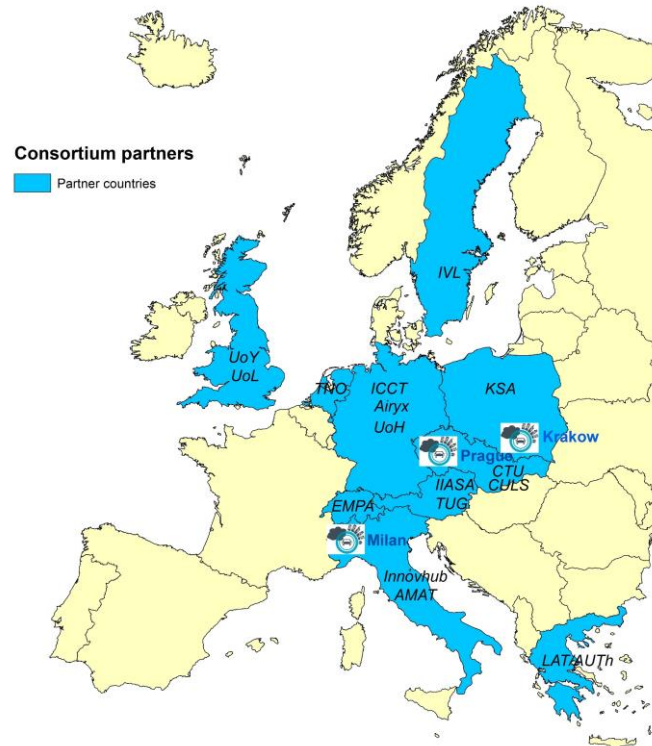


H2020 CARES - Exploring remote sensing techniques for monitoring real-world vehicle emissions performance



Åke Sjödin
Swedish Environmental Research Institute

CARES – an InCo flagship project bringing together RES expertise in Europe and China



Overall objectives

“Reduce the hurdles for practical applications of remote emission sensing (RES) and to make it a widespread means of both monitoring and enforcing improvements in road vehicle emissions.”

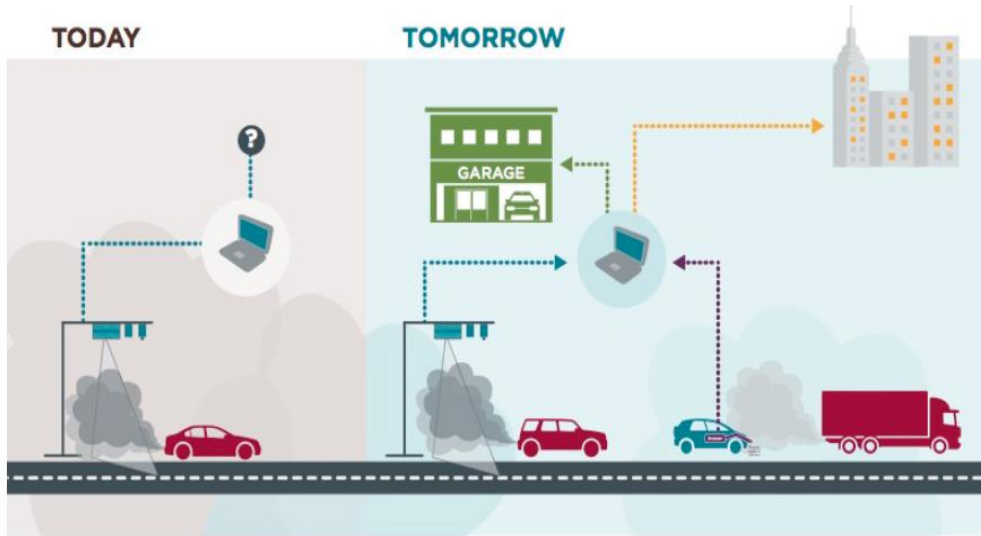
Why this then?

- Poor air quality is still a big issue in many European cities
- Road transport has persisted to be the main source to urban air pollution
- Failure of EU emission legislation and poor knowledge about emissions in real-world traffic have hampered improvements in urban air quality for long (e.g. gate”)
- Real-world emission surveillance and more efficient measures need to be implemented

 *Further refinement and widespread deployment of RES can improve urban air quality!*

Overall objectives

“Reduce the hurdles for practical applications of remote emission sensing (RES) and to make it a widespread means of both monitoring and enforcing improvements in road vehicle emissions.”

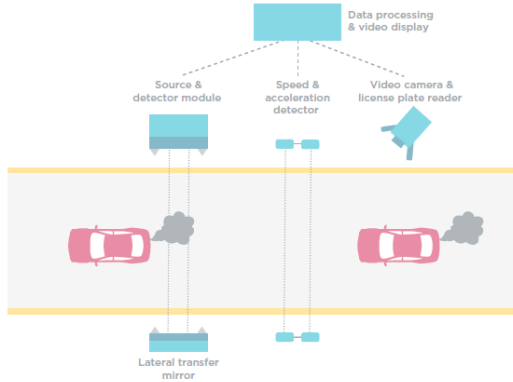


CARES elements

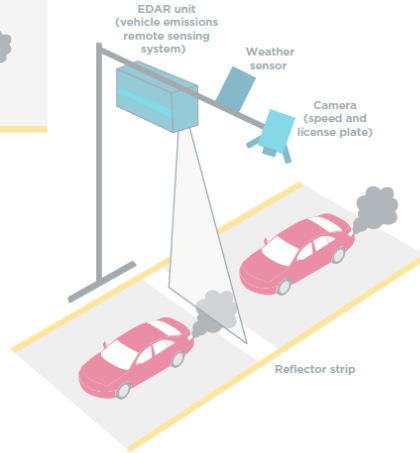
- Hardware development
- Software and data platform development
- Demonstrations in three polluted cities
- User toolboxes and guidance

Hardware development

Existing (commercial) technologies



Schematic of cross-road remote emission sensing device.

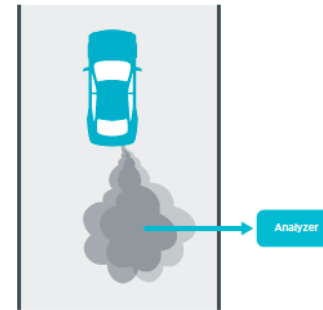


Schematic of top-down remote emission sensing device.

CARES technologies



Schematic of plume chasing remote emission sensing device.

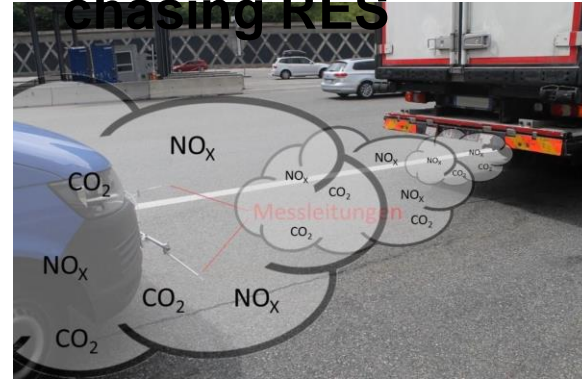


Schematic setup of point sampling remote emission sensing device.

- Conventional
(commercial) RES



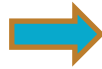
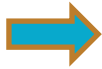
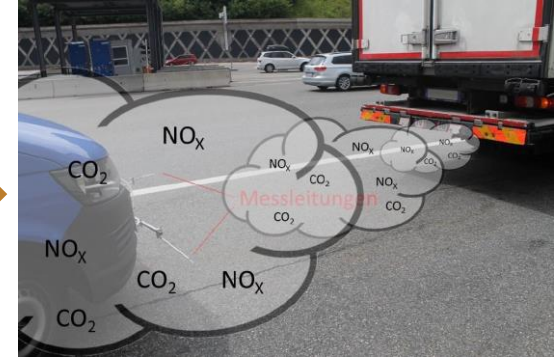
- CARES plume
chasing RES



- CARES point
sampling RES

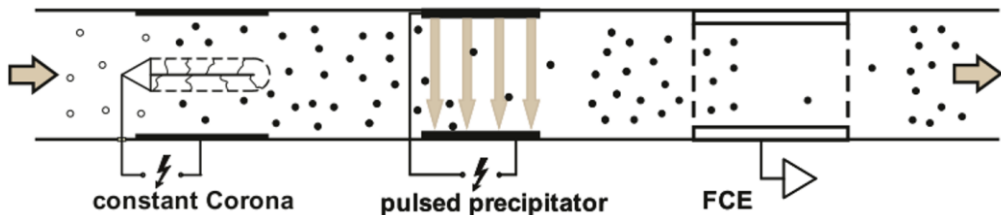


Plume chasing technology

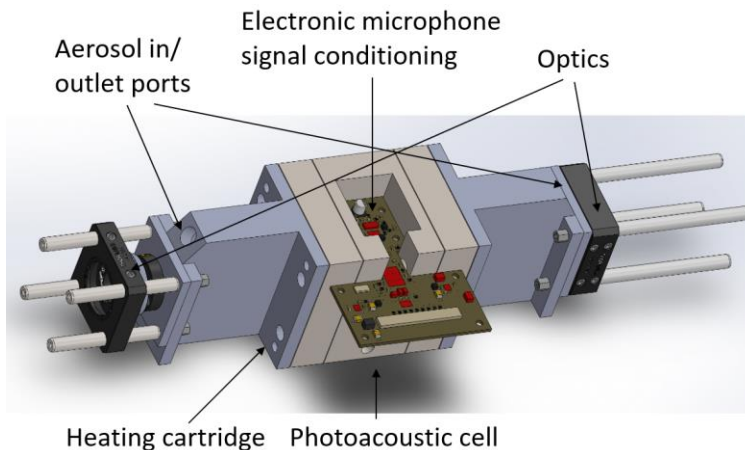


Point sampling technology

- Low-cost, low-power, small size sensors
- Measuring concentrations of particles with high time resolution (1 Hz)
- Photoacoustic sensor for **Black Carbon (BC)**, i.e., soot particles
- Diffusion charging technology
- Diffusion charging sensor for



Photoacoustic technology



Characterization and validation experiments

- Emission characterization and technology validation experiments at a test track

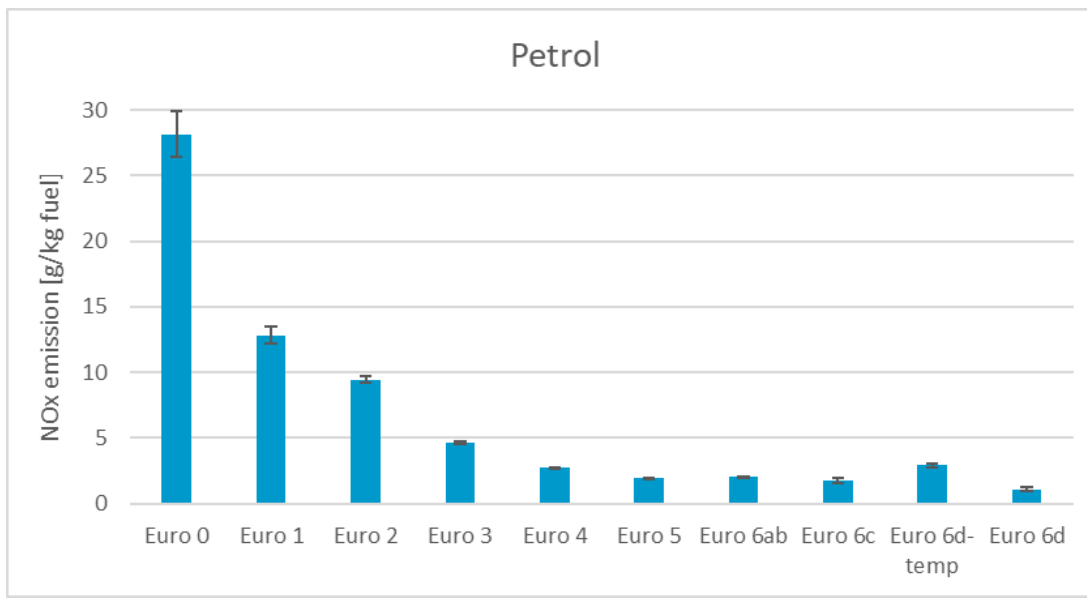


RES data

- CARES presently hosts (as legacy) ≈ 1.5 mio measurement records/vehicle passages
- Each record contains >100 parameters (emission and vehicle data)
- NO_x emissions by Euro class as measured on $\approx 600,000$ cars across Europe 2011-2020:

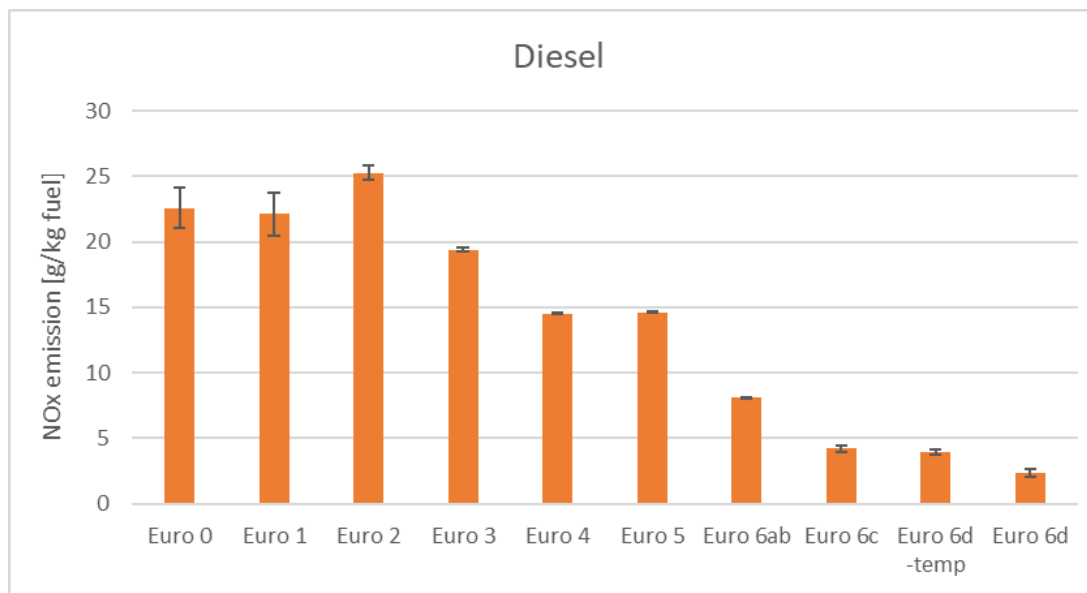
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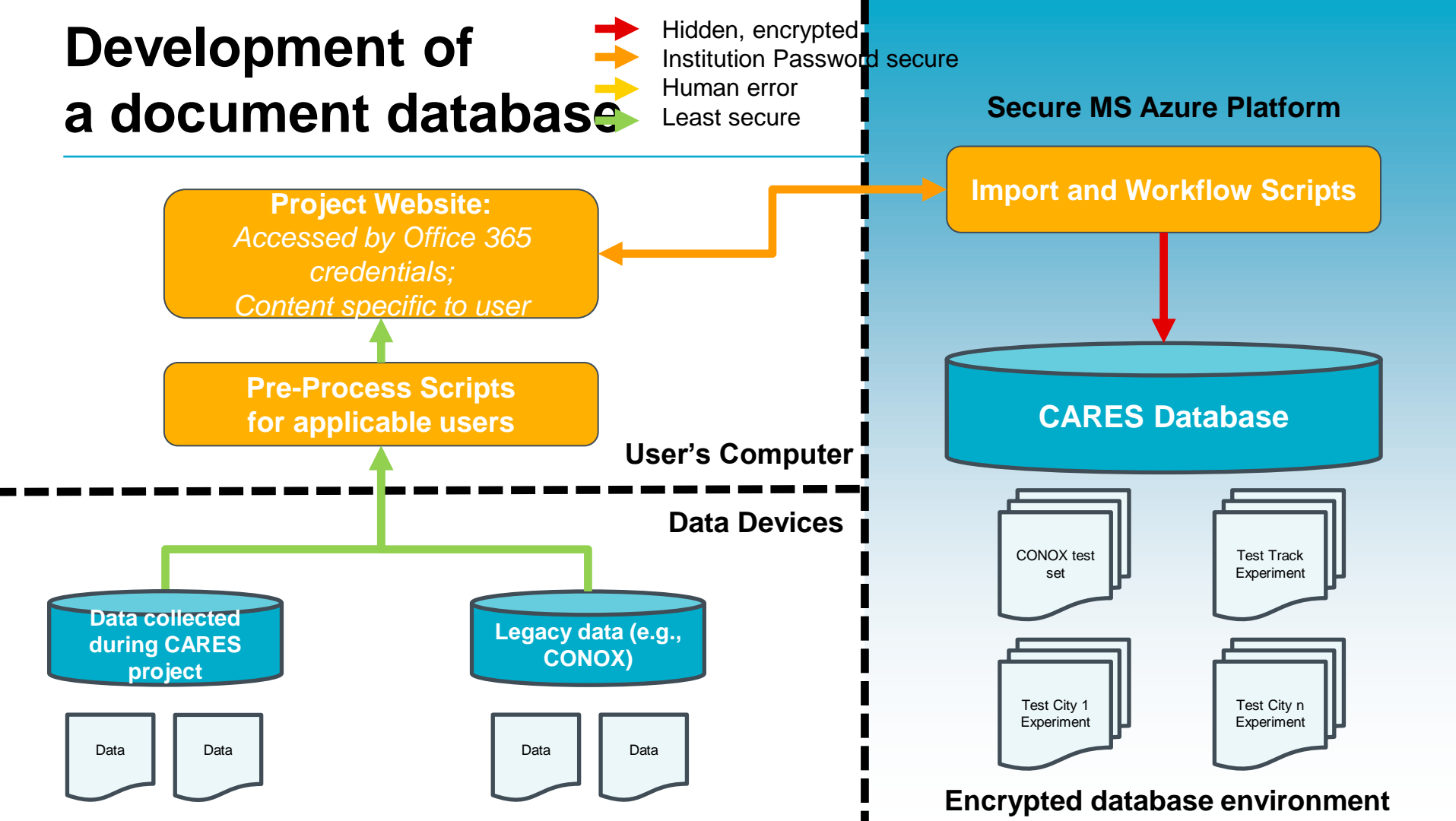
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Development of a document database

- ➔ Hidden, encrypted
- ➔ Institution Password secure
- ➔ Human error
- ➔ Least secure



Development of user toolboxes and guidance

- For smoother integration of RES into policy making and enforcement practices
- The *openCARES* software package:
 - [R statistical software](#) for automated **data analysis** (fully open source)
 - [GitHub](#) for version control of the code
 - [R markdown](#) for automated analysis **report production**
- User **guidance document** for RES measurements and data analysis & interpretation
- Characterisation of **high-emitting vehicles** and their impact on emissions and air quality in polluted cities

City demonstrations

- Demonstrations of RES applications in three polluted cities:



RES applications:


- 1) Identification of **high-emitting vehicles**
- 2) Generation of real-world **emission factors**
- 3) Steering **new policies**
- 4) Track **policy effectiveness**
- 5) Track **technology effectiveness**
- 6) Screen fleets for **market surveillance**
- 7) Monitoring **single fleets**
- 8) Understand **impact** of driving conditions
- 9) Inform **purchasing decisions**

1st city demo campaign in Milan, 27 Sep – 18 Oct



Thank you for your attention!

For further information:

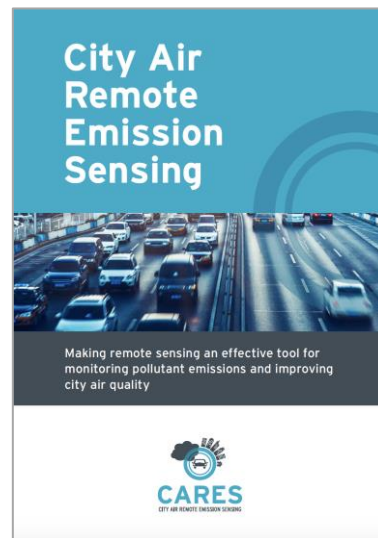
- Check the website: <https://cares-project.eu>
- Download the project brochure 
- E-mail contact: ake.sjodin@ivl.se
- Follow us on social media:



@cares_project



<https://www.linkedin.com/company/city-air-remote-emission-sensing-cares>



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 814966



HERE Technologies
and Bosch
Air Quality Solutions

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Matthias Mann

Co-Author
Eric Lindzus

Environmental Sensitive Traffic Management

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1

Why?

Improve Air Quality

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Air Quality

Road transport as main source of emissions

Did you know?



400 000 premature deaths in the EU every year are linked to air pollution



Air pollution costs over
€4 billion in healthcare
and **€16 billion in lost workdays**



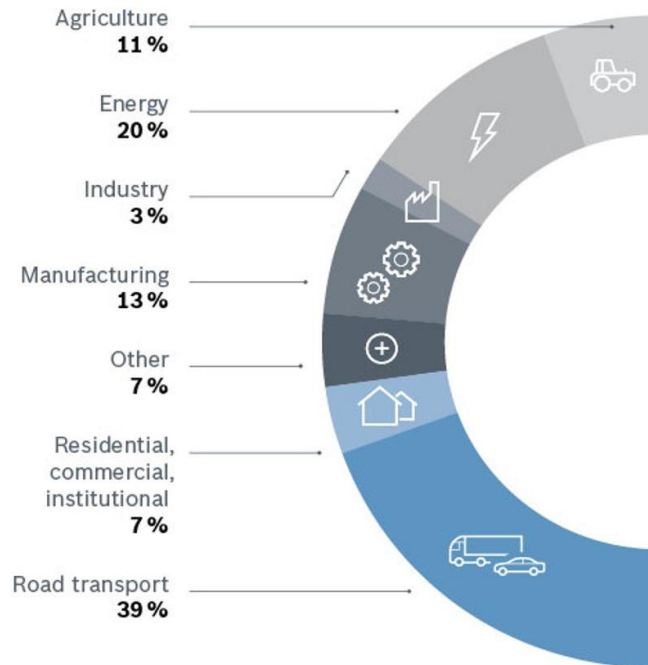
Particulate matter and nitrogen dioxide are the main urban pollutants and are **very harmful** to **human health**



About **130 cities** across Europe do not meet EU air quality standards



72 % of Europeans want **public action** to improve air quality



Source: European Commission / Air Quality in Cities 2017

Source: EEA/Air pollutant emissions data viewer 7/2016

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2

How?

From Vehicle Probe
Data to Air Quality

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Value proposition

What sets us apart?

- Focus on road traffic emissions
- No / little additional sensor infrastructure needed
- Main input is coming from vehicle probe data
- Consideration of vehicle dynamics
- High spatial resolution (20m segments)
- High accuracy of used emission model
- Detailed insights into NOx, PM (tailpipe), CO2

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Emissions

Driving factors

traffic volume

number of vehicles / h



„too much vehicles“

traffic situation

1/(average speed)



„vehicle delay“

vehicle dynamic

emission / second



„bad driving behavior“

Factor: 1x

Factor: 4-10x

Mean values of NO_x-emissions

	Constant driving between 20 and 40km/h	Constant driving between 40 and 140km/h	Constant driving >140km/h	All acceleration states	Acceleration states between 0 and 40 km/h	Acceleration states between 40 and 100 km/h	Acceleration > 100 km/h
	[mg/km]	[mg/km]	[mg/km]	[mg/km]	[mg/km]	[mg/km]	[mg/km]
Fahrzeug 1	100%	69%	<200%	490%	>650%	>400%	>400%
Fahrzeug 2							
Fahrzeug 3							

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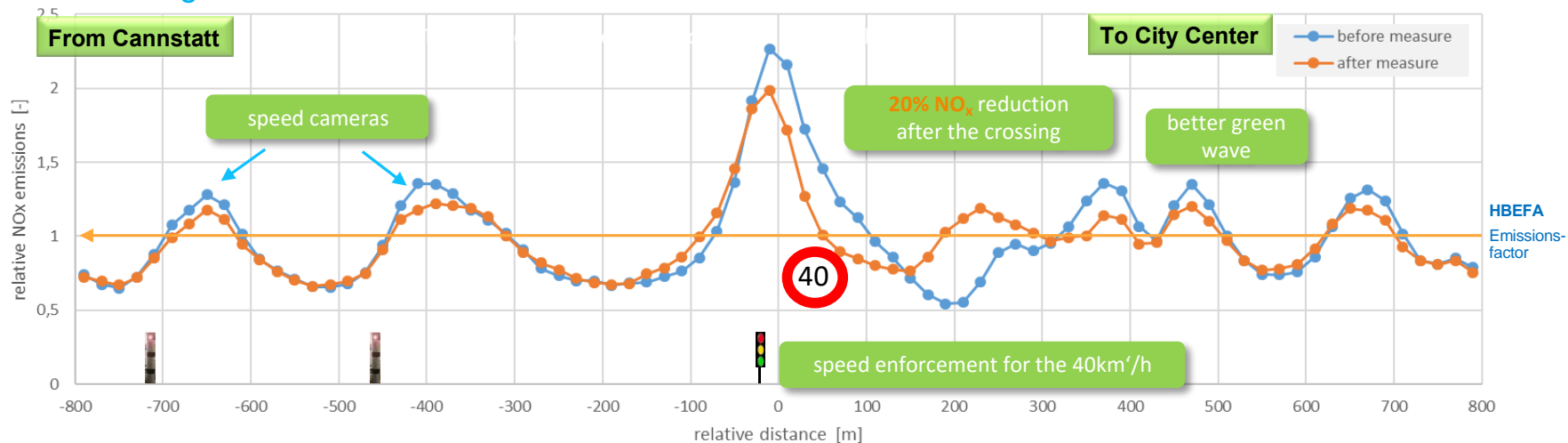
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Emissions

Detailed insights



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What?

Emission data

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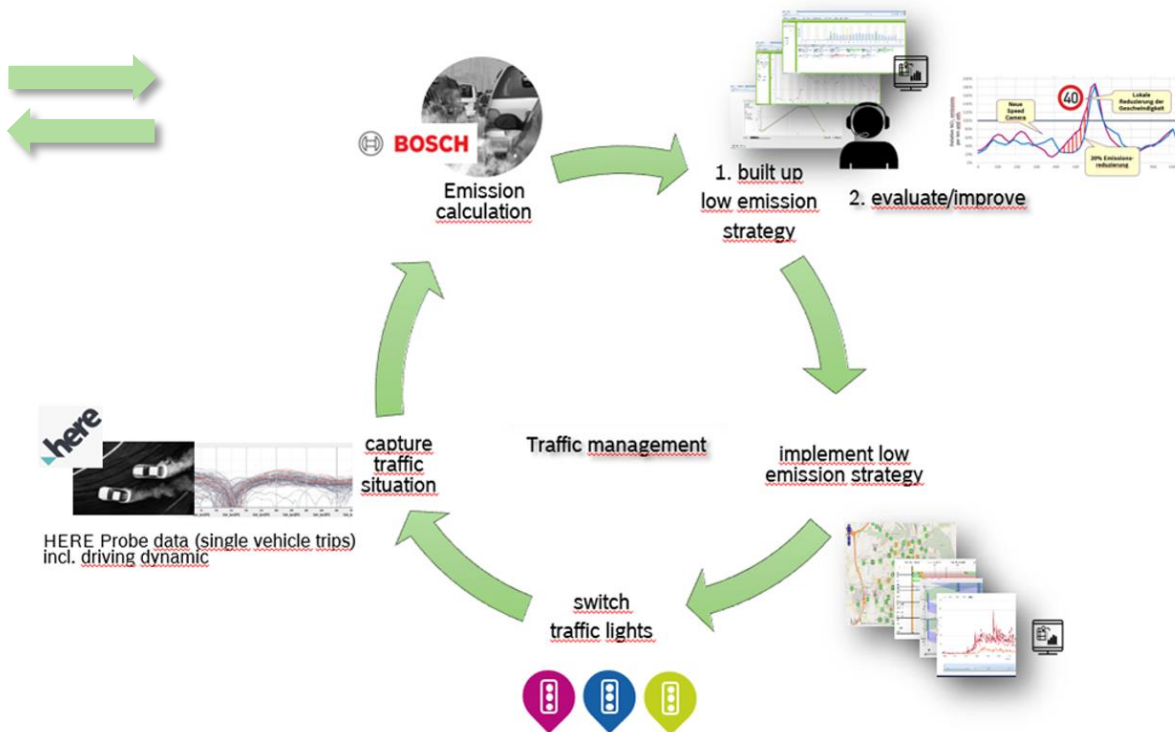
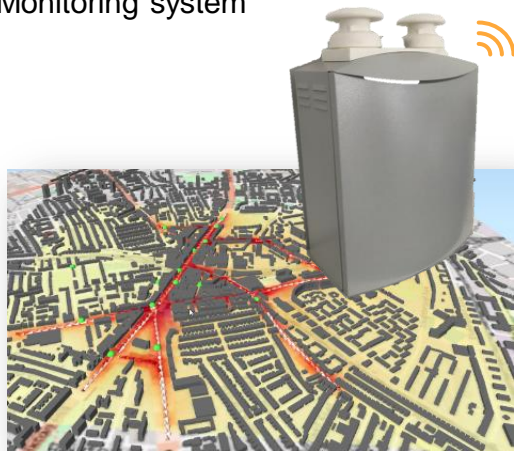


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Solution setup

Insights

Modular approach, expandable by certified **Air Quality measurement boxes** and an **dispersion calculation** to get a holistic environmental Monitoring system



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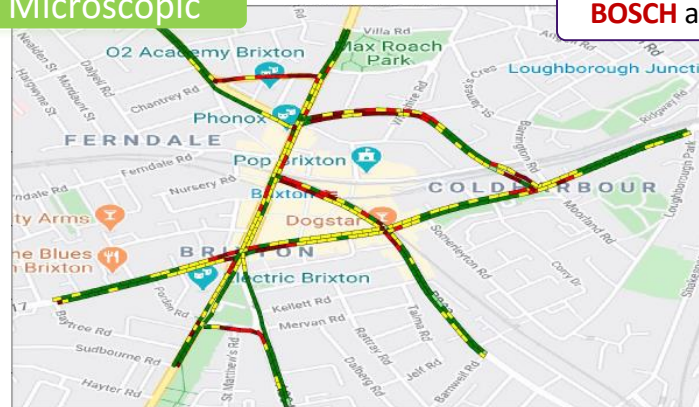
Delivery

Historical insights

- Emission data based on vehicle probe data
- Providing NOx, PM (tailpipe), CO2
- Enabling emission hotspot identification
- Allowing before and after analysis to evaluate impact of traffic measures

Microscopic

BOSCH approach



spatial extent of emission hotspots

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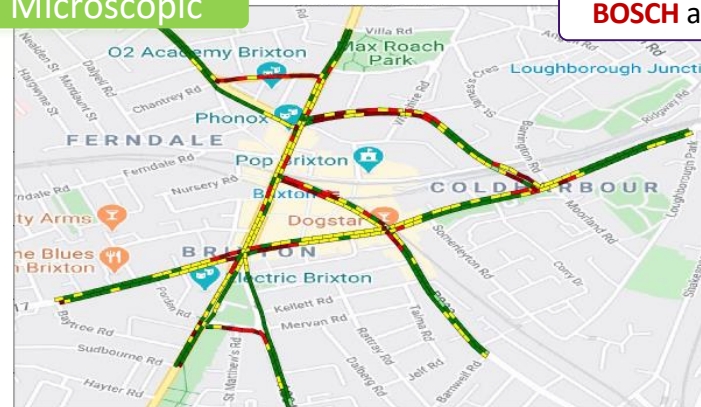
Delivery

Near real-time insights

- Hourly updates of emission data
- Providing NOx, PM (tailpipe), CO2
- Supporting traffic management aiming for smoothening traffic flow
- demand distribution

Microscopic

BOSCH approach



spatial extent of emission hotspots

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Questions

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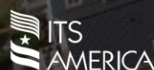
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