

The End of the ICE Age
It's time to phase out the Internal Combustion Engine

21
APRIL
2021

AVERE
The European Association
for Electromobility
WEBINAR

**Clean air and NOx
emissions from
vehicles**

*The end of the ICE Age means cleaner
air for everybody*



ENS 

Clean air solutions



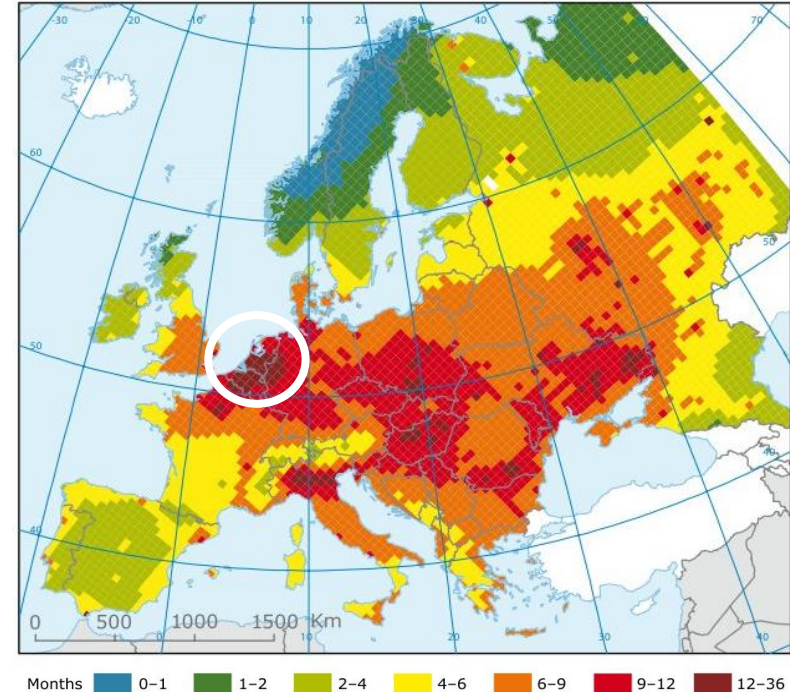
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What does the end of the ICE age
mean for (urban) air quality?

The Netherlands On Top

- Outdoor air pollution yearly causes **6 to 9 million premature deaths** worldwide
- In the Netherlands the average life expectancy is **reduced by 11.8 months** due to PM2.5
- Researchers have linked air pollution to many **adverse health effects and diseases**, especially related to (unborn) children, elderly and the most vulnerable

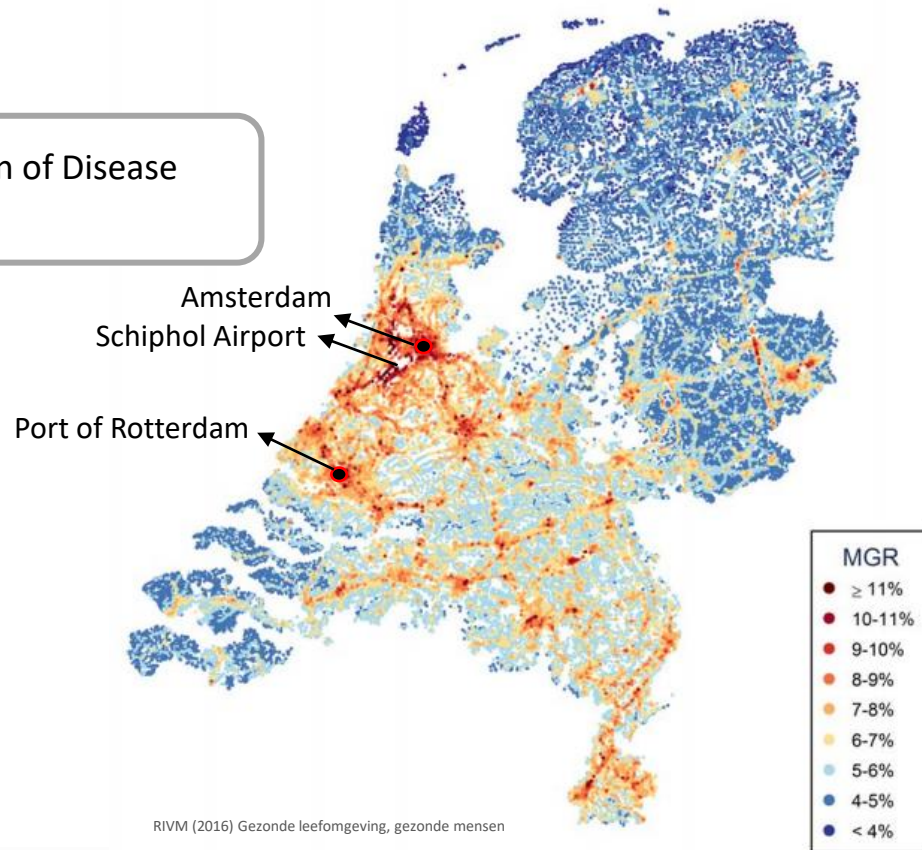


Loss of life expectancy attributed to man-made emissions contributions of PM2.5.

Burden of Disease

- Environmental impact has 4-14% impact on Burden of Disease
- 75% is a result of air pollution

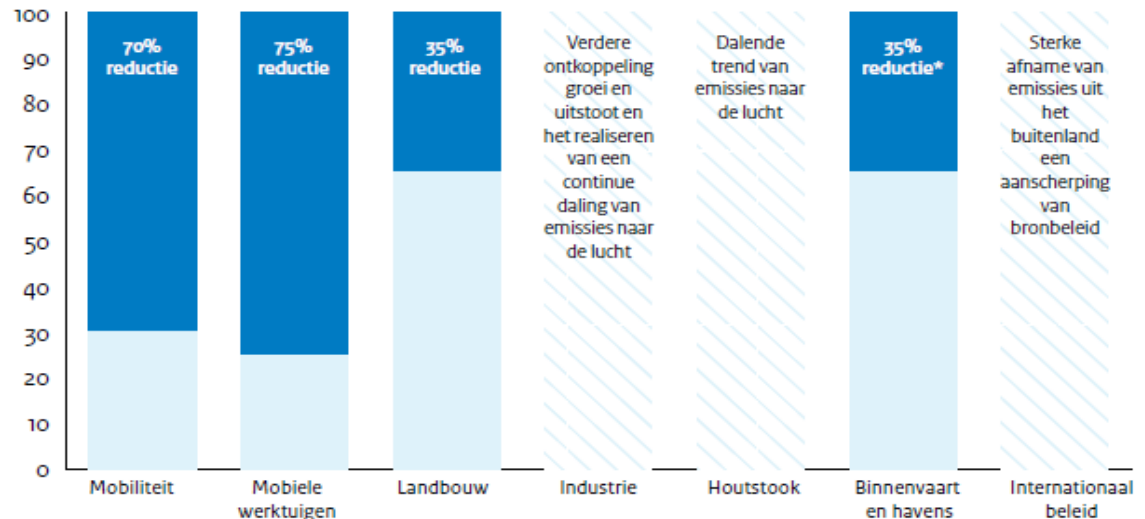
		Burden of Disease	Mortality (x1000)
	Smoking	9,4%	20,0
	Overweight	3,7%	4,2
	Alcohol	1,5%	1,8



RIVM (2016) Gezonde leefomgeving, gezonde mensen

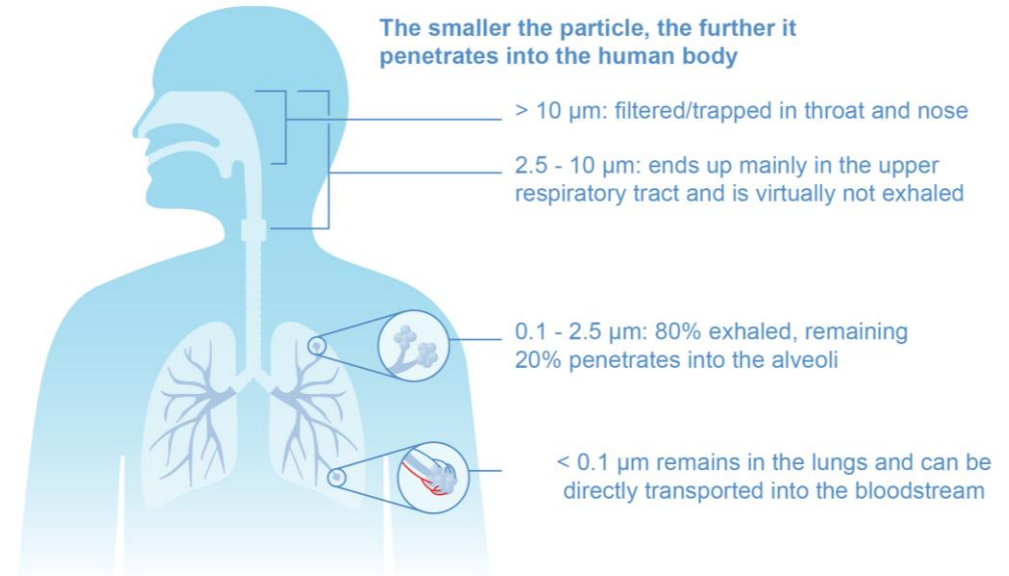
The Netherlands towards 2030

- 'Clean Air Deal' - 50% health gain in 2030
- Reduction of emissions in mobility, mobile machinery, agriculture, shipping, industry and wood burning for heating.



Health Impact PM

Particulate matter (PM) is a mixture of **solid and liquid particles** suspended in air (=aerosols)
Fine Particulate matter can **penetrate** deep into the **lungs and bloodstream**.



Adapted from: Gezondheidsraad(2018) Gezondheidswinst door schone lucht

Health Impact PM

Particulate matter (PM) is a mixture of **solid and liquid particles** suspended in air (=aerosols)
Fine Particulate matter can **penetrate** deep into the **lungs and bloodstream**.

- The health impact of PM_{2.5} is approx. **7 times higher than NO₂**
- An increase in the PM concentration immediately translates into higher mortality rates.
- **Direct correlation between $\mu\text{g} / \text{m}^3$ PM and deaths** from heart and lung disease.

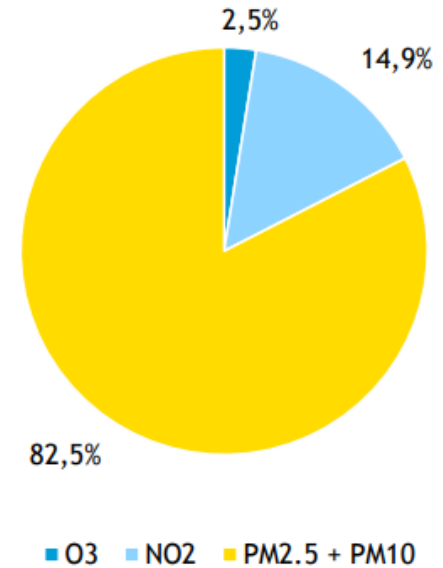
EU-28, 2018	PM2,5	NO2	O3
Premature Deaths	379,000	54,000	19,400
Years of healthy life lost	4,381,000	610,000	232,000

EEA (2020) Air Quality in Europe

Health costs of PM

- PM is also main contributor to total cost of health impact
- Morbidity, premature mortality and secondary effects
- Exposure leads to Health damage
 - Geography
 - Local emissions
 - Weather influences
 - Urban planning
 - Social situation
 - (international) Policy
 - Local mitigation measures

Distribution of health damage costs attributed to main pollutants



CE Delft (2020) Health cost of air pollution in EU cities and the linkage with transport

How do we value clean air?

- **Long-term effects** are harmful and costly. For the Netherlands, these are estimated at € 20 - € 40 billion per year.
- **Cost per capita** within EU ranges €400 to €3000
- The **socio-economic costs** average: €1250 per capita
- Equivalent to 3,8% of the European GDP

- Recent studies suggest that long term exposure to **PM2.5 is associated with higher COVID-19 mortality** rates.

No.	City/urban area	Country	Social costs € mln
1	London (greater city)	UK	11,381
2	Bucuresti	Romania	6,345
3	Berlin	Germany	5,237
4	Warszawa	Poland	4,223
5	Roma	Italy	4,144
6	Metropolia Silesia	Poland	3,596
7	Paris	France	3,505
8	Milano	Italy	3,499
9	Madrid	Spain	3,383
10	Budapest	Hungary	3,272
11	Hamburg	Germany	2,936
12	München	Germany	2,878

CE Delft (2020) Health cost of air pollution in EU cities and the linkage with transport

PM and Covid-19 Risks

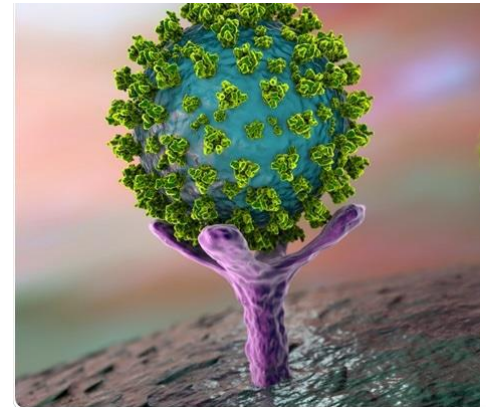
Exposure to air pollution **increases the risk of infection** and the spread of viruses, such as COVID-19. This exposure causes an increase in the number of binding sites for the SARS-CoV-2 virus in the airways, thereby facilitating COVID-19 infection^[1].

Advantages of air treatment^[2]

- Inactivates and removes airborne particles, such as the COVID-19 causing virus (SARS-CoV-2).
- Reduces the risk of the virus spreading/infection pressure.
- 1/5 of COVID-19 casualties can be linked to air pollution

Clean air in Europe during lockdown 'leads to 11,000 fewer deaths'

Study into effects of coronavirus curbs also finds less asthma and preterm births

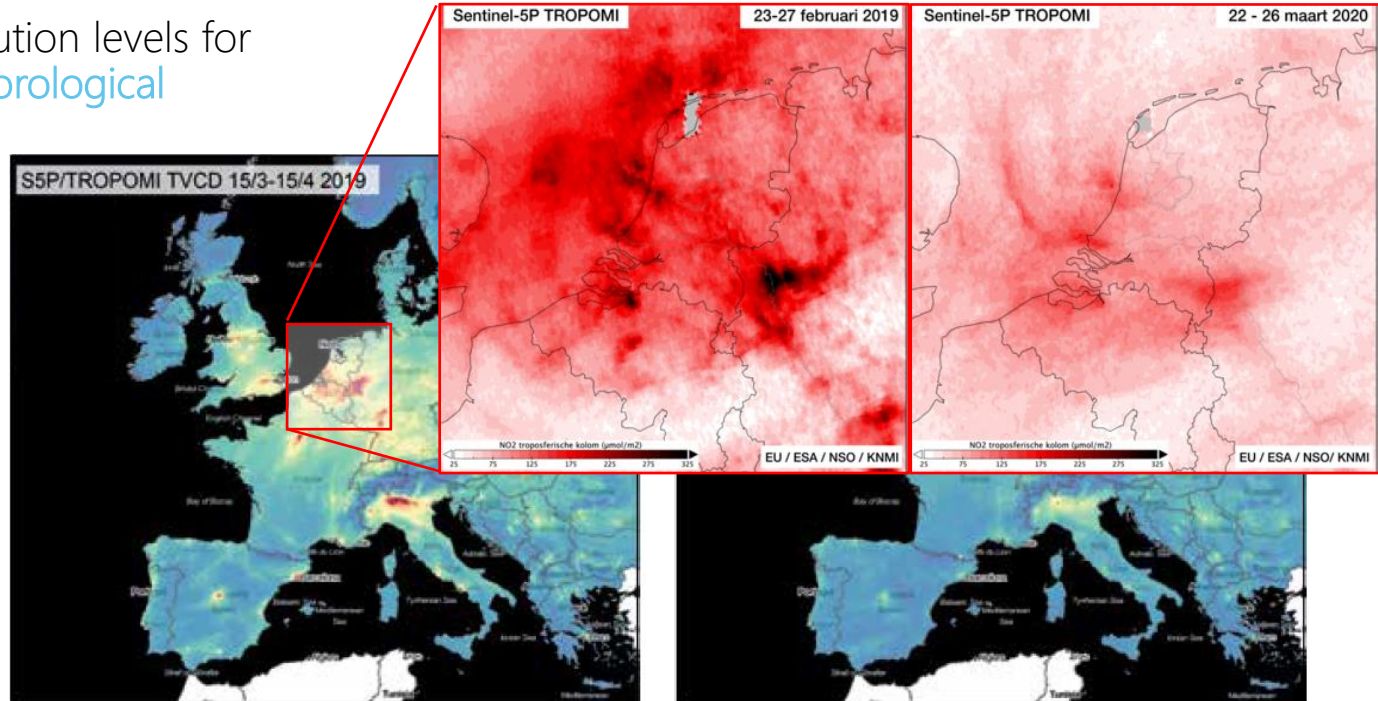


[1] Hoffmann-2020 -SARS-CoV-2 Cell Entry Depends on ACE2 and TMPRSS2

[2] Hagbom-2015-Ionizing air affects influenza virus infectivity and prevents airborne-transmission

Lockdown = End of ICE Age?

- Tropomi NO₂-pollution levels for comparable meteorological circumstances



Average NO₂ pollution level (tropospheric vertical column) for 15 March - 15 April 2019 (left panel) and for the same period in 2020 (right panel)

Lockdown = End of ICE Age?



- Tropomi NO₂-pollution levels for comparable **meteorological circumstances**
- For long-range **transported air pollutants, such as PM_{2.5} and O₃**, the lockdown demonstrates a relatively modest air quality improvement



Changes in air quality during COVID-19 'lockdown' in the United Kingdom ☆

Calvin Jephcote ^a, Anna L. Hansell ^{a, b}, Kathryn Adams ^a, John Gulliver ^{a, b}

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<https://doi.org/10.1016/j.envpol.2020.116011>

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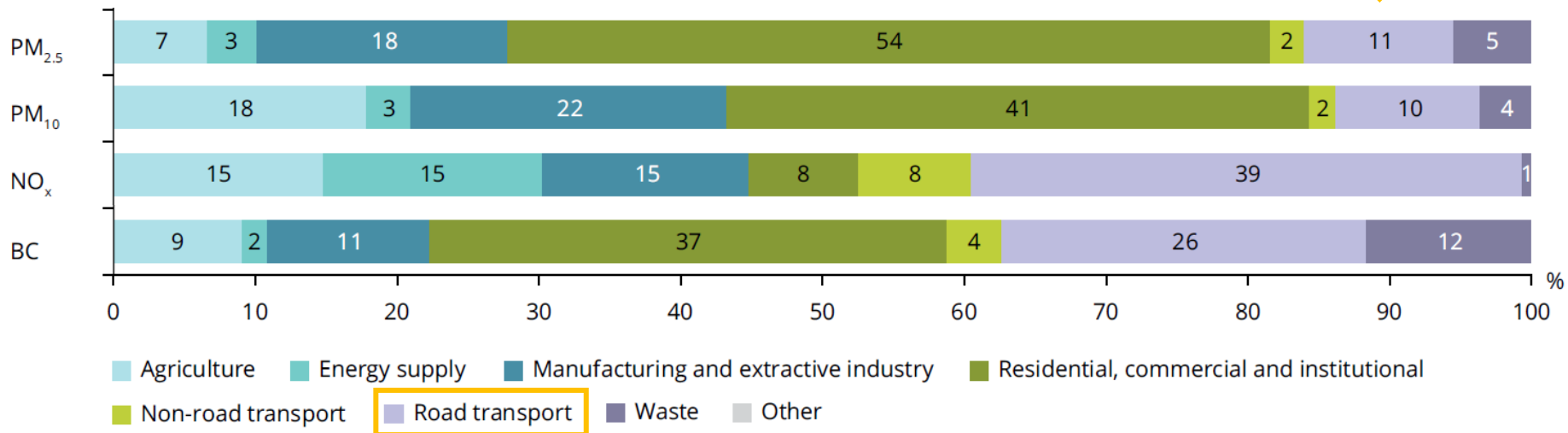
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Highlights

- Monthly-average daily traffic counts in April-2020 fell by 69% compared to April-2019.
- NO₂ and PM_{2.5} concentrations fell respectively by 38.3% (8.8 μg/m³) and 16.5% (2.2 μg/m³).
 - O₃ increased by 7.6% overall as the atmospheric chemistry changed.
 - NO₂ and PM_{2.5} improvements were largest at urban traffic sites.
 - Weather conditions contributed to particulate episodes that were seen despite traffic reductions.

Distribution of emissions in the EU (2018)

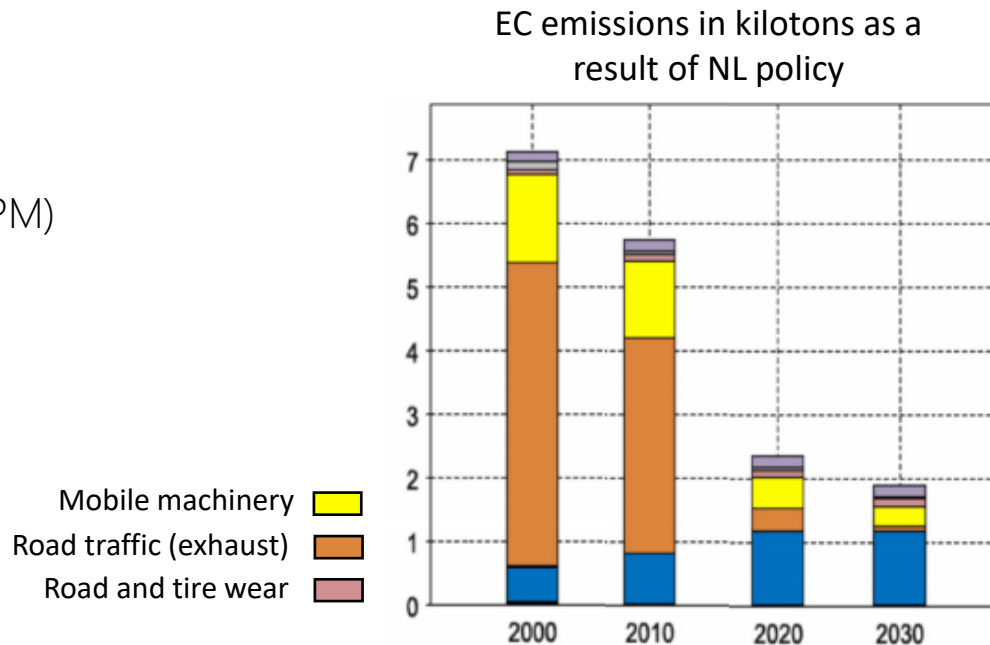


- Contribution of traffic related PM in city centres can (locally) add up to 30%

Exhaust vs. Non Exhaust emissions

Reduction of fossil fuels – exhaust emissions: EC, NO₂ & PM

- Elemental carbon (EC) emissions decrease significantly with new regulations
- By 2030 EC (harmful component of PM) is minimized



RIVM 2015 Luchtqualiteit en gezondheidswinst

Exhaust vs. Non Exhaust emissions

Internal Combustion Engines

- Substantial improvement on PM and EC (Soot)
- Mainly non-exhaust emissions

Car Type	Exhaust (mg/vkm)			Non-Exhaust (mg/vkm)		
	PM ₁₀	PM _{2.5}	Soot	PM ₁₀	PM _{2.5}	Soot
Petrol (EURO 5)	1	1	0.2	30	17	2.7
Diesel (DPF, EURO 5)	4	4	0.8	30	17	2.7
Diesel (no DPF, EURO 2)	62	62	50	30	17	3

DPF, diesel cars with particulate filter.

Exhaust vs. Non Exhaust emissions

No **exhaust PM contributions** from electric vehicles

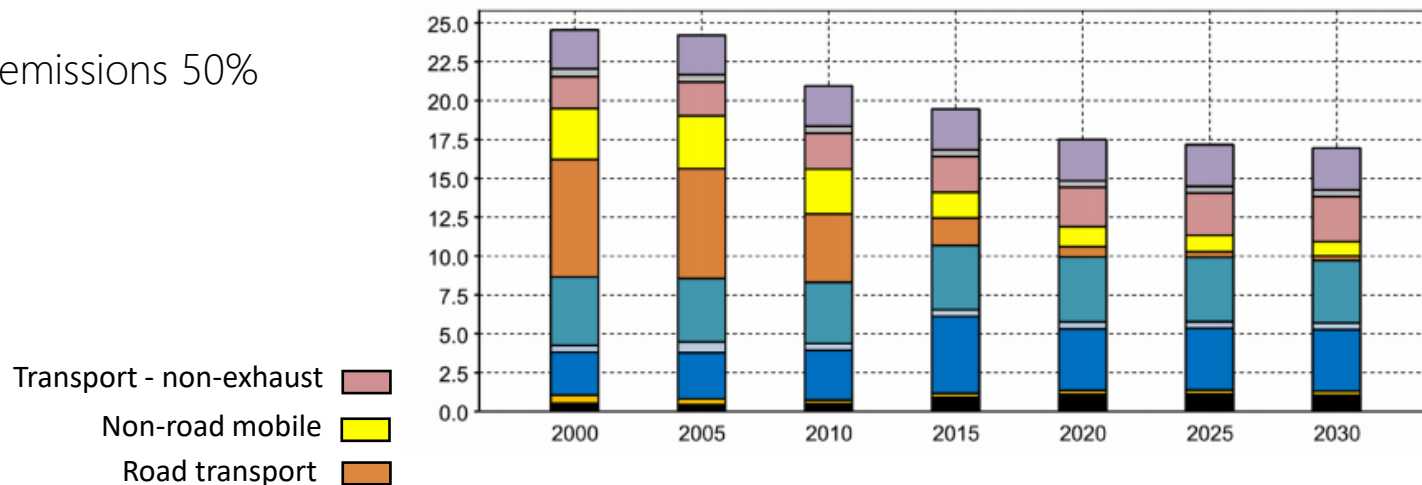
Vehicle Technology	Exhaust (mg/vkm)	Non-exhaust				Total (mg/vkm)
		Tire Wear (mg/vkm)	Brake Wear (mg/vkm)	Road Wear (mg/vkm)	Resuspension (mg/vkm)	
EV	0	7.2	0	8.9	49.6	65.7
Gasoline ICEV	3.1	6.1	9.3	7.5	40	66.0
Diesel ICEV	2.4	6.1	9.3	7.5	40	65.3

Timmers, Achten (2018) Chapter 12: Non-Exhaust PM Emissions From Battery Electric Vehicles, in: Amato (Ed.), *Non-Exhaust Emissions, An urban air quality problem for public health impact and mitigation measures*, Elsevier

End of the ICE age

- Increase in electric vehicles
- Increase of road transport
- Non-exhaust emissions 50% increase

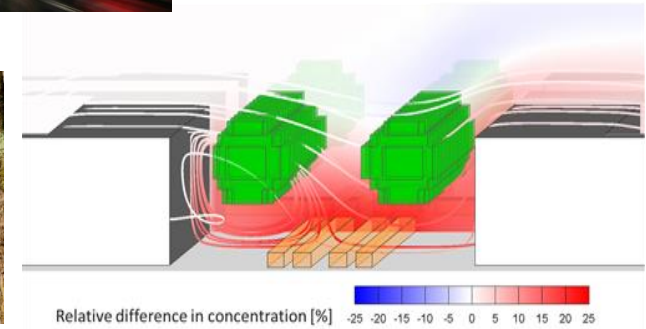
PM2.5 emission in kilotons as a result of NL policy



The effect of air quality measures

Focus on [monitoring](#), [behavioral change](#), [sustainable mobility](#), [\(re\)design of public space](#)

- Encouraging [electric transport or ULEZ](#) zones is a good step to reduce local emissions, especially with regard to No_x and EC.
- [Greening](#) has several advantages, but it is not very effective on its own and is sometimes counter-productive.



Vos, P.E.J., Maiheu, B., Vankerkom, J., Janssen, S. (2013). Improving local air quality in cities: To tree or not to tree? Environmental Pollution, 183, pp. 113-122.

Urban Clean Air Strategy

Improvement of living environment & air quality

1. Source treatment: minimize local emissions

- Enhance behavior change
- Stimulate Public Transport
- Electrification of mobility

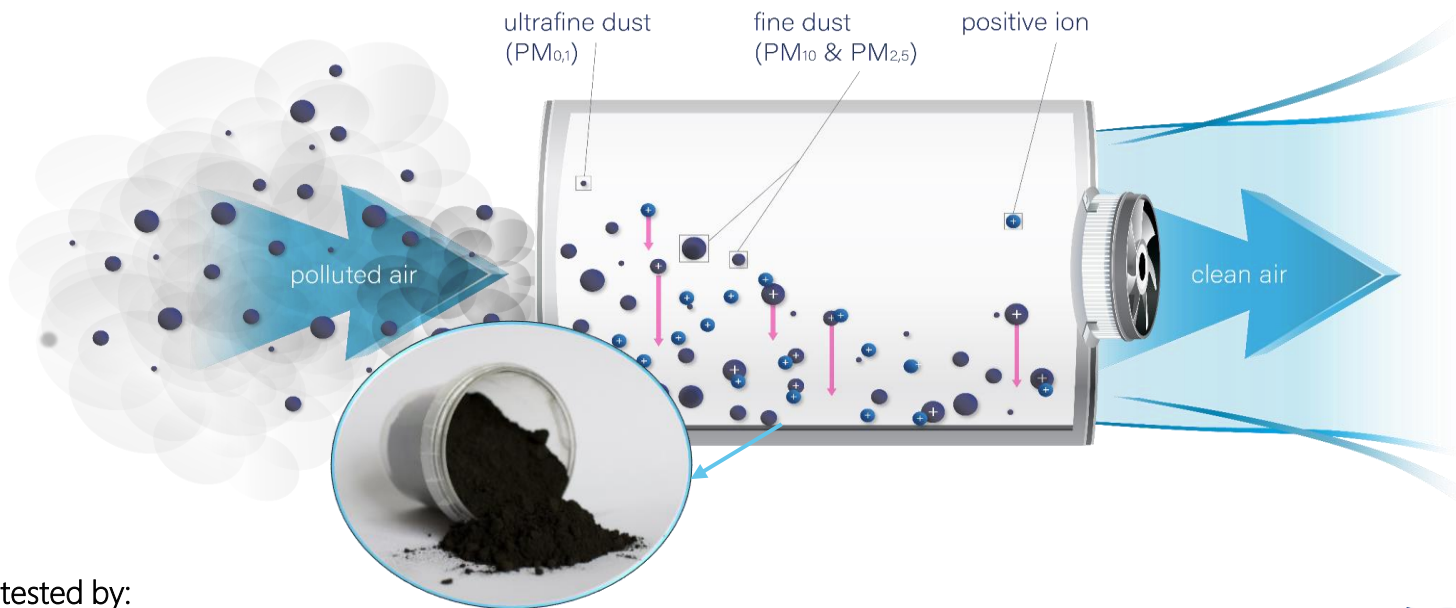
2. Reduce exposure at public 'hotspot locations'

- Intervention strategies (LE zones, rerouting of traffic)
- Mitigation measures (natural / technical)



Positive Ionization Technology

The **electric field** charges the airborne particles which then move towards the grounded collector plate. The pollutants are immobilized and transform into a **layer of coarse dust**.



Certified and tested by:



Lungs of the City

Active air treatment integration in existing infrastructure to improve urban air quality for city residents by cleaning polluted hotspots such as:

- Underground Parkings
- Public transport
 - Metro stations
 - Bus terminals
- Public Buildings
- Street furniture
- Tunnels

M

Metro

P

Parking

B

Bus

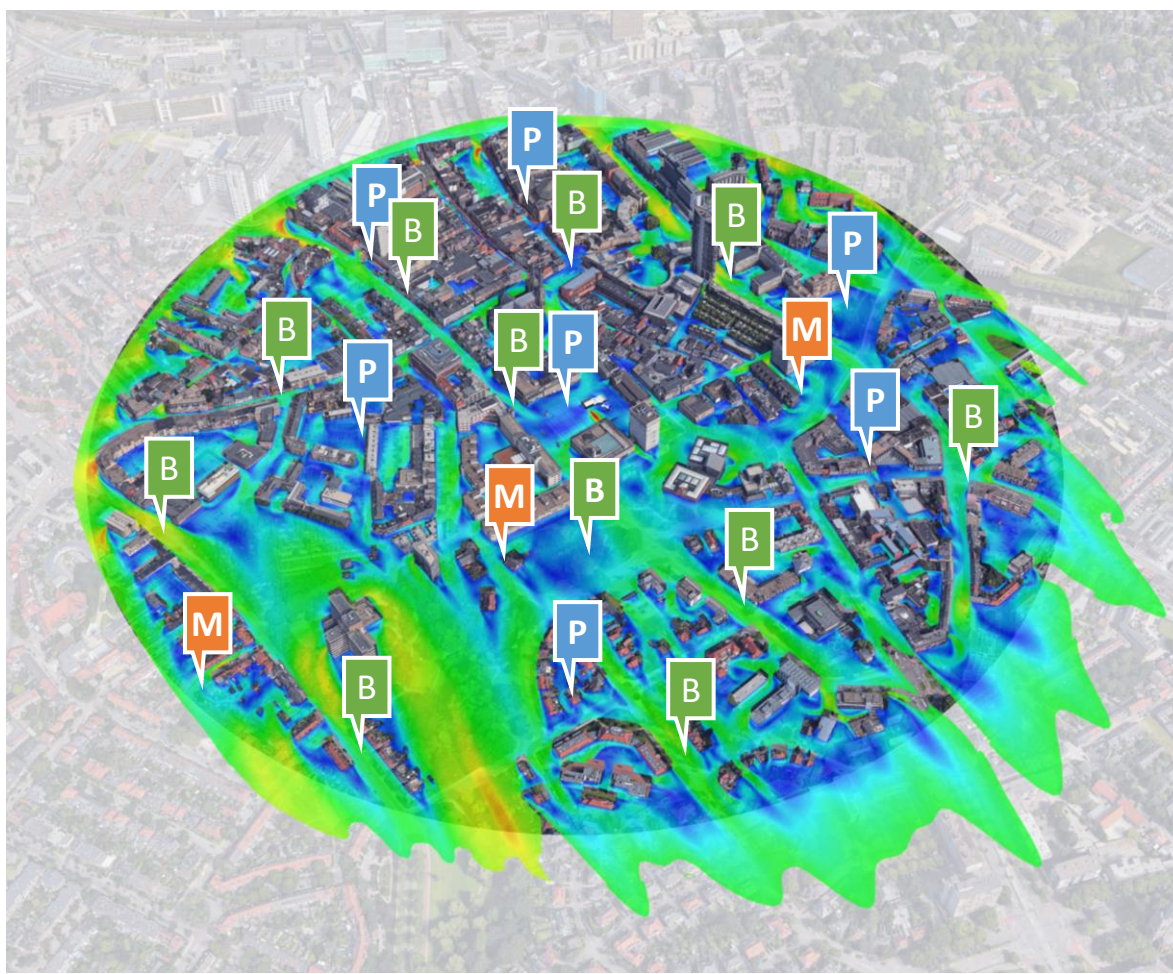
T

Tunnel

S

Streets





Metro stations



Parking

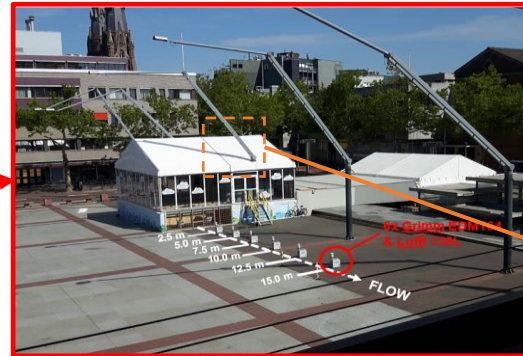
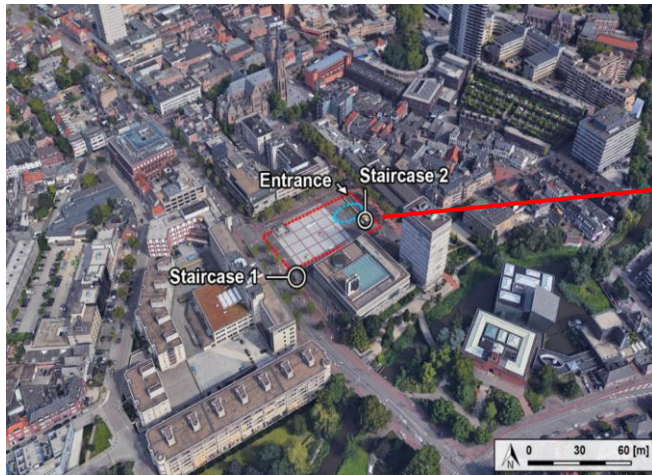


Bus stops



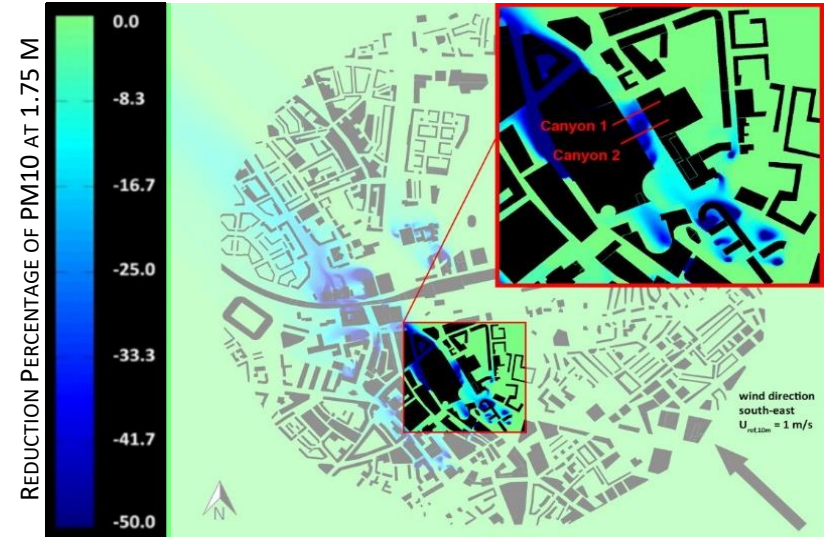
Lungs of the City

- Lungs of the City is a unique approach to **PM mitigation** with a cumulative effect on an urban scale



Lungs of the City

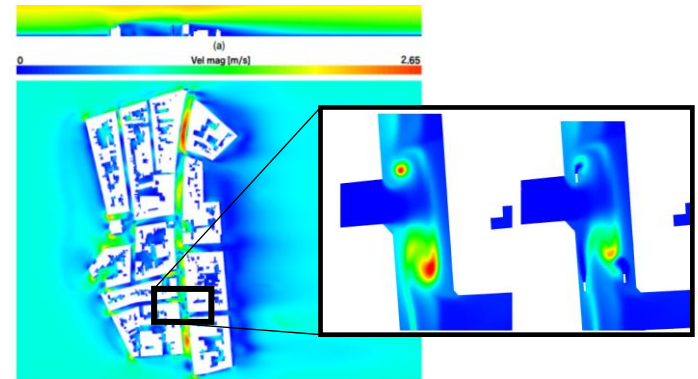
- A combination of **practical applications** and **scientific effect studies** prove the effectiveness of the solution with measurement data and CFD simulations



Blocken, *et al*: “Reduction of outdoor particulate matter concentrations by local removal in semi-enclosed parking garages: A preliminary case study for Eindhoven city center,” *Journal of Wind Engineering and Industrial Aerodynamics* (December 2016): <http://www.sciencedirect.com/science/article/pii/S0167610516304536>.

Lungs of the City

- A combination of **practical applications** and **scientific effect studies** prove the effectiveness of the solution with measurement data and CFD simulations
- The results show that wide application and smart integration enable a **PM reduction of up to 50%** PM10 at street level.



Lauriks, et al. (2020) Application of Improved CFD Modeling for Prediction and Mitigation of Traffic-Related Air Pollution Hotspots in a Realistic Urban Street, Atmospheric Environment 246 (2021) 118:127 <https://doi.org/10.1016/j.atmosenv.2020.118127>

Circularity



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with the Solar Impulse Solution Label

YOUR SOLUTION TO AIR POLLUTION



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