sustaining** through enforcement revenues and generate **significant indirect savings** by reducing air pollution and its associated health and economic costs. The **30% minimum target is critical**, as it is also a minimum requirement to ensure **reasonable high-emitter identification**. If the screening is lowered, high-emitter detection capability collapses. Moreover, lowering that requirement would drastically limit the ability to perform the **market surveillance objective** proposed by the Commission and would make it difficult to meet the requirement of three repeated measurements to identify them as high emitters, which would be necessary for this to be a reliable enforcement method. This 30% value is in line with other countries, where the technology has been in operation for a long time with the aim of identifying the most polluting vehicles on the road.

Evidence from existing RSD programs shows **dramatic emission reductions**, such as a 39–47% drop in pollutants in Hong Kong, and successful enforcement rates above 95%. **False positives are extremely rare**—well below 1%—thanks to robust multi-detection methods. The Proposal's built-in 3-times detection criterion ensures **strong legal and technical reliability**.

In conclusion, remote sensing is a powerful, validated and **ready-to-deploy** tool for reducing transport emissions. It complements traditional PTI programs and supports a stronger, smarter, more efficient and fairer environmental enforcement policy in the EU.

OPUS RSE stands ready to support Member States with turnkey technology and expertise to help achieve the goals of the Roadworthiness Package.

FAQ

Frequently Asked Questions

1. Why has the European Commission introduced the mandatory use of the RSD?

Air quality in Europe remains a significant environmental health risk, with many areas exceeding recommended World Health Organization (WHO) guidelines. The total number of premature deaths attributable to air pollution in Europe is estimated to be over 400,000. Road traffic is a significant contributor to air pollution. As it is a mobile source of emissions, it is difficult to identify and, of course, control. Each vehicle moves freely and emits very different amounts and types of emissions. Not all vehicles pollute the same; while many are rather clean, others can be extremely polluting, especially when maintenance is not conducted properly, when there are severe breakdowns, manipulations or the vehicles are tampered with. The RSD allows remote and non-intrusive measurement of emissions from all vehicles passing in front of the sensor, solving the previous challenge. International evidence of the value of using vehicle emissions remote sensing is overwhelming. Many European organizations, including the European Commission itself, have been testing and analyzing the technology independently, concluding that its potential is enormous.

2. Why the RSD would be necessary in addition to existing PTI for emissions?

Because PTIs are limited: they are infrequent, national, and predictable. RSD provides continuous, large-scale, cross-border surveillance that fills the enforcement gap and ensures high-emitters are identified in real time. The RSD is the only technology capable of massively and remotely identifying the most polluting vehicles under real-world conditions. It is a key tool to effectively, fairly and affordably reduce transport emissions and restore trust in environmental enforcement. By supplementing emissions measurements on public roads with measurements at vehicle inspection stations, vehicle condition checks are completed as they should be.

3. Is the technology reliable? Is it robust?

Yes. The RSD has been scientifically validated since the 1990s. It is certified by international authorities and has been successfully used in 38 countries. Several public authorities worldwide emit certificates on the instruments. It is ISO-accredited and a European UNE standard is being published in 2025. The most modern devices demonstrate outstanding robustness in operation on all types of streets and roads, ensuring 24/7, fully unattended operation at minimal maintenance costs.

4. Can RSDs reliably detect high-emitting vehicles? What experiences demonstrate this application?

Absolutely. False positives are below 1% using 2-time exceedance rules, with existing programs in countries like Hong Kong, South Korea and the USA, who have reported emission reductions of up to 40% after deploying the RSD. The EU's 3-time exceedance rule ensures maximum legal robustness.

5. Why is the European Commission proposing that all EU countries measure at least 30% of the fleet registered in each country annually? Isn't that a very demanding requirement?

30% fleet screening is the minimum required to reliably detect high-emitters, resulting in an estimated 66% of probability to detect the high-emitters on the roads. If the screening is lowered to 10%, high-emitter detection collapses: nearly 3 in 4 high-emitters would go unnoticed, which would make the RSD implementation insufficiently rewarding.

The large-scale RSD monitoring is highly efficient and affordable, as each device scans thousands of vehicles daily. The number of RSDs that each country needs is quite reasonable. In addition, the scale effects are very large, such that the incremental cost of deploying and operating new systems decreases with the number of RSDs, ensuring massive monitoring at very low cost.

International references support the logic of the 30% target. For example, achieving 30% coverage is possible in densely populated Hong Kong but is also achieved in far less dense northern Virginia. The Denver remote sensing program achieves even 42% fleet coverage across a much larger geographic area with half the population density of Northern Virginia using the same number of total RSDs (~20) by focusing a few RSDs at the highest volumes sites and moving the remainder across 166 total active remote sensing sites.

6. What is the cost of implementing and maintaining a remote sensing system of this scale?

Very low. The system pays for itself through enforcement revenues. Plus, it generates substantial indirect savings by reducing healthcare costs and improving air quality across society. The economic model described in this report shows that the economical figures are very attractive.

7. What are the benefits of implementing this solution across Europe?

Cleaner air, healthier citizens, economic savings, fairer enforcement and centralized emissions data across the single market. The benefits are immediate, scalable and long-lasting. PTIs are reinforced, overall vehicle emissions are reduced, Europe preserves the air quality while ensures a realistic motorized mobility in the EU.

8. What guarantees that RSD enforcement will be fair to citizens?

The system targets only the worst polluters, using strict and repeated detection criteria. Only extremely high-emitting vehicles would be targeted. Enforcement would only apply to vehicles that are indisputably too polluting to be allowed on the road without control.

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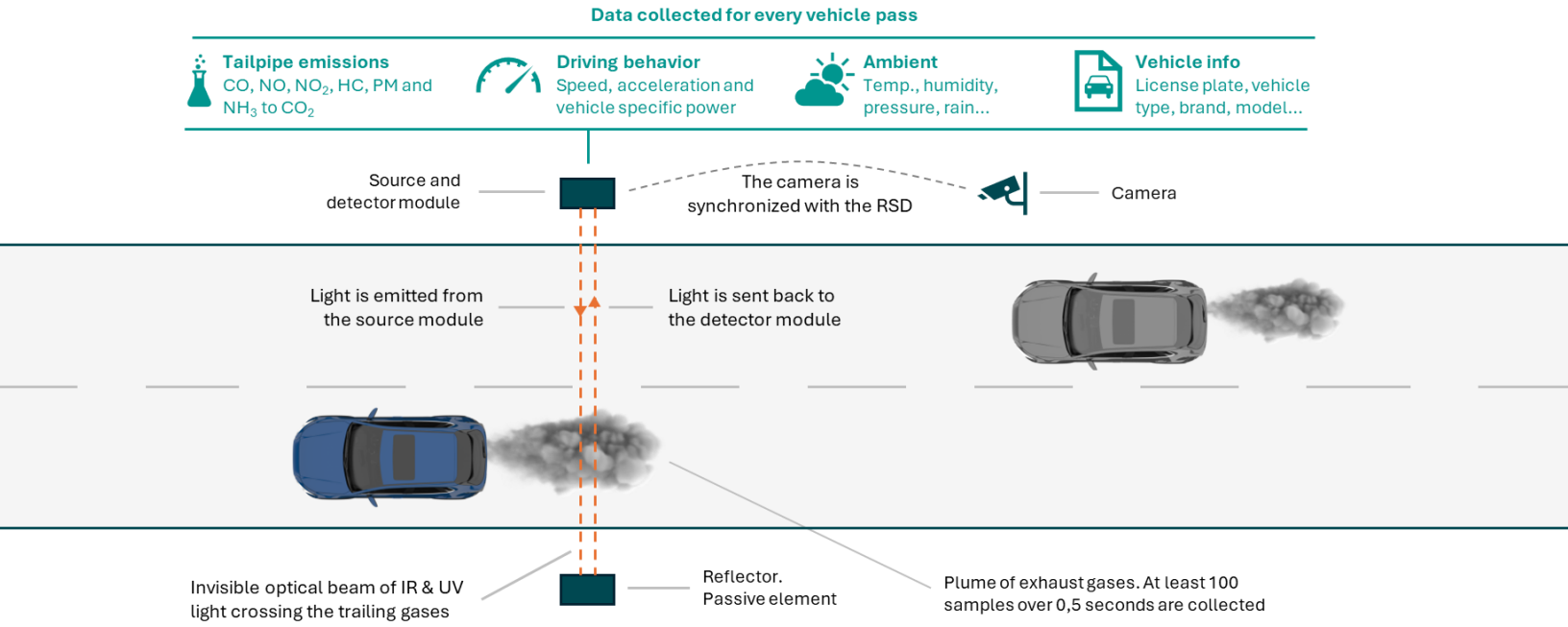
1 Introduction

For decades, vehicle emissions remote sensing technologies have shown strong technical capabilities in monitoring **real-world, real-driving emissions from vehicles in free circulation** and identifying the most polluting vehicles (***high-emitters***), for selective action [1]. Independent studies worldwide, including from the European Commission's Joint Research Centre (JRC) [2], have **validated the maturity of the technology.** High-emitter enforcement using this technology is in operation in USA, China, India, South Korea, Taiwan and Hong Kong. To a lesser extent, also in Europe, by identifying potentially tampered trucks for selective roadside inspection.



In April 2025, the European Commission published a proposal (the Proposal) to revise the EU's roadworthiness framework [3], aiming to modernize periodic technical inspections (PTI), roadside checks, and vehicle registration systems. The proposal responds to **the need for more accurate and real-world monitoring** of vehicle safety and **emissions**, especially in the context of **growing environmental challenges** and an increasingly complex vehicle fleet.

One of the most relevant updates is the introduction of remote measurement of vehicle emissions. The Commission proposes the use of remote sensing technology to detect high-emitting vehicles directly on the road. This approach enables **large-scale**, **cost-effective screening** of vehicles under real driving conditions, allowing authorities to **focus enforcement on the small fraction of vehicles responsible for a disproportionate share of pollution**.

The initiative is expected to bring substantial societal benefits, including improved air quality, better enforcement of environmental rules, and significant public health gains. The proposal is now under discussion by the European Parliament and Council, and its implementation will require collaboration between Member States, technical experts, and industry stakeholders.

Vehicle emissions remote sensing – the Proposal

The Commission's regulatory proposal includes the RSD in the following terms:

1. National authorities in **all EU countries are required to equip** themselves with **remote sensing devices**.

2. All EU countries **must measure the real-world emissions of 30%** of their registered fleet each year with RSDs.

3. All EU countries **must detect high-emitters** with RSDs. They must report this to the Commission for centralized monitoring and market surveillance.

4. **High-emitters must be enforced**. Once a high-emitting vehicle is detected on the road (3x times detection over a period of 6-months) it shall be verified in a PTI. High-emitters can also be directed for further roadside police inspection.

5. If **foreign high-emitters** are detected, the national authorities must **inform the responsible Member State**, who must request the owner to present the vehicle at any authorized testing center within a maximum period of 45 days.

The capabilities are in place and backed by international experience

RSD technology has been used in 38 countries, in some of which remote detection of high-emitters on public roads is carried out on a large scale, is regulated, and yields excellent results. OPUS offers portable and fixed systems to facilitate large-scale monitoring. OPUS has 30 years of experience in commercial programs for detecting high-emitters and is part of the working group to publish the first UE's UNE standard about this technology [4].

OPUS offers turnkey solutions, including all the software, APIs, and analytics & alert platforms to easily implement the vehicle emissions remote screening and automatic high-emitters identification.

2 Support for the Commission's Proposal

We clearly support the European Commission's proposal regarding the introduction of vehicle emissions remote sensing technology for the following reasons.

Emissions must be measured where they happen: on the road

We strongly support the Commission's proposal to mandate the use of vehicle emissions remote sensing on public roads, given the overwhelming scientific evidence demonstrating its validity and positive impact on society [1]. Just as Member States are required to monitor air quality, it is logical that they should monitor road traffic emissions too, especially when this enables selective identification and correction, targeting the few vehicles that are really the problem. Vehicle emissions must be checked in real-world, real-driving conditions, therefore using remote sensing devices. This method reinforces periodical technical inspection programs, which are totally complementary. The RSD can support to modernize the inspection methods as well.

Proven, certified, ready: the technology is no longer in question

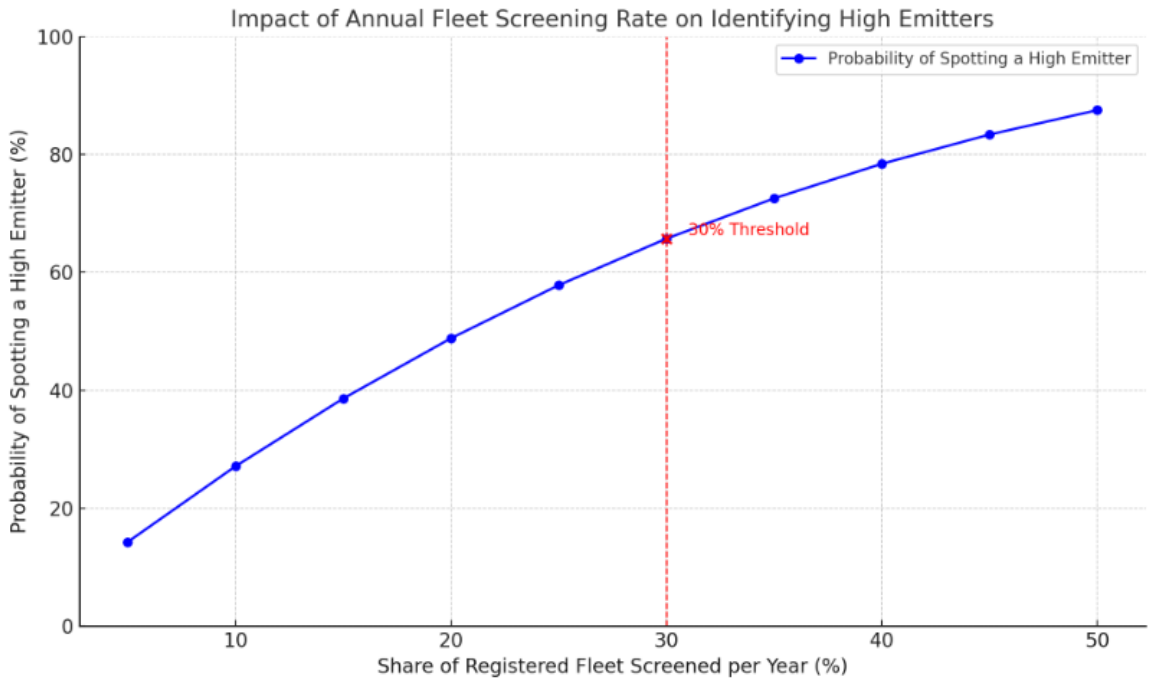
Vehicle emissions remote sensing technologies have been **verified** by very **exhaustive studies, proving that technology works and can detect high-emitting vehicles remotely**. Some of these technologies have been verified and accredited by the European Commission's own VELA laboratory [2]. Some suppliers also have ISO-17025 accreditation, and the Spanish Metrology Center is about to publish a UNE standard for this type of instrument in 2025 [4]. Since the functionality and reliability of remote emission sensing technology has been verified numerous times, we call for the implementation of this technology without any delay.

30% Fleet Coverage is achievable, affordable and the minimum screening target

We support the Commission's proposal that all Member States shall be required to use remote sensing technology to monitor vehicle emissions. This obligation must be accompanied by a minimum screening requirement. The EC's proposal to measure **at least 30% of each country's registered fleet** is perfectly feasible and could be achieved at low cost, precisely because these systems can measure passing vehicles remotely, non-intrusively and automatically.

International references support the logic of the 30% target. For example, achieving 30% coverage is possible in densely populated Hong Kong but is also achieved in far less dense northern Virginia. The Denver remote sensing program achieves even 42% fleet coverage across a much larger geographic area with half the population density of Northern Virginia using the same number of total RSDs (~20) by focusing a few RSDs at the highest volumes sites and moving the remainder across 166 total active remote sensing sites.

OPUS has done a probabilistic study. If the RSDs screen 30% of the registered fleet and each vehicle is required to pass by an RSD site at least 3 times/year to be identified as a high-emitter, there is about 66% of probability to detect the high-emitters. However, **if the screening is lowered to 10%, high-emitter detection collapses: nearly 3 in 4 high-emitters would go unnoticed.**



Ideally, Goverments should target at least 40% screening of the registered fleet, which would increase the chances of finding the high-emitters to 78%. In any case, there should be no particular qualms about setting this percentage as high as possible, as the cost of increasing surveillance is very low and the benefits for the society are enormous. It is important to remark that vehicle emissions remote sensing is currently **the cheapest method of emissions inspection** available today. Implementing a strategy for 30% screening is cost-effective. More information is provided in chapter 4.

Europe needs centralized data sharing on real-world vehicle emissions

We also welcome the inclusion in the proposal of a **centralized platform** where data can and must be shared between the Member States. If there is free movement of vehicles within the EU, it makes sense that this information can be shared for efficient monitoring, also considering that detected high-emitters can be from foreign countries.

All the PTI sector should be able to access this platform, so that when a vehicle is to be checked at a PTI station, they can check if it is a high-emitter. This creates a critical link between **real-world vehicle emissions monitoring** and **regulatory enforcement**, ensuring that RSD data leads to concrete action.

In fact, the **greater the remote sensing coverage**, the more valuable and accurate this centralized database becomes. Increased coverage allows:

- **Supervision of vehicle emission trends** across the EU.
- **Cross-border enforcement**, preventing high-emitters from evading responsibility simply by changing registration country or manipulating their vehicles outside their countries.
- **Early warning mechanisms** for PTIs and environmental agencies, improving their ability to prioritize inspections or recalls.

Without centralized access to remote sensing data, **Member States would be limited to a fragmented and inconsistent enforcement approach**, undermining the single market and delaying action on air quality and health. Shared data also strengthens **transparency, fairness and equity**—all vehicles are treated equally, regardless of origin, and environmental compliance becomes a truly European matter.

In short, the **central EU platform is the backbone** of a modern, intelligent and European vehicle emissions control system. The more Member States invest in remote sensing coverage and feed data into this shared system, the **greater the collective benefit**.

Why the RSD is necessary in addition to existing PTI for transport emissions control?

The Proposal to modernize the EU's roadworthiness framework rightly introduces remote measurement of vehicle emissions as a core tool for achieving cleaner air and more effective emissions enforcement. This initiative comes not only in response to environmental urgency but also to the increasing gap between **laboratory-tested compliance** and **real-world performance** of vehicles on European roads. While Periodic Technical Inspections (PTI) remain necessary, they are no longer sufficient on their own. PTIs are limited by design: they occur **infrequently**, only inspect **registered in-country vehicles**, and are **vulnerable to circumvention**. The RSD is the logical and essential complement for five key reasons:

1. **Real-World verification over laboratory tests**
   Public trust in declared emissions performance has been severely eroded. The RSD restores that trust by measuring emissions as vehicles operate in real-world driving conditions.
2. **Detection of Cross-Border High Emitters**
   Vehicles registered in other Member States or third countries are not subject to national PTI regimes, yet they pollute within EU borders. The RSD allows Public Authorities to identify out-of-region high emitters, ensuring uniform enforcement across the single market.
3. **Timely identification and intervention**
   PTIs are typically conducted every 1–2 years, allowing high-emitting vehicles to remain undetected for long periods. The RSD enables continuous and large-scale surveillance, helping authorities intervene earlier and prevent prolonged environmental damage.
4. **Deterrence and detection of fraudulent behavior**
   A known tactic among non-compliant motorists is to temporarily reconfigure or repair emissions systems just before PTI. The RSD negates this by monitoring emissions anonymously and unpredictably, making evasion tactics far less viable.
5. **Cost-efficiency and targeted enforcement**
   The RSD facilitates the screening of thousands of vehicles per day at a fraction of the cost of traditional inspections. This allows authorities to focus enforcement resources—e.g., roadside inspections or recalls—only on the vehicles that matter most: the high emitters. More information about the cost-efficiency of the RSD is shown in chapter 4.

Mandating the RSD across the EU is **not about replacing PTI**—it's about making the emissions control framework fit for the 21st century. It enables **data-driven**, **real-time**, **non-intrusive** and **fair** enforcement. It provides societal gains in air quality and public health and helps ensure that no vehicle, regardless of origin or intent, escapes scrutiny. To meet the EU's climate and clean air objectives, the RSD must become part of the national inspection programs for every Member State.

3 Technical Feasibility and Readiness

Mature, Proven Technology

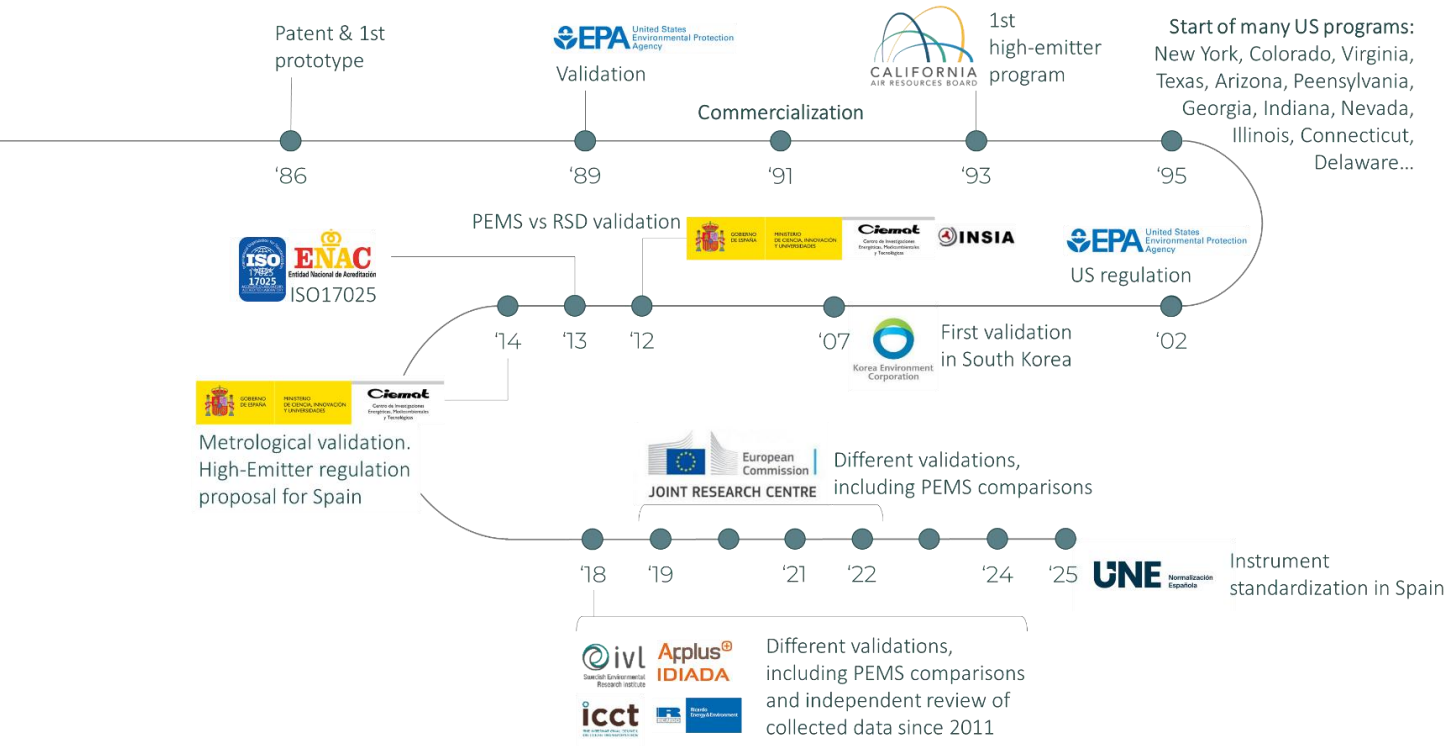
Remote sensing for vehicle emissions has evolved **since the late 1980s** and is now a globally verified and standardized tool to analyze vehicle emissions in real-driving conditions. Numerous large-scale studies and deployments—from Hong Kong's regulatory programs to campaigns in North America and Europe—demonstrate consistent, reliable performance in real-world conditions.

The diagram below shows just a few key milestones about the technology validation across the world for decades. Different vehicle emissions remote sensing instruments have been verified by laboratories, research centers or metrological agencies [5], proving that the systems measure within secifications and they are trusted tool to measure exhaust emissions from moving vehicles. These studies include dry-gas and wet-gas testing, dynamometer testing, dynamic plume testing and PEMS intercomparison, covering a vast range of different experiments.

Dozens of independent EU organizations, including universities and specialized companies, have tested the technologies in multiple projects, covering in-house testing to real-world testing. The Joint Research Centre's technical report affirms remote sensing's readiness for EU-wide deployment [2].

in recent years, the technology has taken a leap forward in maturity. The systems are more robust, allow for portable or fixed operation, and have proven to work in a wide range of operations, including continuous, 24/7, completely unattended monitoring.

The technology is mature; it is ready for large-scale and low-cost operation.



Accredited and Certified

Not only has the technology been validated for a long time, but it also has specific accreditations. OPUS RSE is the world's only ISO-17025 accredited company for the remote measurement of real-driving vehicle emissions. This accreditation is granted by the Spanish Accreditation Agency (ENAC), through the Spanish Ministry of Industry, giving the entity the ability to report emissions from remotely measured vehicles with demonstrable uncertainties and accuracies.

Other organizations independently and uniformly evaluate each RSD deployed on the street. Some of these entities are the State of Colorado in the US, the South Korean Environmental Control Agency, and the Taiwan Environmental Control Agency. These entities test each instrument, issuing a certificate that enables its use for actual high-emitter detection programs or other operational purposes.

Moreover, in 2025, the Spanish Association for Standardization, UNE, and the Spanish Metrology Centre, CEM, are going to pubish a UNE standard for vehicle emission remote sensing instruments. This pioneering standard will be the basis for any large-scale deployment in Europe.

High Precision in identifying High Emitters

The European Commission's proposal is clear on the use of this technology. The real potential lies in finding the most polluting vehicles on public roads in a non-intrusive way. These vehicles are very few (typically between 1 and 3%) of the total number of vehicles on the road, but they are so polluting that they are responsible for a large proportion of total emissions (in some cases, up to 40%). Selectively targeting these vehicles is the smartest policy for controlling traffic emissions.

The evidence that high-emitting vehicles can be accurately identified, without false positives, is overwhelming. Countries like **China**, **South Korea** and **USA** include remote vehicle emissions inspection. Vehicle emissions are screenned in public roads, not only at PTIs. **High-emitters** found by RSDs are **sent to urgent physical inspections**. Different studies have shown the effectiveness of detecting high-emitters. In Virginia (USA) 1,722 high emitter notices were issued in the year 2023 and only 7 complaints were accepted. That is a **false positives rate of only 0.4%**, far less than from other traffic enforcement tools. In Hong Kong, dual-measurement logic (two consecutive exceedances) ensures **robust identification of high-emitters with very low false-positive rates**. Vehicles are only flagged if they fail two consecutive readings within a short time span. Once notified, owners are required to repair the vehicle and pass a chassis dynamometer test at a designated testing center within a defined deadline.

As part of the EU-funded LIFE GySTRA project, a method to identify high-emitters was also proposed and tested, showing that high-emitters can effectively be identified by the RSDs and checked in PTIs.

All the above methods use 2-times exceedance with robust results, showing that false positive identification is minimal. **The European Commission is proposing 3-times exceedance, so the possibility of false positives is almost non-existent.**

4 Economic Impact Analysis

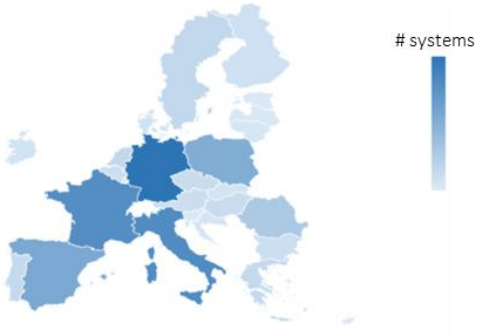
It might seem that the obligation for all countries to implement remote measurement programs for road traffic emissions, **covering at least 30% of the registered fleet in the country**, is too ambitious or costly, but it is not.

Precisely because the technology measures remotely, non-intrusively, and unattended, **its scalability is extraordinary**. Each device can analyze thousands of vehicles every day. The ability to deploy fixed cabins on the road network, where the sensors are housed, provides extensive geographical coverage at a minimal operating cost.

Opus has developed a technical-economic model for Europe, resulting in an estimate of the resources needed by each country to meet the Commission's targets, the annual costs of operating the entire program, and the economic returns that could be obtained from it. The results are very clear: implementing a remote sensing program is not expensive and has a positive return for society.

The following table shows numbers from the model, considering three country types[1]:

- **Large**: an average from Germany, Italy, France, Spain and Poland.
- **Medium**: an average from countries, ranging from 5.5m pop. (Finland) to 19m pop. (Romania).
- **Small**: an average from the rest of the EU countries, ranging from 0.5m pop. (Malta) to 5.5m pop. (Slovakia).



Country	**# systems**	**CAPEX** *Initial investment*	**OPEX** *Annual cost for the Goverments*	**Revenue** *Annual revenue for the Goverments*	**Indirect savings** *Derived from air pollution reduction*	**Balance** not including indirect savings	**Balance** including indirect savings
Large	80	8.239.000 €	11.808.000 €	17.712.000 €	22.854.000 €	5.904.000 €	28.758.000 €
Medium	16	1.628.000 €	2.321.000 €	3.482.000 €	4.493.000 €	1.161.000 €	5.654.000 €
Small	4	461.000 €	671.000 €	1.006.000 €	1.299.000 €	335.000 €	1.634.000 €
Total EU	620	64.170.000 €	91.954.800 €	137.932.200 €	177.972.538 €	45.977.400 €	223.949.938 €

The figures of the table are explained below:

- **# systems**: The model takes into account the urban distribution by region in the EU, as the priority objective is to capture 30% of the vehicle fleet in each country. Based on these figures, the number of RSDs that each country would need to deploy is estimated. Only fixed RSDs are considered.
- **CAPEX**: An initial investment is required to purchase the equipment and get the entire program

[1] The specific estimates for each country can be extracted from the model. For simplicity, data is grouped in these 3 groups.

up and running. This figures includes all costs for manufacturing and installing the systems on the roads, designing and deploying all IT and communications infrastructure, as well as all costs necessary to start up the automated monitoring system for the vehicle fleet monitoring and high-emitter enforcement. It is understood that this would be an investment by each Member State.

- **OPEX**: This figure is the average annual cost to operate and maintain the program. It includes all costs of maintaining the entire operating system (regular maintenance, service, repairs, data processing, calibrations, etc.) related to traffic emissions screening and high-emitter identification. The providers (i.e. Opus) would cover all costs of operating and maintaining the program and charges a variable fee in exchange for the service (or annual maintenance contract).
- **Revenue**: Governments can also obtain a return to help fund the program. This figure representes the potential annual revenue for each country. For example, by identifying high-emitters, funds can be obtained that more than cover the program costs. In the model developed here, it has been estimated that 1.5% of the registered fleet in each country could be identified as high emitters. The state could obtain a return from each identified high-emitter. After consulting with public officials, it has been estimated that this enforcement could generate significant revenue for the public treasury, potentially generating €100 per high-emitter.
- **Indirect savings:** The purpose of this regulation should not be forgotten, which is not to collect taxes, but to reduce road traffic emissions due to the serious negative consequences they have on society. It is well documented that pollutant emissions of NOx, PM, CO, HC, and NH_3 have significant economic consequences for countries, mainly due to higher healthcare costs, lower labor productivity and an increase in chronic diseases. Using data from different models, the potential economic savings generated in each country have been estimated thanks to the identification and correction of high-emitters (repairs, withdrawals, or replacements of vehicles with less polluting ones).
- **Balance (not including indirect savings)**: If one calculates the balance solely by considering the returns from enforcement on high emitters minus the annual costs of operating the entire program, one obtains a positive balance for the public administration. In other words, it is possible to implement a model that directly funds the remote sensing program at the national level.
- **Balance (including indirect savings):** If, in addition to the above, the economic savings for the country resulting from effective control over high emitters are taken into account, it can be seen that the final balance far exceeds the cost of the remote sensing program.

In summary:

The large-scale implementation of a remote sensing program for vehicle emissions in all EU countries requires a very low initial investment, and the costs of operating the entire program are much lower than the returns derived, making it a solution with a net positive impact on society.

Further evidence on the Economic & Environmental Returns from Remote Sensing

USA:

High emitters contribute disproportionately to ozone forming HC and NOx in urban areas. The USA learned that targeting high emitters for timely repair can substantially reduce vehicular emissions. The US has over 25 years of experience targeting high emitters in its emissions inspection programs [7]. The northern Virginia remote sensing program covered 42% of the inspected fleet in 2023, which enabled its high emitter enforcement element to achieve fleet-wide 5% HC and 3% NOx emissions reductions by targeting only the top 0.1% emitters with less than 1.0% of re-inspected vehicle owners claiming false failure [8].

Broad RSD coverage of motor vehicle fleets in airsheds with poor air quality is key to achieving emissions reductions regardless of whether the high emitter program is voluntary, government-subsidized and large (e.g., Hong Kong) or mandatory, consumer-funded and small (e.g., Virginia). Just as police presence has been shown to reduce crime both through deterrence and focus on high-crime areas, broader RSD coverage improves high emitter program effectiveness by deterring tampering and disproportionately increasing the livelihood of finding the high emitters among middle-age and older vehicles, which not only harbor the highest percentages of gross emitters, but travel disproportionately less as they age.

A decade-long RSD monitoring across Chicago, Denver, Los Angeles, and Phoenix measured dramatic reductions in fleet emissions: HC fell by 27–63%, CO by 56–71%, and NOx by 48–68% [10].

The Colorado I/M program is also unique among US programs in that it is the only one that still conducts tailpipe emissions inspections in its inspection stations. In 2025, model year 1982 through 2014 (32 model years) received both OBD and the transient dynamometer IM240 inspection [9]. Analysis of this unique dataset indicated that at least 25-30% of *high emitters* (vehicles that failed back-to-back IM240) passed their OBD tests [11]. With fewer and fewer vehicles being tailpipe tested in periodic inspection programs in the US and Europe, and a growing reliance of OBD inspections in both the US and Europe, the importance of on-road emissions testing to enforce emissions standards, deter tampering, and ensure conformity is undeniable.

Hong Kong:

Hong Kong began piloting remote sensing of vehicle emissions in the early 2000s and formally launched its enforcement-based remote sensing program on high-emitters in 2014. Between 2014 and 2018, over 5,000 high-emitting vehicles were identified and required to be repaired. A separate evaluation revealed that 96% of high-emitting vehicles were repaired, dramatically cutting pollution—with HC down 22%, CO 47%, and NO 39%—while minimizing costs by targeting just the worst offenders. According to the Hong Kong Environmental Protection Department, improved emission control—including remote sensing—was a key driver behind a 69% reduction in particulate matter and 39% decrease in NO_x. This experience clearly validates vehicle emissions remote sensing screening it as a scalable policy tool.

South Korea:

Since 2013, South Korea has implemented remote sensing across 2–3 million vehicles annually at 39 sites, identifying and repairing high-emitters. Repeat offenders are mandated to get fixed or face fines, ensuring strong real-world compliance. Remote sensing plays a key role in achieving cost-effective emissions control compared to less targeted measures such as universal DPF installation, which studies have flagged as less efficient.

EU research:

The EU-funded H2020 NEMO project carried out a detailed cost-benefit analysis of the potential implementation of RSD for the detection and correction of high emitters in Europe. This model showed that the balance was clearly positive:

> *"The **high-emitters** programme is shown to have a **positive net present value** (i.e. **deliver a net benefit for society**) across all four methods for identifying high emitters. In other words, the benefit achieved through reduction in air pollution and noise emissions, outweigh the costs of the system to identify and incentivise the vehicles, and the costs of repairing these vehicles".*

Broad societal benfits

The implementation of the RSD as a continuous monitoring system has multi-sector implications that benefit society in a positive spiral. By increasing mass control of vehicle emissions, citizens become more aware and keep their vehicles in better condition (feedback reported by authorities in the US and South Korea), improving the overall health of the fleet and reducing its overall emissions. The program will enable the collection of massive amounts of data that can be used for other positive purposes, such as refining emissions inventories or improving traffic and air quality models. These activities have positive returns for society, resulting in more effective and efficient policies and decisions. Furthermore, the identification of high-emitters is seen as a fair policy by citizens, as it targets vehicles that are indisputably gross polluters in a very surgical manner. This reinforces political action to continue on the EU's path of reducing transport emissions.

5 Recommendations for Fine-Tuning the Proposal

The Commission's proposal is correct, but we note only one point that we believe should be corrected in order to make the regulation fully feasible and consistent:

The method for identifying high emitters should be adjusted

We believe that **the proposed method** for identifying a vehicle as a high-emitter **should be improved**. This is key to avoiding false positives and to providing full guarantees that only the most polluting vehicles are selected.

Current text:

Article 4a:

"*Member States shall take the measures necessary to verify the exhaust emissions, the noise level or both of any vehicle that, based on remote sensing data of at least three measurements of that vehicle within a period of six months, is suspected to emit above a certain level. For exhaust emissions, that level shall be double the average level for vehicles belonging to the same vehicle category, emission class, and having the same type of ignition, namely positive or compression ignition*."

Proposed text:

Article 4a:

"*Member States shall take the measures necessary to verify the exhaust emissions, the noise level or both of any vehicle that, based on remote sensing data of at least three measurements of that vehicle within a period of six months, is suspected to emit above a certain level. For exhaust emissions,* ***that level is defined in Table XX in Annex XX***."

Table XX - Maximum emission limits permitted on public roads - levels for identifying a high-emitter episode for each pollutant and each type of vehicle.

Parameter – high-emitting limit	*Units*	*Passenger cars – UNECE M1*	*Motorcycles – UNECE L-cat*	*Heavy vehicles – UNECE M2, M3, N2, N3*	*Light Commercial Vehicles – UNECE N1*
NO/CO2	[ppm/%]	118	190	190	118
NO2/CO2	[ppm/%]	86	375	100	86
CO/CO2	[%/%]	0.5	1.0	0.5	0.5
HC/CO2	[ppm/%]	19	200	19	19
PM	[g of PM/kg-fuel]	4	7	5	4

Justification:

High-emitters should be "gross polluters", independently of their type. In other countries, regulations seek to identify the most polluting vehicles (typically accounting for between 1% and 5% of the fleet) in order to implement targeted measures. Ultimately, the goal should be to identify the vehicles with the highest emissions, regardless of their type. However, the Commission's text would lead to an undesirable result.

The Commission's proposal states that a high-emitter will be a vehicle that emits **twice the average** emissions **of its group** (including emission class, thus Euro Standard), which **penalizes relatively low-emitting vehicles**. For instance, a very modern, very clean group of vehicles, like: [passenger cars, petrol, gasoline, Euro 6] may have average real-world NOx emissions very close to zero; for example, 50 ppm. According to the current text, a vehicle in this group emitting only 100 ppm (still close to zero) would be classified as a high-emitter, which makes no sense. This methodology would result in most of the high-emitters being relatively clean vehicles. Also, the proportion of high-emitters identified by governments would be a high percentage of the total vehicle fleet.

The solution is to establish **sufficiently high cut-off levels for high emitters** identification, so that there is **no doubt that the vehicle has a serious problem and cannot continue to be driven**, as it poses a risk to other citizens. In fact, as drivers do not know the actual emissions of their vehicles, they need robust legal certainty; that is, if their vehicle is identified as a high-emitting vehicle, it must be because its emissions are extreme, as these levels are unkwown to the driver or owner of the vehicle. Emitting just the double than other similar vehicles is too aggressive.

Furthermore, the aim of high-emitetrs enforcement is to remove high-emitters from circulation or correct them, regardless of their type of propulsion or age; this is a fair solution and gives meaning to remote screening.

These discussions have already taken place in Spain, where work has been done on the high-emitter methodology for many years and the cut-off points included in the table above were agreed. These "high-emitter limits" differ only by vehicle type but not on fuel type or age of the vehicle. The result of these cutpoints is that less than 3% of the fleet would be identified as high-emitters (alligned to other countries' strategies), but they will be, unquestionably, high-emitters.

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