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Centre for Low Emission Construction

Air Quality in Pavement Works Workshop – National Highways SDF

12 September 2023 – 1pm to 3pm

Daniel Marsh, Centre for Low Emission Construction

national highways

SUPPLY CHAIN SUSTAINABILITY SCHOOL

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Please Participate!

Please use your microphones and cameras – just switch the mics off when not speaking

If you have **QUESTIONS**, feel free to shout out – we are very informal!

Also use the **CHATBOX**

Join in with the Mentimeter activity

SLIDES will be distributed afterwards

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Workshop Overview

- What is air pollution and where does it come from?
- How polluting is the construction industry?
- Which policies regulate air pollution?
- What can we do to reduce emissions and personal exposure?

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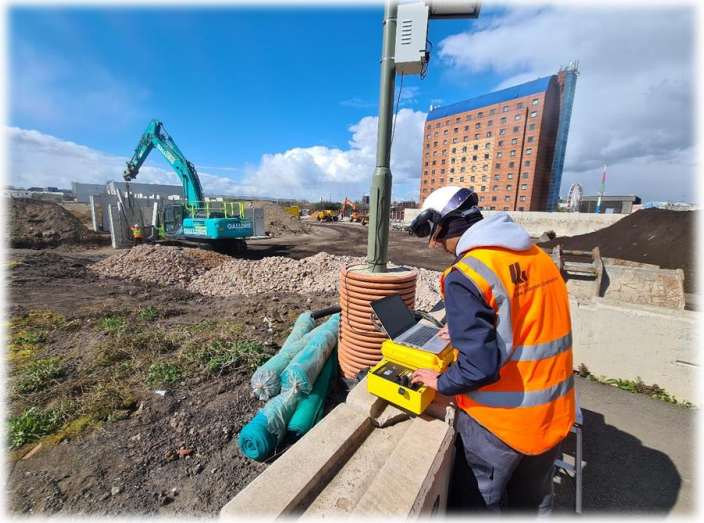
The Centre for Low Emission Construction

- Raising awareness of air quality impacts from construction and demolition
- Providing high quality scientific research to inform policy development
- Working with manufacturers to develop low emission technologies
- Quantify the health impact of exposure to emissions for the public and people working in the construction sector
- Developing guidance for industry, planners and air quality professionals



Environmental Research Group

UKRI Medical Research Council

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Go to Menti.com on your phone or laptop

Participate in the poll now....

Enter the code 14 18 53 1

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Mentimeter – Question 1

- How important do you think air quality is as an environmental health concern?
  - Extremely Important
  - Very Important
  - Moderately Important
  - Slightly Important
  - Not at all Important

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Mentimeter – Question 2

- How much do you think the construction sector contributes to air pollution compared to other emission sources?
  - A significant amount
  - Somewhat
  - A small amount
  - Not at all
  - Don’t know

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Are ‘health’ and ‘safety’ equal in Construction?

- Accident prevention
- Health & Safety law
- Risk assessments
- Reporting unsafe acts

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What is air pollution?

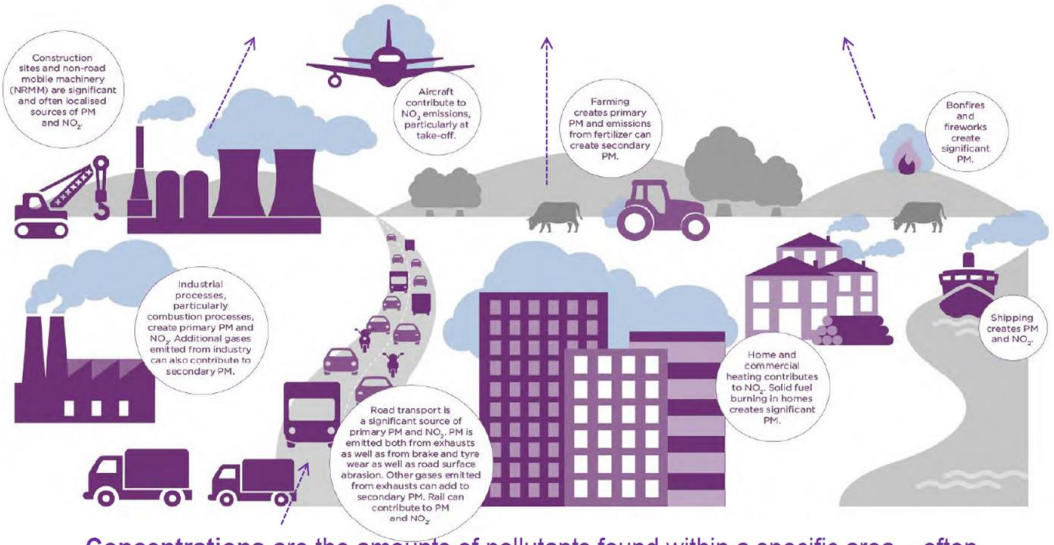
Air pollution is the release of particles and noxious gases into the atmosphere

Emissions can be natural or manmade and are considered to have an effect on human health.

Natural emissions of particles come from the sea, the soil and from plants.

Pollution from human activity is largely the result of the combustion of fossil fuels such as coal, oil, petrol or diesel.

Emissions are the total amount of each pollutant that ends up in the atmosphere.



Concentrations are the amounts of pollutants found within a specific area – often where people are.

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Pollution sources – primary and secondary

- Primary sources are directly emitted to the atmosphere.
- Have shorter lifetimes and stronger concentration gradients
- Black carbon, carbon monoxide, nitrogen dioxide…

- Secondary pollutants form in the atmosphere.
- Have longer lifetimes and cover wide areas.
- Ozone, nitrogen dioxide, sulphates, nitrates…

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Pollution sources – primary and secondary

- Pri mitted to the atmosphere.
- Ha onger concentration gradients
- Bla e,
- Se the
- Ha er
- Ozone, nitrogen dioxide, sulphates, nitrates…

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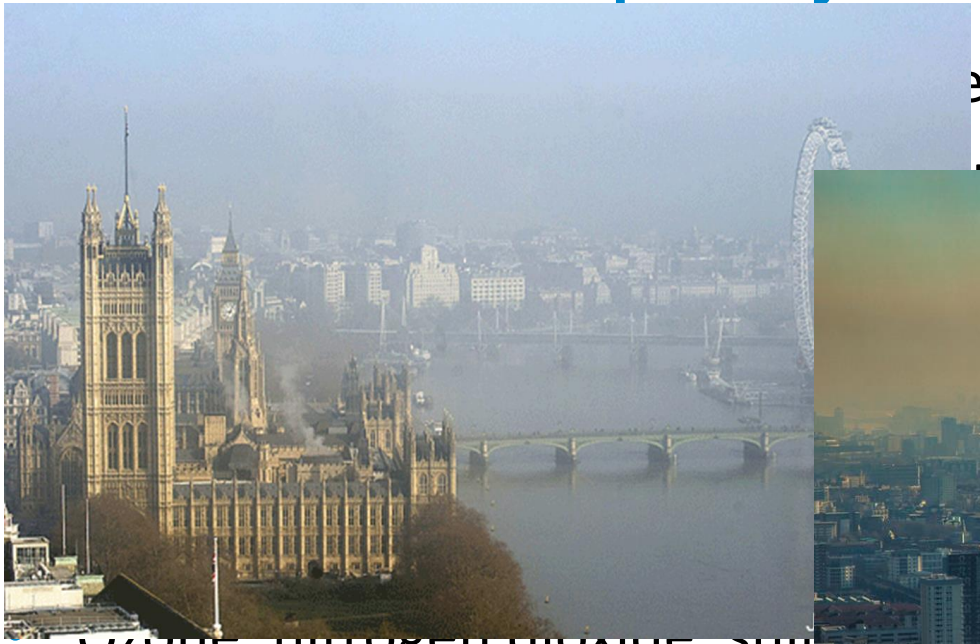
Pollution sources – primary and secondary



ed to the atmosphere.

- Ozone, nitrogen dioxide, sulp

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Pollutants of concern – Nitrogen Dioxide (NO2)

- Nitrogen dioxide (NO_2) is one of a group of gases called nitrogen oxides
- Road transport is estimated to be responsible for about 50% of total UK emissions of nitrogen oxides
- Nitrogen dioxide levels are highest near busy roads and urban areas
- Nitrogen dioxide also reacts with hydrocarbons in the presence of sunlight to create ’ground level’ ozone, and contributes to the formation of particles

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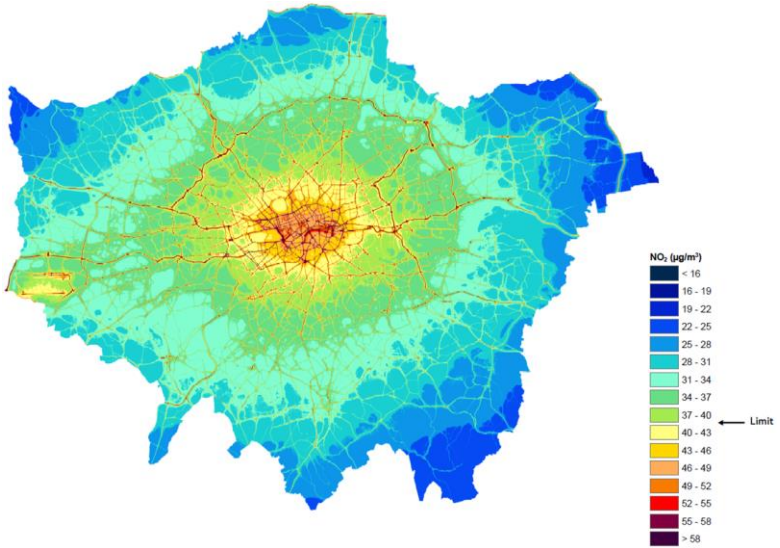
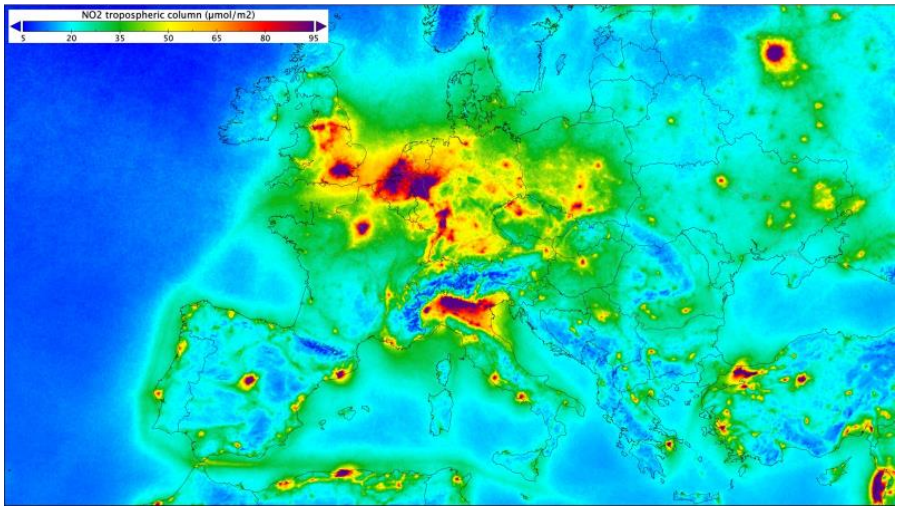
Pollutants of concern – Nitrogen Dioxide (NO2)





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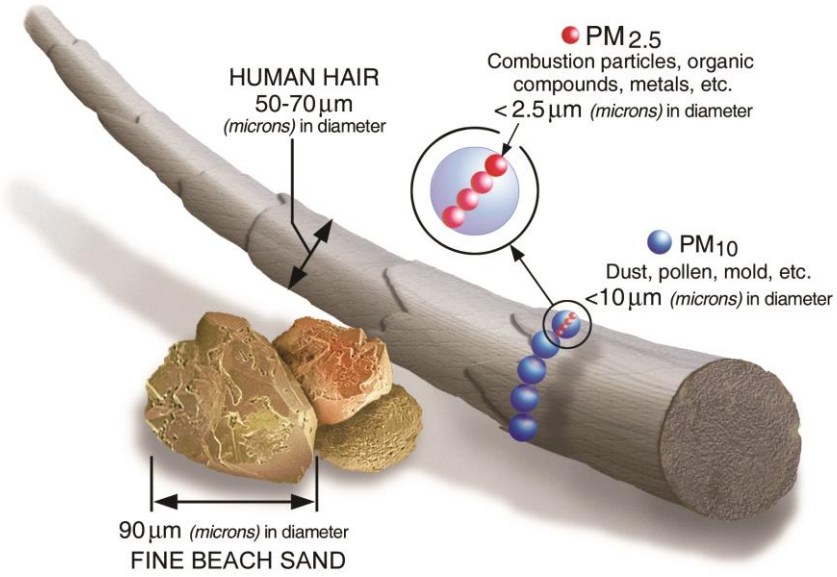
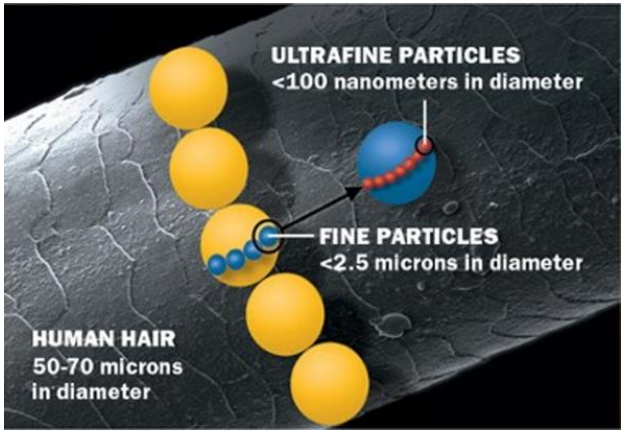
Pollutants of concern – Particulate Matter (PM)





Small particulate pollution has health impacts even at very low concentrations – there is no threshold that has been identified below which no damage to health is observed (WHO 2004)

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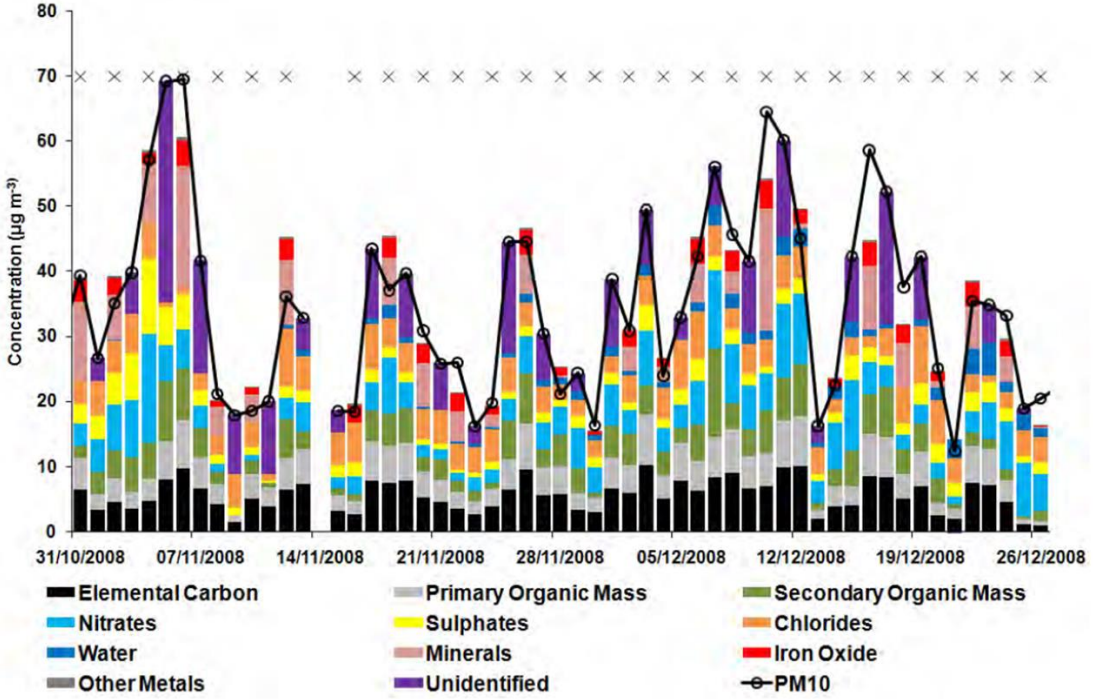
Pollutants of concern – Particulate Matter (PM)

The composition of particles changes depending on time and location

Construction particulates will significantly differ from other micro-environments



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Health Impacts

Chief Medical Officer's
Annual Report 2022

Air pollution

4.5.3 The construction industry

Ben Pearce - Portfolio Manager, Health effects of air pollution programme, Impact on Urban Health
Kate Langford - Programme Director, Health effects of air pollution programme, Impact on Urban Health

Air pollution emissions from construction

Construction sites contribute significantly to air pollution, particularly in urban areas, where poor air quality can harm health and disproportionately affect some of the most vulnerable people in communities, as discussed in Section 1.2.

Of the many different types of pollution emitted from construction sites, the pollutants that are the biggest concern for health are particulate matter (PM), and nitrogen oxides (NO_x). NO_x is emitted by engines that power non-road mobile machinery (NRMM), while PM is emitted from demolition and earthworks. PM often leaves sites on the wheels of vehicles and is then re-suspended back into the air we breathe.

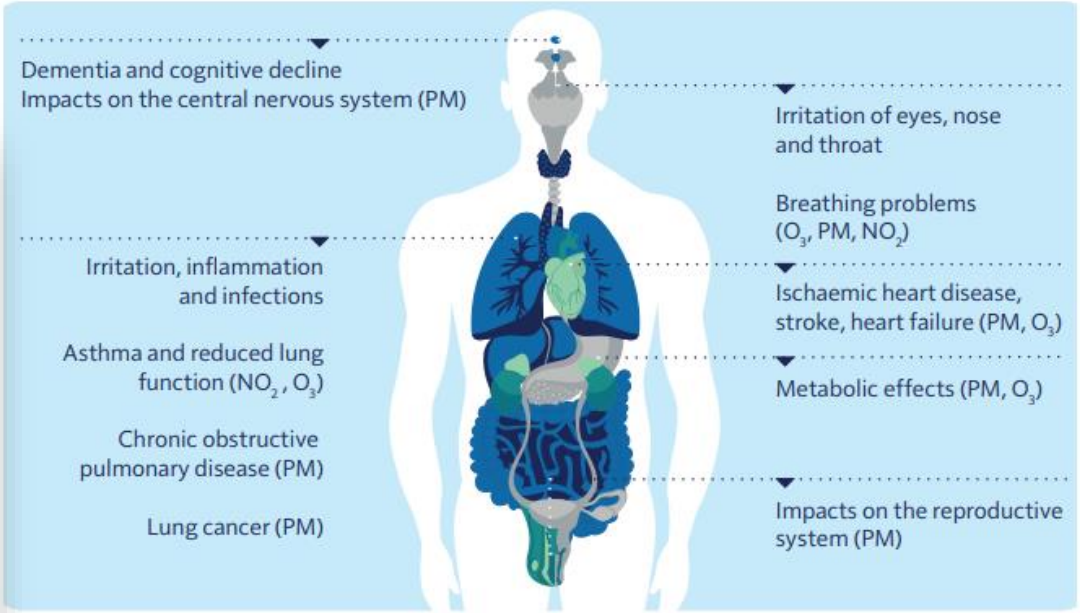
People who work on construction sites, and those living near sites, are most at risk from being exposed to the highest concentrations of emissions from on-site works. As construction sites vary in size and the length of time they are in place, the scale of polluting emissions varies between sites. However, in densely packed urban areas where construction sites are a common occurrence, they can contribute significantly to overall levels of air pollution.

The construction industry has adopted several approaches and regulations to help minimise the construction sector's polluting emissions – for example, hybrid or electric NRMM, emissions standards for NRMM, and low-emission zones for construction plant and planning.

Improving air quality in and around construction sites

Impact on Urban Health,[1] which is part of Guy's & St Thomas' Foundation, are running a 10-year programme that tests equitable interventions to address air pollution in inner city areas. The programme aims to improve health, particularly for those who are disproportionately affected by poor air quality. One of the programme's key areas of focus is working with the construction industry to reduce the sector's pollution emissions.

In partnership with Arup, Impact on Urban Health are developing up to 4 low-emission construction sites in the London boroughs of Lambeth and Southwark. These sites will demonstrate best practice for mitigating air pollution. One of the sites is a social housing estate comprising over 600 homes, with the programme spanning over 6 years. While results will not be available until the developments are completed, their aim is to limit NO_x and PM to levels significantly lower than the standards set by the Greater London Authority's NRMM Low Emission Zone (LEZ).[2] Based on research undertaken by the project, as well as consultations with stakeholders, approaches that are expected to reduce air pollution from construction sites include:



Source: Adapted from EEA (2020)[20]

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In summary, outdoor air pollution is…

- Gaseous, solid or liquid contaminants emitted into the atmosphere causing harm (to humans) or damage (to plants and materials).
- Pollutants have diverse sources, behaviour and health effects, dependent on chemical and physical properties.
- These can be difficult so separate, so can be grouped by source, e.g., ‘diesel exhaust’.
- Once emitted into the air, they can react/transform (from gas to particle) over scales from a few centimetres to hundreds of kilometres

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World Health Organisation

World Health Organization

- Air pollution is one of the **greatest environmental risks to health**. By reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma.
- In 2019, 99% of the world's population was living in places where the WHO air quality guidelines levels were not met.
- The combined effects of ambient air pollution and household air pollution are associated with 6.7 million premature deaths annually.
- Ambient (outdoor) air pollution is estimated to have caused 4.2 million premature deaths worldwide in 2019.

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Construction air pollution sources

- Fugitive dust
  - Mechanically generated dusts i.e. from concrete breaking
  - Typically, worse during demolition and earthwork phases
- Non-road mobile machinery
  - Engine emissions – dominated by diesel exhaust
- Trackout dust
  - Resuspended particles that are transported onto the public highway
- Construction transport (supply chain)
  - Road transport used for material delivery and waste collection

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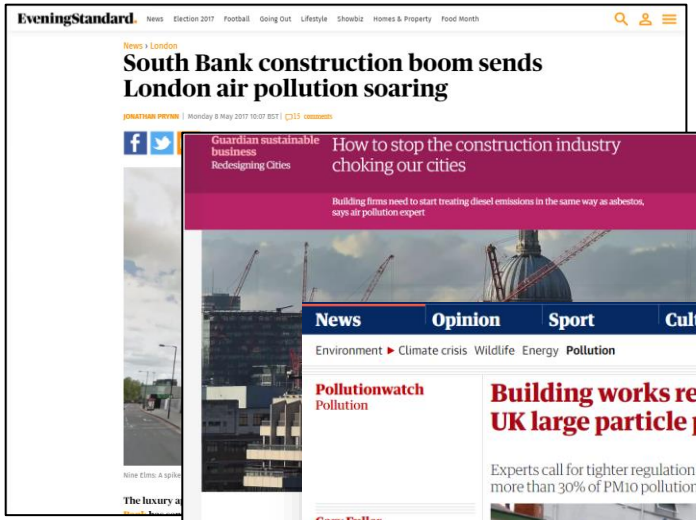

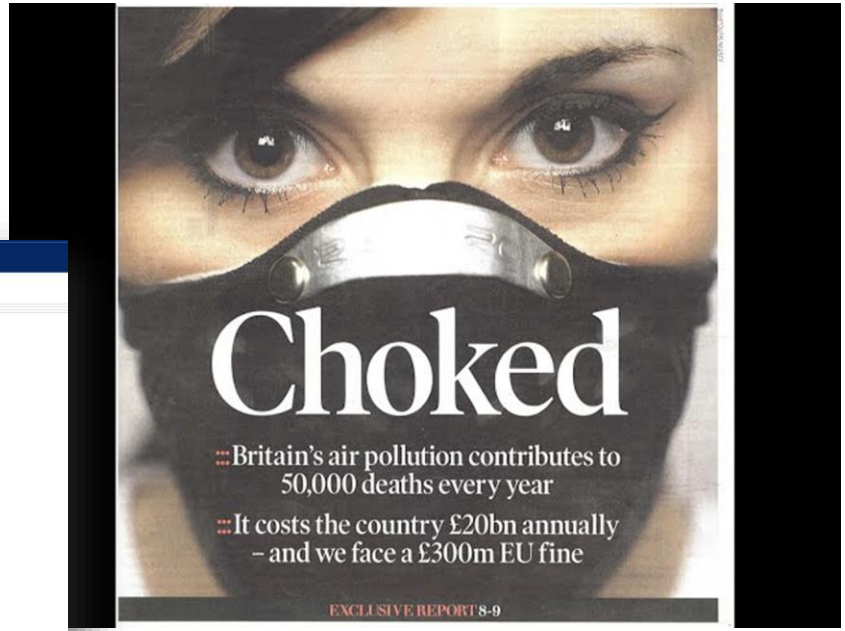

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What is an atmospheric inventory?

Helps accurately quantify the contribution from current sources of emissions.

Enables testing of future policies and scenarios.

Long term information on pollutants and trends.

Validates intervention policies

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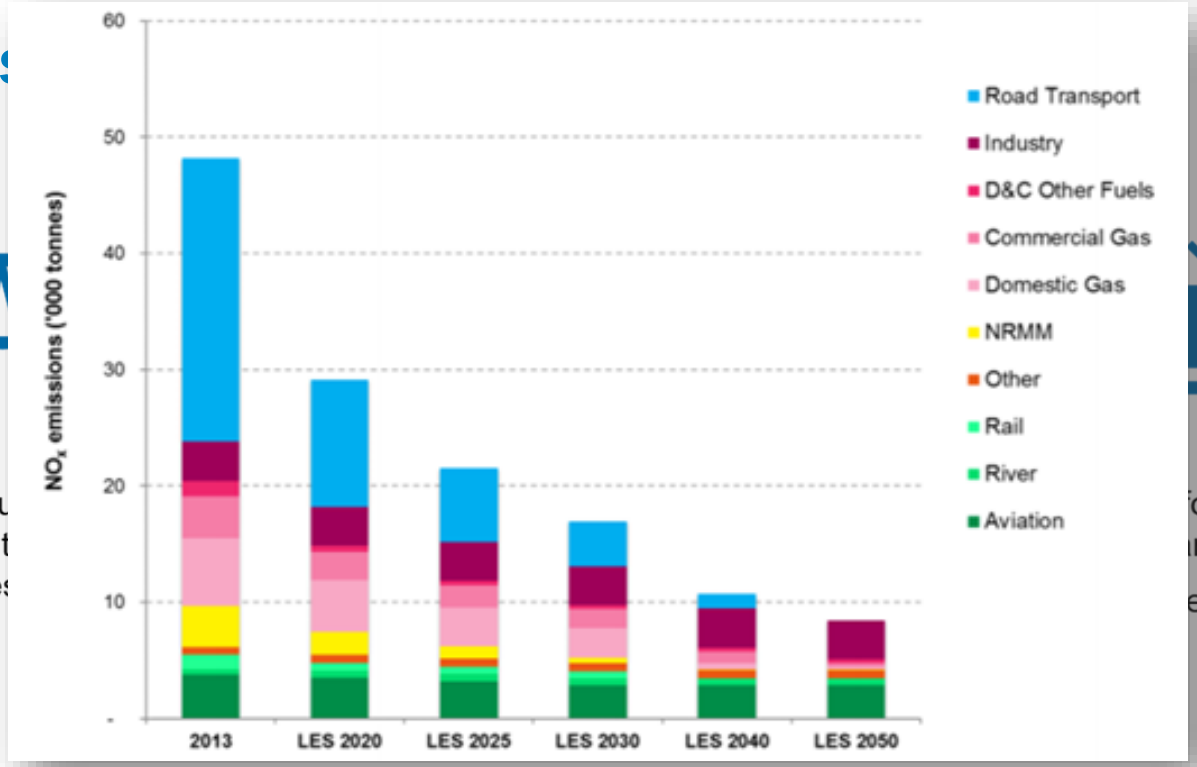
What is



Helps accu
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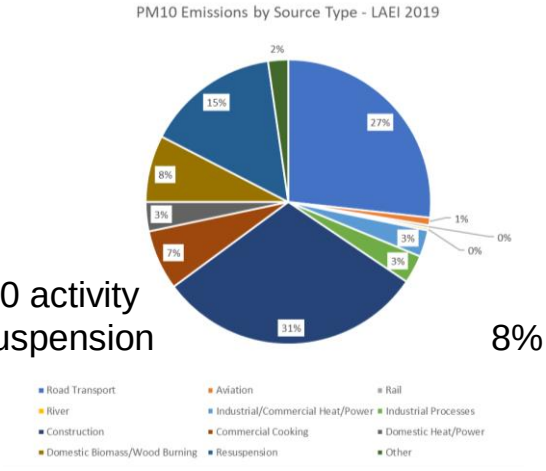
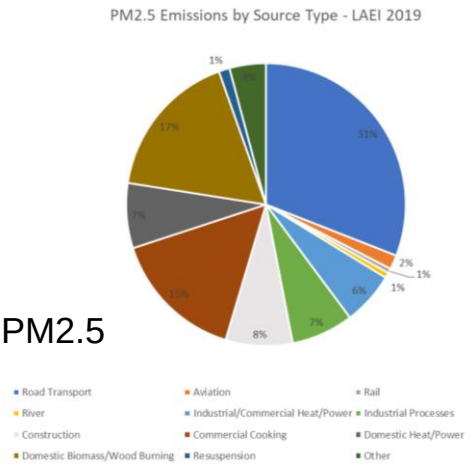
How polluting is the construction industry?

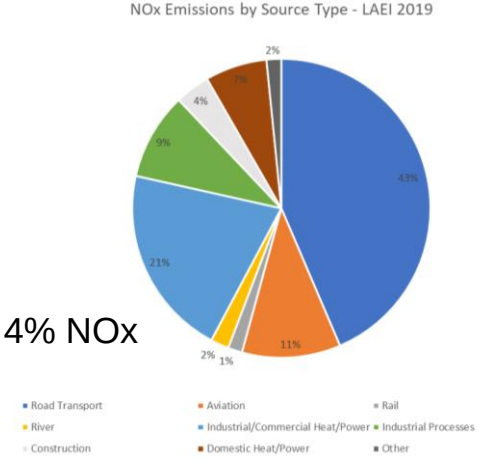
31% PM10 activity
15% Resuspension



8% PM2.5



4% NOx



https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory--laei--2019

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What is non-road mobile machinery?

Non-Road Mobile Machinery (NRMM) is a broad category which includes mobile machines, and transportable industrial equipment or vehicles which are fitted with an internal combustion engine and not intended for transporting goods or passengers on roads

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The NRMM challenge

- The UK government has committed to be carbon ‘NetZero’ by 2050
- It is estimated that there are > 300,000 items of NRMM in use across the UK
- In 2020 the UK construction sector used 2.5 million tonnes of diesel
- Burning diesel has an impact on local air, public health and the environment

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Occupational exposure

Diesel exhaust fumes were classified as "probable carcinogens" back in 1988, but the International Agency for Research on Cancer, part of the World Health Organization, has recently upgraded them to a Group 1 carcinogen, so these emissions are now treated as a definite cause of cancer in humans. The IARC has said that people regularly exposed to diesel exhaust fumes at work can be up to 40 per cent more likely to develop lung cancer.

… people regularly exposed to exhaust fumes are 40% more likely to develop lung cancer…

Anyone who works with or around diesel-powered equipment or vehicles may be concerned about diesel exhaust emissions

Diesel exhaust emissions may contain more than **10 times** the amount of soot particles than petrol exhaust fumes, and the mixture includes several carcinogenic substances, meaning they are classified as a carcinogen

iosh

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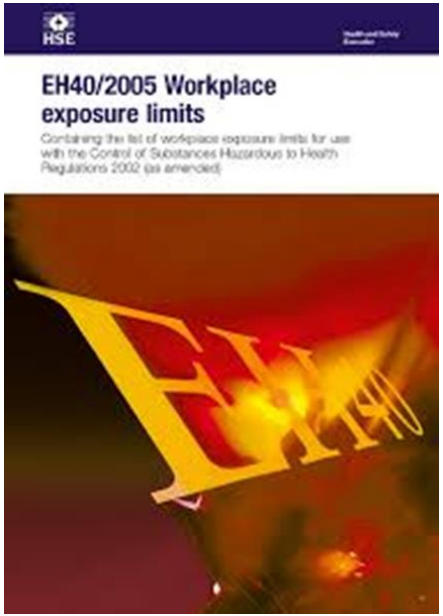
HSE Workplace exposure

- As an employer, you must protect workers from exposure to hazardous substances, including dust, fumes, chemicals, vapours, mists, nanotechnology, gases, biological agents and germs that cause disease.
- Where substances have been classified as carcinogens, mutagens or asthmagens, to comply with the Control of Substances Hazardous to Health Regulations 2002 (COSHH), exposure must be controlled to as low as is reasonably practicable (ALARP).



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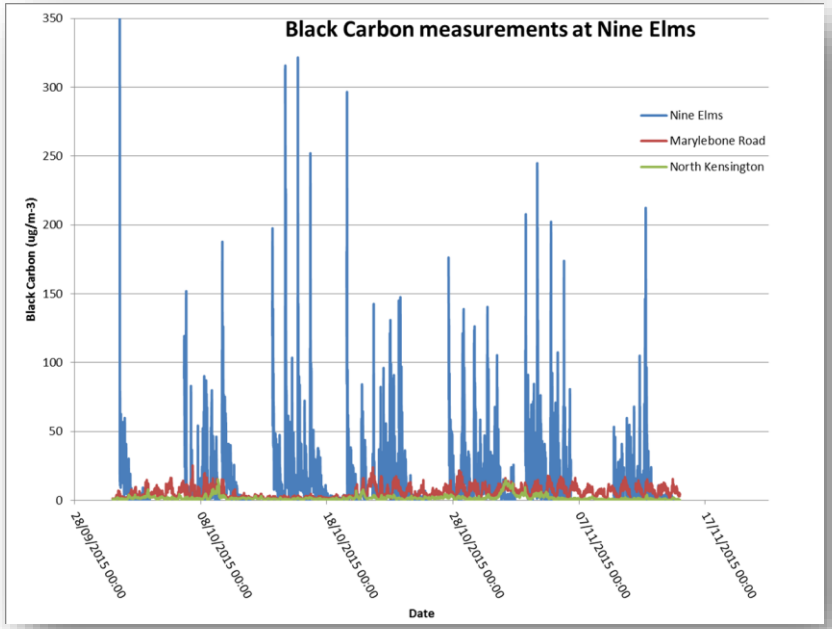
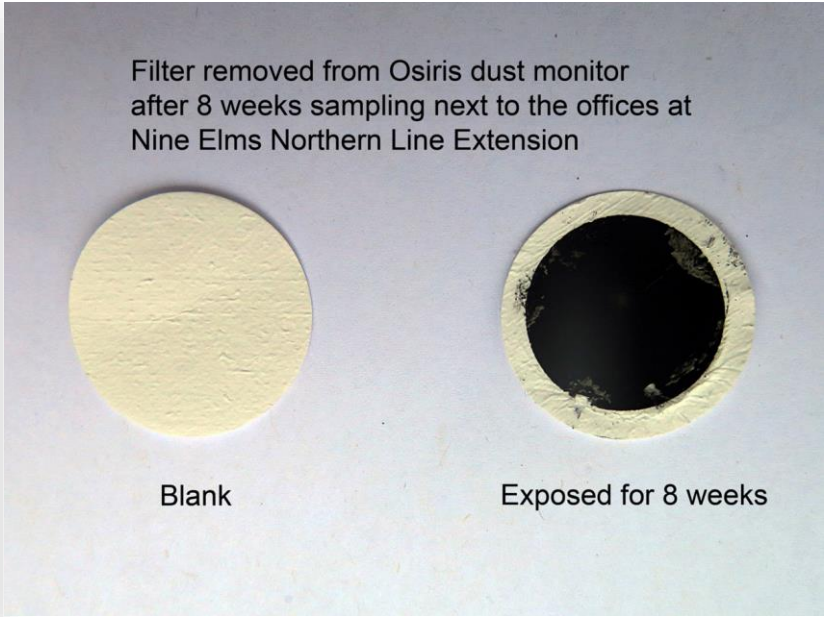
Measuring black carbon (soot)





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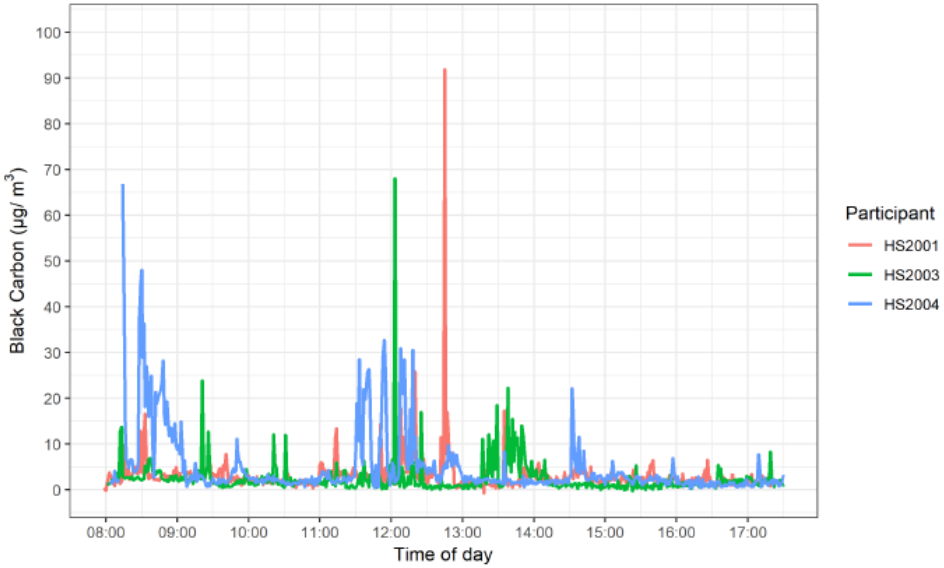
Worker exposure research



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HSE Construction statistics

- Across all industries past occupational exposure to known and probable carcinogens is estimated to account for about **5% of cancer deaths** and 4% of cancer registrations currently occurring each year in the UK
- This equates to about 8000 cancer deaths and 13,500 new cancer registrations each year
- Of those 8000 deaths, it is estimated that **3,500 would be in the construction sector**

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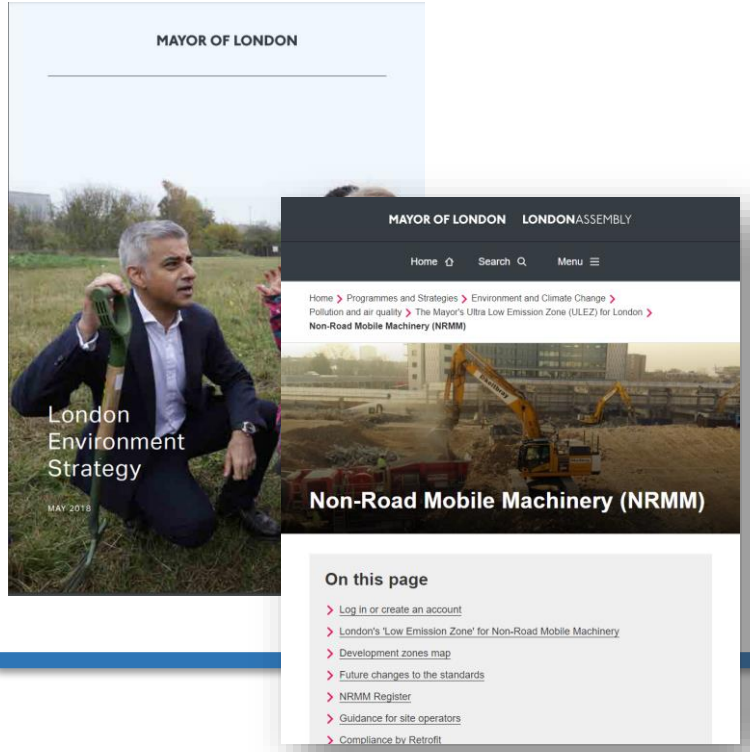
London's Low Emission Zone for NRMM



- The NRMM Low Emission Zone uses the Mayor and London Borough's planning powers to control emissions from NRMM used on construction sites.
- In a similar way to the **Ultra Low Emission Zone** the NRMM Low Emission Zone requires that all engines with a power rating between 37 kW and 560 kW meet an emission standard based on the engine emission "stage"

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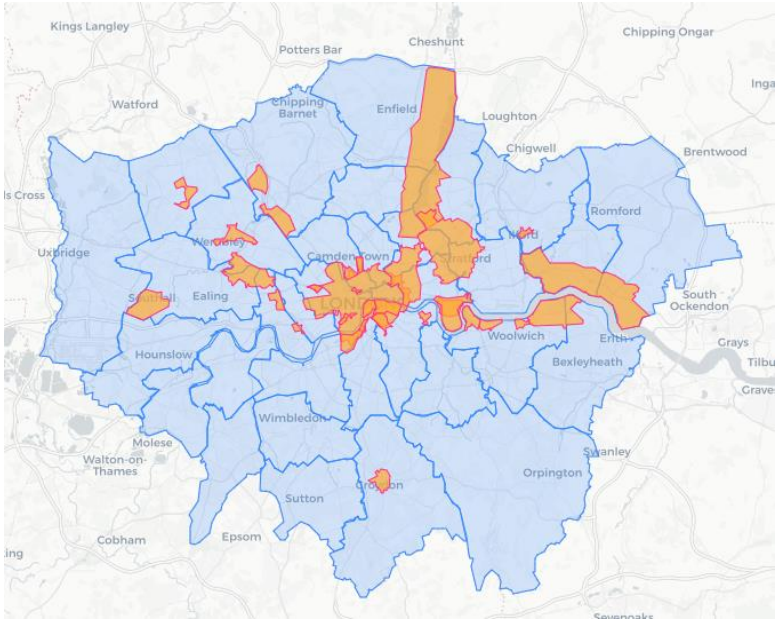
London's Low Emission Zone for NRMM

The current standards are stage IV for construction machinery operating in the Central Activities Zone and Opportunity Areas (including Canary Wharf) and stage IIIB in the rest of London.

- From 1 January 2025 the standards will be stage IV throughout London
- From 1 of January 2030 the standards will be stage V throughout London
- From 1 of January 2040 only zero emission machinery will be allowed.



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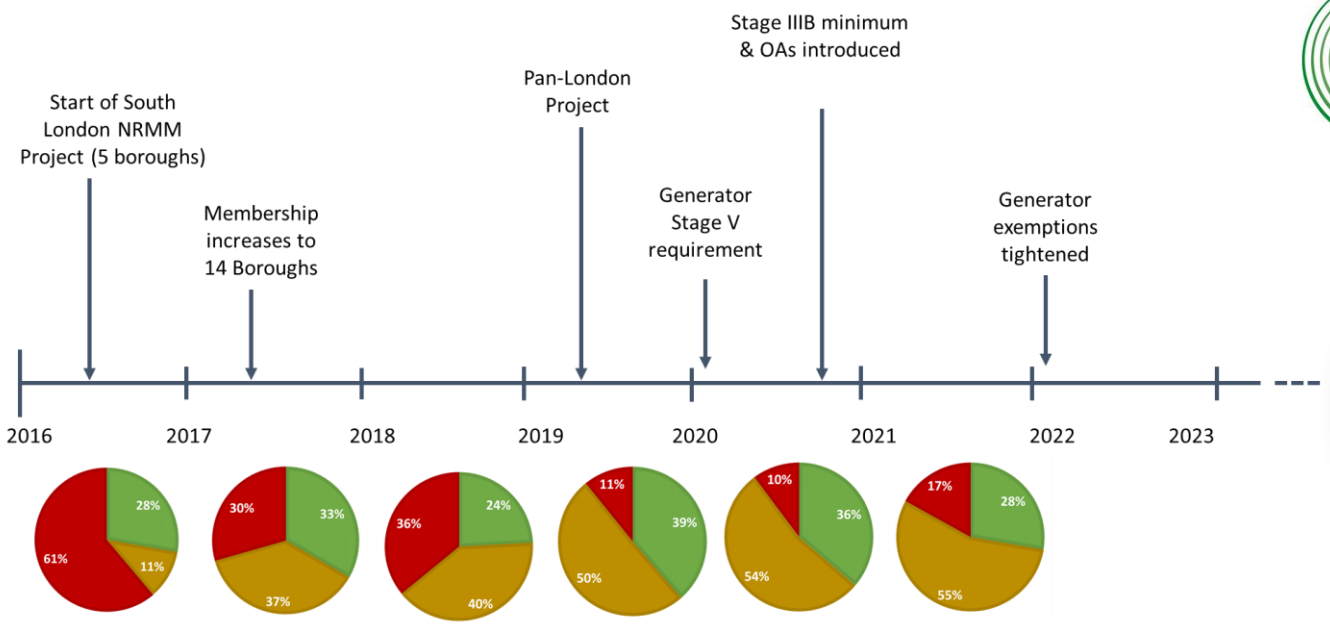
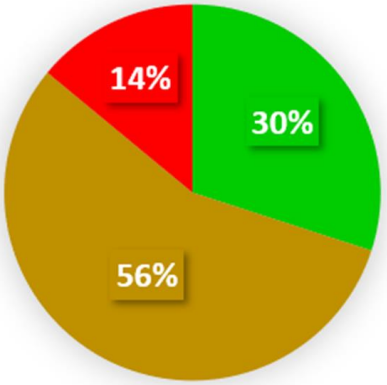
CLEANER CONSTRUCTION FOR LONDON
Putting Air Quality First

Improved compliance due to NRMM policy





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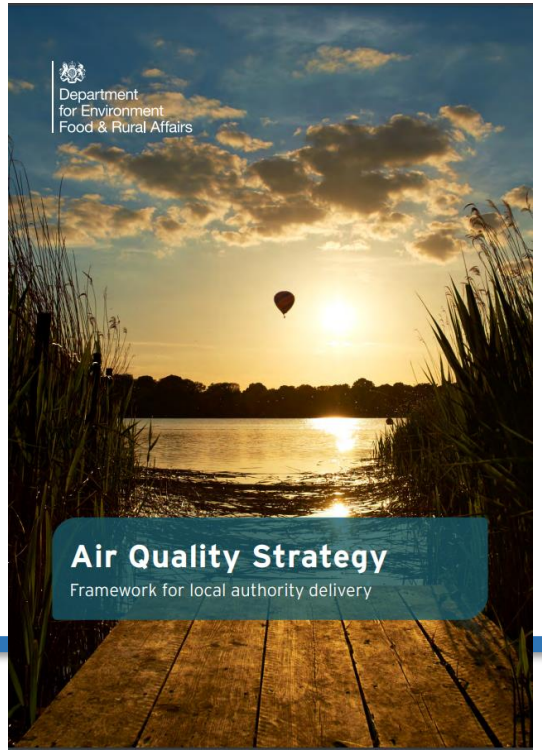
National NRMM regulation



*"Local authorities are **encouraged** to promote the use of cleaner non-road mobile machinery as part of construction and environment management plans for development they grant planning permission for and consider incentivising cleaner construction equipment through tendering processes where there is clear evidence of air quality issues"*

Defra AQS – April 2023

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Low Emission Neighbourhoods

LOW EMISSION NEIGHBOURHOOD CLEANERAIR FOR LONDON

A Low Emission Neighbourhood (LEN) is an area-based scheme that includes a package of measures focused on reducing emissions (and promoting sustainable living more generally). A LEN is delivered by a borough with support from Transport for London (TfL), the Greater London Authority (GLA) and the local community.

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Clean Air Zones (CAZs)

Environment Act 2021

- Long term environmental plans
- Targets include air quality & $PM_{2.5}$
- There are currently 7 cities charging under clean air zones in England: Bath, Birmingham, Bradford, Bristol, Portsmouth, Sheffield, and Tyneside
- *Creating a 'level playing field'*

clean air Sheffield

Cleaner air AHEAD

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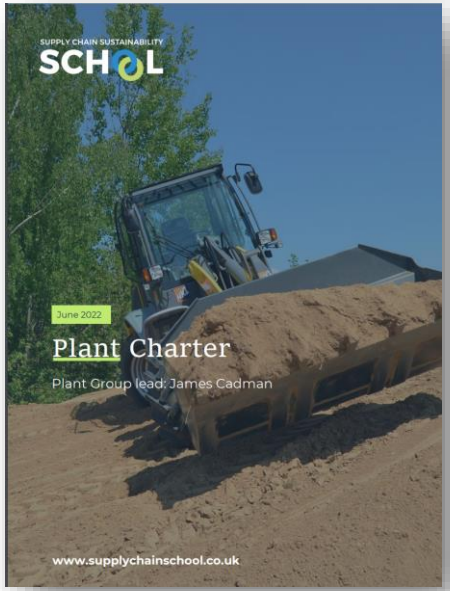
SCSS Plant Commitment Charter



- **Minimum standards in procurement:** buy or hire CPE that meets, or exceeds, the minimum standards for AQ and GHG emissions, as laid out in the latest technical paper3 .
- **Engagement:** engage suppliers and contractors to actively participate in meeting the minimum standards
- **Awareness raising and education:** providing our supply chain with the skills, knowledge and confidence they need to achieve our aims.
- **Measurement and reporting:** measure progress in reducing our emissions and report them to stakeholders.
- **Innovation:** investigate, trial and implement new technologies that will help us on the route to zero emissions onsite.

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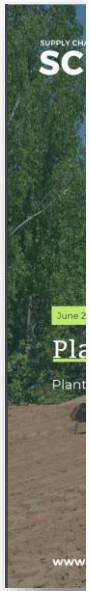
SCSS Plant Commitment Charter



Signatories to the Updated Charter

Advanté · bam · CHC · COSTAIN · EKFB · FLANNERY · CAP GROUP HIRE SOLUTIONS · HERCULES SITE SERVICES · M O'Brien Group of Companies · MORGAN SINDALL GROUP · ROBERTSON · SKANSKA · COSTAIN · STRABAG · Working in partnership with HS2 · Select · Vp plc · WH WELFAREHIRE KELLING GROUP

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National Highways AQ Policy

Stephen Inch, Air Quality Lead

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Go to Menti.com on your phone or laptop

Participate in the poll now....

Enter the code 14 18 53 1

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Mentimeter – Question 3

Which of the following approaches does your organisation currently use to improve air quality and / or reduce carbon emissions?

- Cleaner machinery and technology solutions
- Alternative fuels
- Anti-idling
- Something else
- Nothing

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Mentimeter – Question 4

Who is responsible for reducing air pollution from industry?

- Employer
- Government
- Lead organisation
- Contractor groups
- Individual

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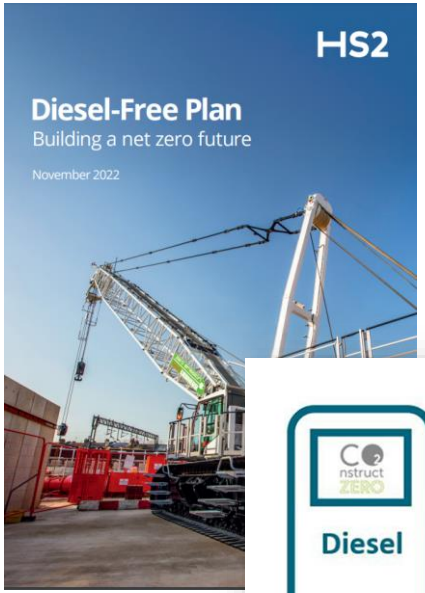
Diesel-free construction



- **HS2** achieved the first diesel-free site in May 2022, they now have ten similar sites
- Committed all sites diesel-free by 2029
- The **Construction Leadership Council**'s CO2nstruct Zero campaign, has set a target to cut diesel used in construction by 78% by 2035

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A Diesel-free future

- Improving efficiency: Using best practice
- Transition to cleaner fuels
- Transition to electric
- Wider industry support

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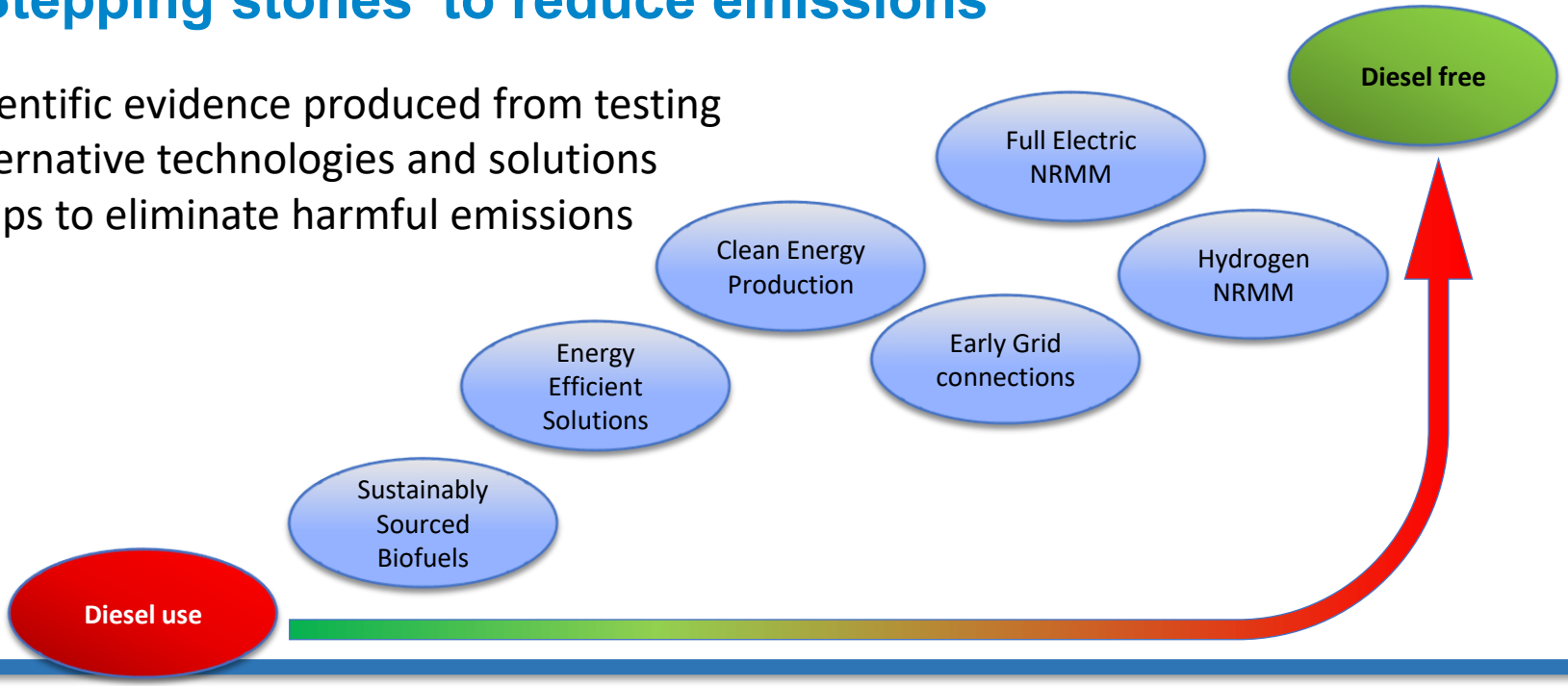
‘Stepping stones’ to reduce emissions

Scientific evidence produced from testing alternative technologies and solutions helps to eliminate harmful emissions



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Behavioural change

- Understanding engine telematics
- Anti-idling & operator training
- Using AI and machine learning

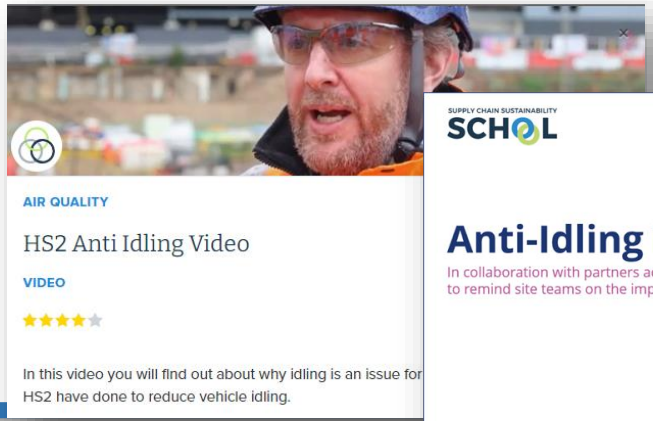

Image is an example for indicative purposes only

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Alternative fuel studies

Trial carried out to test the potential air quality benefits of alternative fuels to help HS2's push to cut the use of diesel and introduce low-carbon solutions

The results showed limited air quality benefits when compared to diesel; however, there could be a potential carbon reduction through the **sustainable sourcing** of alternative fuels

Alternative fuels are not as effective as using cleaner machinery or retrofitting existing plant

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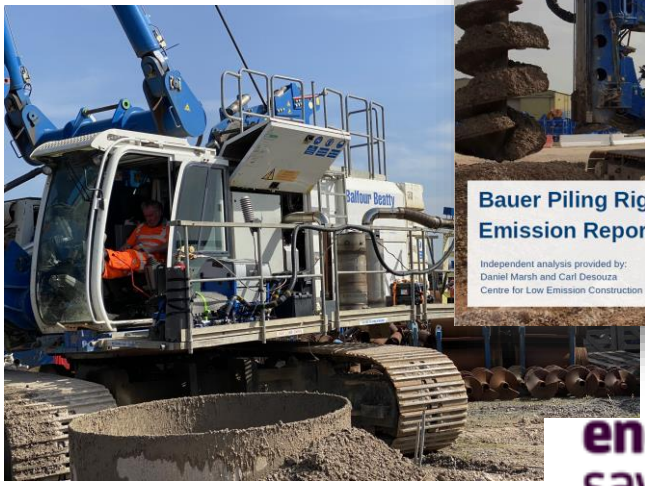
Retrofit technology

AVAILABLE NOW

- Successful pilot of world's first retrofit on large construction equipment will have massive impact across the HS2 project, saving millions of pounds
- Certified by the Energy Saving Trust
- The trial on older vehicles showed emissions reduced below Stage V NRMM standards, leading to better air quality on construction sites
- Allows for industry-wide roll-out that will bring benefits for the environment, communities and the workforce



Eminox

energy saving trust

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Flywheel energy storage systems

- Technology adopted from Formula 1 used to capture energy from an engine that is normally wasted and stored in a high-speed flywheel
- Smaller generators are used more efficiently

AVAILABLE NOW

PUNCH | Flybrid

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Smart energy management systems

- Actively manages energy demand
- Intelligently switches off non-essential assets when energy demand spikes
- Down-sizing generators reduces hire and fuel costs whilst reducing emissions

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CAGE Powered by OakTec

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Clean Air Gas Engines

- CAGE generator currently using LPG
- Recognisable ICE technology
- System integrated into an Advanté Hybrid welfare cabins during covid
- Being trialled as standalone H_2 generators
- BEIS Red Deisel Replacement project

AVAILABLE NOW

COMING SOON

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ULEMCo
ultra low emission mileage company limited

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Hydrogen dual-fuel

- Retrofitting existing on-road fleet to run on diesel and H_2
- Transferable technology for NRMM
- First dual fuel H_2 piling rigs being trialled on HS2
- Requires national H_2 infrastructure

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GeoPura

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Hydrogen fuel cell

- Demonstrating safe use of H_2 on construction sites
- Developing safe fuel handling and storage protocols
- Zero harmful exhaust emissions

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The importance of science-based evidence

"The results from these trials highlight how important it is that we continue to independently test and evaluate existing and emerging low emission fuels and technologies to produce scientific evidence to inform and encourage the uptake of low emission approaches across the wider construction industry.

This research will support accelerated decarbonisation programmes to meet stringent carbon targets by 2050, whilst still delivering local air quality benefits."

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What are the alternatives?

Hybrid

Solar

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Fully electric NRMM

- Battery technology already exists for small to medium NRMM
- Larger machines still likely to be hydrogen or hybrid
- Requires better site energy efficiency measures

- Clean off-grid power generation essential as numbers of electric machines increase
- Early planning for site electrification

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Hydrogen NRMM

- Hydrogen has potential to decarbonise sectors, such as construction
- Zero tail-pipe emissions
- Low-carbon hydrogen could meet 10% of global energy needs under the International Energy Agency's Net Zero by 2050 scenario
- Hydrogen demand is forecast to double by 2030
- Clear and consistent policy still required from Government

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CESAR Emissions Compliance Verification

- Engine emission plates can be hard to locate or read
- Paperwork does not contain required information
- Delivery accepted at the site – avoids wasted time
- Compliance officers need safe access

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CESAR Emissions Compliance Verification

- National NRMM database required!

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Go to Menti.com on your phone or laptop

Participate in the poll now....

Enter the code 14 18 53 1

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Mentimeter – Word cloud

What do you feel is the greatest environmental challenge currently faced by the construction industry today?

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Any More Questions?

CLEC.UK

We need your feedback please

Click here for the feedback form
https://forms.office.com/e/GBDwts68hS

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