Noise and **E**missions
MOnitoring and Radical Mitigation

Research and Innovation Action

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D8.4 What are the best practices for policy linked to remote sensing?

An overview of remote sensing policy for air pollutants

WP8, Task 8.4

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Author(s): Cecilia Mattea, Transport & Environment

www.nemo-cities.eu @nemo-cities Nemo Cities

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Abbreviations and acronyms

Acronym	Description
PTI	Periodical Technical Inspection
USA	United States of America
RS	Remote Sensing
MEP	Ministry of Environmental Protection

Executive Summary

The purpose of this deliverable is to provide an overview of policy trends that are present (historically and to date) in relation to remote sensing devices linked to air pollutant measurements coming from road transport.

The deliverable was executed in doing desk research and interviews with partners in the project, as well as external ones such as the ICCT.

What the research shows is that due to the nature of remote sensing technology, meaning that it can be used in an array of different applications, there are several policy options that can be reproduced with the right political will from governments. Whilst Europe has been behind for many years in this technology, compared to the US for instance, it is now slowly gaining ground.

1 Introduction

1.1 Purpose, scope and target group

The aim of this deliverable is to provide an overview of existing policy options linked to remote sensing devices for monitoring air pollution from road transport at a global level. The deliverable is for public dissemination.

1.2 Contribution partners

Table 1: Contribution of partners

Partner nº and short name	Contribution
1 CARTIF	Provided knowledge based on their experience with previous projects linked to air quality and remote sensing.
10 ORSE	Provided expertise based on their global footprint.

1.3 Relation to other activities in the project

Table 2: Relation to other activities in the project

Task	Description
WP8	This task is linked to wider deliverables in WP8, including the whitepaper as well as the report on the different pilots.

2 Introduction

As explored in previous publications of the NEMO project, on-road vehicle remote sensing (RS) has the great potential of being able to monitor the exhaust emissions, across a range of pollutants, from thousands of vehicles under so-called real-driving conditions. With vehicle emissions being the most significant source of air pollution in an urban environment, reducing air pollution is key to ensure an increased quality of life.

Many remote sensing technology pilots have occurred across the globe, spanning from Nashville to Beijing and whilst some regions are more advanced than others in terms of policy development, it is clear that there is a growing interest in using remote sensing devices to get high emitters off the roads and gather information as to who they are.

As previously presented under the NEMO project, remote sensing technologies can have different purposes. These are:

- Identifying high-emitting vehicles (and thereby vehicle categories) for market surveillance purposes;
- Monitoring fleet emission trends;
- Support in the design of local policies such as low emission zones by assessing individual vehicles;
- individual low-emitting vehicles whereby proper functioning results in bypassing the annual technical inspection;
- Identifying individual high-emitting vehicles with the purpose of triggering an early technical inspection or for tampering detection;
- Developing emissions factors to be used as inputs in determining emissions inventories; and more.

This short paper wishes to provide an overview of the state of play from a global perspective, showcasing how remote sensing related policy varies widely from local city efforts to more national ones.

3 United States

In the United States, early remote sensing systems were pioneered in Colorado, by the University of Denver in the late 1980s[1] via the development of the so-called Fuel Efficiency Automobile Test (FEAT).

As highlighted in recent research conducted by the TRUE initiative, remote sensing campaigns have taken place across the US in 19 states and Washington DC[2] albeit with different purposes showcasing the diverse nature of this technology. Today, the most active US states using remote sensing are California, which uses it for open path and extractive sampling. Open path refers to measuring pollutant concentrations in a vehicle's exhaust plume via spectroscopy as the vehicle drives through a light beam, using remote sensing technology. Extractive sampling refers to extracting a sample from the exhaust plume to measure with pollutant analyzers.

[1] https://digitalcommons.du.edu/feat/

https://digitalcommons.du.edu/cgi/viewcontent.cgi?article=1194&context=feat_publications

[2] https://www.trueinitiative.org/media/791467/us-emissions-database-true-initiative-report.pdf

With regards to the regulatory environment, as aforementioned, remote sensing in the US is used to different ends. The main one is for identification of individual high emitters triggering them to undergo an early periodical technical inspection (PTI) or tampering detection.

In a recent pilot which took place in Nashville, Tennessee, as well as in other pilots in Virginia, Ohio and Colorado, remote sensing was used to identify individual low emitters exempting them from periodic technical inspections using the open path method[3]. Each state gathers on a yearly basis several million remote sensing measurements.

Another use seen in the USA[4] is making use of the technology to inform regulatory compliance, thereby demonstrating the feasibility of identifying groups of high-emitting vehicles for market surveillance purposes.

Based on an analysis[5] conducted of the 30+ years of historical remote sensing data in the US, the findings were that NOx emissions from light-duty vehicles increased with vehicle age as emission control technologies deteriorated. Specifically, in older vehicles the emissions could go up to 200% over their lifetime with much quicker deterioration rates than those reported to authorities.

What these and other findings show, is that ultimately further collection of real-world emissions data is needed to understand the impact of motor vehicles on air quality locally with the purpose of helping policymakers develop effective policy solutions

4 China

Historically, remote sensing activities in China have focused primarily on the detection of individual high-emitting vehicles[6]. In 2017, China had over 260 permanent open path systems recording about 38 million vehicle measurements which at the time was likely the largest amount of remote sensing activity in the world.

In 2017, China's Ministry of Environmental Protection (MEP), under the Three-Year Action Plan on Winning the Battle for Blue Sky, published a national regulation[7] for measuring pollutants in exhaust from in-use diesel vehicles using remote-sensing equipment. This policy proposal made China the first country in the world to implement remote sensing on a national level, on both light-duty and heavy-duty diesel vehicles.

With the regulation taking effect immediately, it replaced all local standards related to the monitoring of diesel vehicle exhaust emissions. Whilst the regulation did not mandate remote-sensing programs at the local level, it defined a uniform protocol for local agencies to follow if they currently have or decide to implement a remote-sensing program. At the time of announcement, the MEP stated that the goal of this regulation was to eliminate the top 5% of high emitting vehicles.

[3] https://theicct.org/sites/default/files/publications/World-wide_remote-sensing_2019_4_30.pdf

[4] Carl Fulper et al., "Remote Sensing Data (RSD) From the State of Colorado: 'Real-World' Emission Analysis on Newer Vehicles," 2017, 20.

[5] https://theicct.org/wp-content/uploads/2021/06/US-TRUE-emissions-database-oct2020.pdf

[6] https://theicct.org/sites/default/files/publications/China-diesel-remote-sensing_ICCT-policy-update_19092017_vF.pdf

[7] ibid

By the end of 2018, more than 560 remote sensing units were in active use across China in 23 provinces[8].

5 Europe

Remote sensing in Europe first started in the 90's specifically linked to early research efforts in Scandinavia[9] and in the United Kingdom.

Whilst historically being behind other regions in deploying remote sensing technology, in recent years we have seen a growing adoption and testing of said technology especially in Western Europe.

This has recently changed, and Western Europe is rapidly accelerating remote sensing measurements and expanding the uses of the technology. In fact, since 2010 a large number of projects have been recorded across the EU. Particular mention goes to the CONOX project[10] which was established in 2016 by the Bundesamt für Umwelt (Switzerland's Federal Office for the Environment) with the objective of compiling remote sensing findings from France, Spain, Switzerland, Sweden and the United Kingdom ultimately wanting to build a European remote sensing database.

In 2018 the database held more than 700,000 measurements and since then the number has continued growing thanks to the efforts of other initiatives.

Worth mentioning in this section are also the efforts of individual member states such as Spain and Denmark who have been running pilot programs using cross-road open path remote sensing to detect high-emitting vehicles[11]. These programs specifically aim at identifying tampered vehicles (specifically trucks) that, thanks to illegal devices, are able to turn off their emission control systems.

Other examples at member state level include those in Germany, where a plume chaser system was developed and demonstrated for use as a high-emitter screening tool. In Eastern Europe a notable example is the one in Sofia, Bulgaria, where via deploying remote sensing technology, local traffic authorities rolled out signs that instantly told drivers when their emissions were too high and thereby inviting them to undergo a technical inspection.

Most recently, the Spanish government had been working on creating a legal framework for the use of remote sensing technology by public administrations. Whilst the measure has not yet been approved for several reasons, it sets an important objective the standardization of remote-sensing emissions measurement, as well as the intention to identify and reduce the number of high emitters in urban roads. If approved, the law could set a strong precedent for the use of remote sensing technologies in Europe and globally.

[8] https://theicct.org/wp-content/uploads/2021/06/Worldwide-use-RSD-4.20.20.pdf

[9] Åke Sjödin, "On-Road Emission Performance of Late-Model TWC-Cars as Measured by Remote Sensing," Air & Waste 44, no. 4 (April 1994): 397–404, https://doi.org/10.1080/1073161X.1994.10467261.

[10] Jens Borken-Kleefeld et al., "Contribution of Vehicle Remote Sensing to In-Service/Real Driving Emissions Monitoring—CONOX Task 3 Report" (Federal Office for the Environment, Switzerland, May 2018), https://www.ivl.se/download/18.2aa26978160972788071cd7b/1529408235244/comparing-emission-rates-derivedfrom-remote-sensing-with-pems-and-chassis-dynamometer-tests-conox-task1-report.pdf

[11] https://theicct.org/wp-content/uploads/2021/06/Worldwide-use-RSD-4.20.20.pdf

6 Other parts of the world

In other parts of the world the interest in developing policies linked to remote sensing measurements for road traffic is mainly linked to local efforts. Below some examples worth highlighting.

Bogota

Lawmakers in the Colombian capital of Bogota announced the objective of reducing traffic and cutting air pollution by 10% by 2025 (compared to a 2020 baseline). A key pillar of the strategy is to impose strict emission standards on heavy duty diesel trucks upon entry in the city[12]. Remote sensing has been identified as a key tool in achieving this plan.

Jakarta

With the number of cars and motorcycles growing at an exponential rate in the Indonesian capital, the Environment Agency of DKI Jakarta has put in place a number of efforts to tackle emissions coming from road transport including requiring regular emission testing.

Thanks to a collaboration with the TRUE initiative and an Indonesian university, measurements as to the vehicle fleet in Jakarta are undergoing with the objective of providing a detailed insight into the pollution emissions from the Jakarta fleet[13] and ultimately help regulators assess the impact of the region's air quality improvement plan supporting their authorities in designing better policies to control vehicle emissions and preparing for the implementation of more stringent emission standards.

Conclusions

As previously highlighted in the introduction, remote sensing devices can be used for an array of applications. For this reason, there are different available policy paths being explored globally today.

To maximise this technology however the *fil rouge* is clear. What is needed is:

- Continued investments and political will from governments into remote sensing technology with the objective of identifying the causes of high real-world emissions.
- Greater reliance and use of remote sensing data in decision making and policy development, making data-based informed decisions such as on vehicle pollutant standards.
- Increased use of remote sensing technology for market surveillance purposes.
- At national level, incentivise the usage of remote sensing as a key tool in supporting anti-tampering efforts.

12 https://www.researchgate.net/publication/341677237_A_Decade_of_Air_Quality_in_Bogota_A_Descriptive_Analysis

13 https://www.trueinitiative.org/blog/2022/november/evaluation-of-real-world-vehicle-emissions-and-standards-in-jakarta

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[2] B. Peeters, G. v. Blokland, 2007: IMAGINE – Improved Methods for the Assessment of the Generic Impact of Noise in the Enivroment - The Noise Emission Model For European Road Traffic, Deliverable 11, page. 33.

[3] ISO/CD TS 13471-2 "Acoustics – Temperature influence on tyre/road noise measurement – Part 2: Correction for temperature when testing with the pass-by methods"

[4] ISO 9613-2:1996: "Acoustics – Attenuation of sound during propagation outdoors- Part 2: General method of calculation."

[5] S. Kephalopoulos et al: CNOSSOS-EU: Common Noise Assessment Methods in Europe, JRC Reference Report No. EUR 25379 EN.