



**LONDON LOW EMISSION**  
CONSTRUCTION PARTNERSHIP

**KING'S**  
*College*  
**LONDON**

# Portable emissions measurements of non-road mobile machinery used in London

**Carl Desouza**

**Department of Analytical Environmental and Forensic Sciences  
School of Population Health and Environmental Sciences**

# Contents

---

- What is non-road mobile machinery?
- Why are NRMM emissions important?
- How do we quantify emissions from NRMM?
- Emissions mapping.



# What is non-road mobile machinery?

“Any mobile machinery that is used for transport, without the need for a licence, and is not designed to carry passengers on roads, is considered non-road mobile machinery. This includes machinery that is mounted on the chassis of vehicles intended for use on roads.”

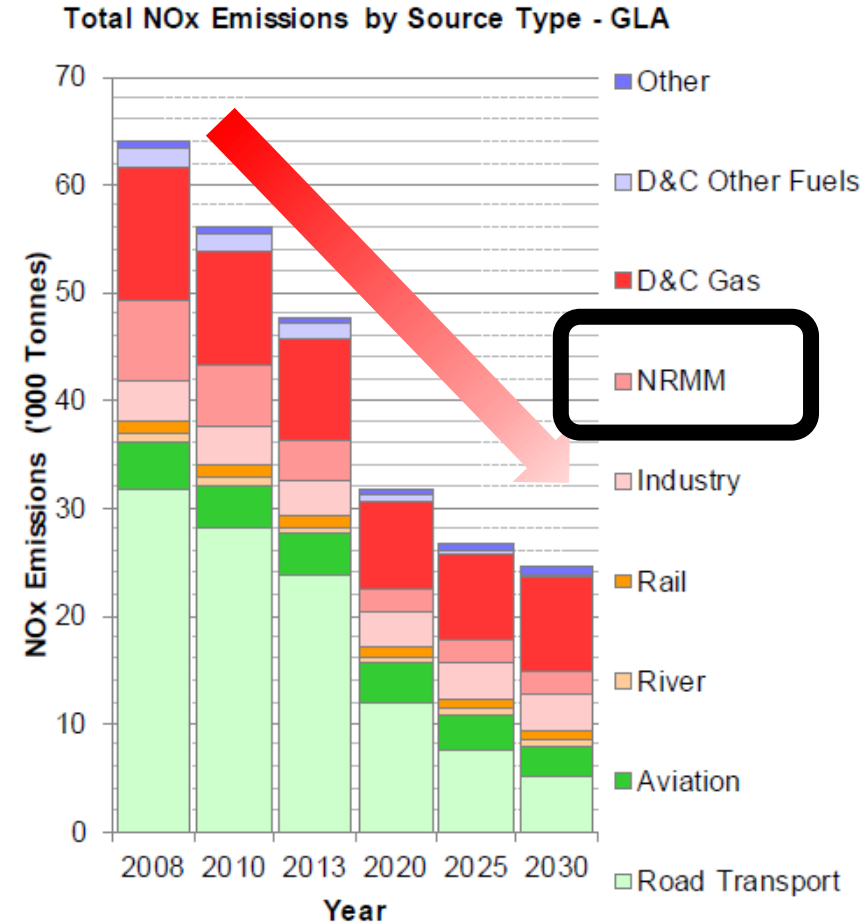


# NRMM emissions: why are they important?

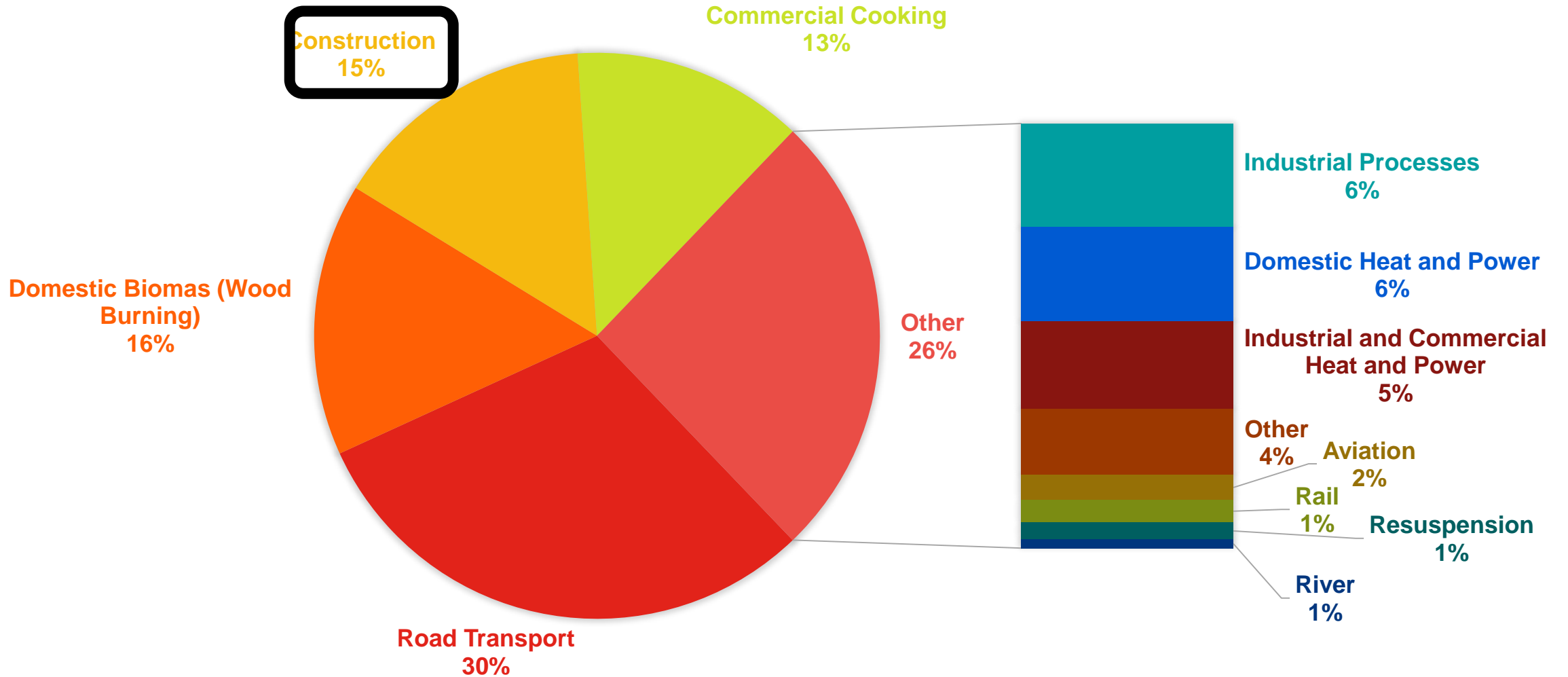
Emissions inventories help to accurately quantify the contribution from current sources of emissions.

Future implications:

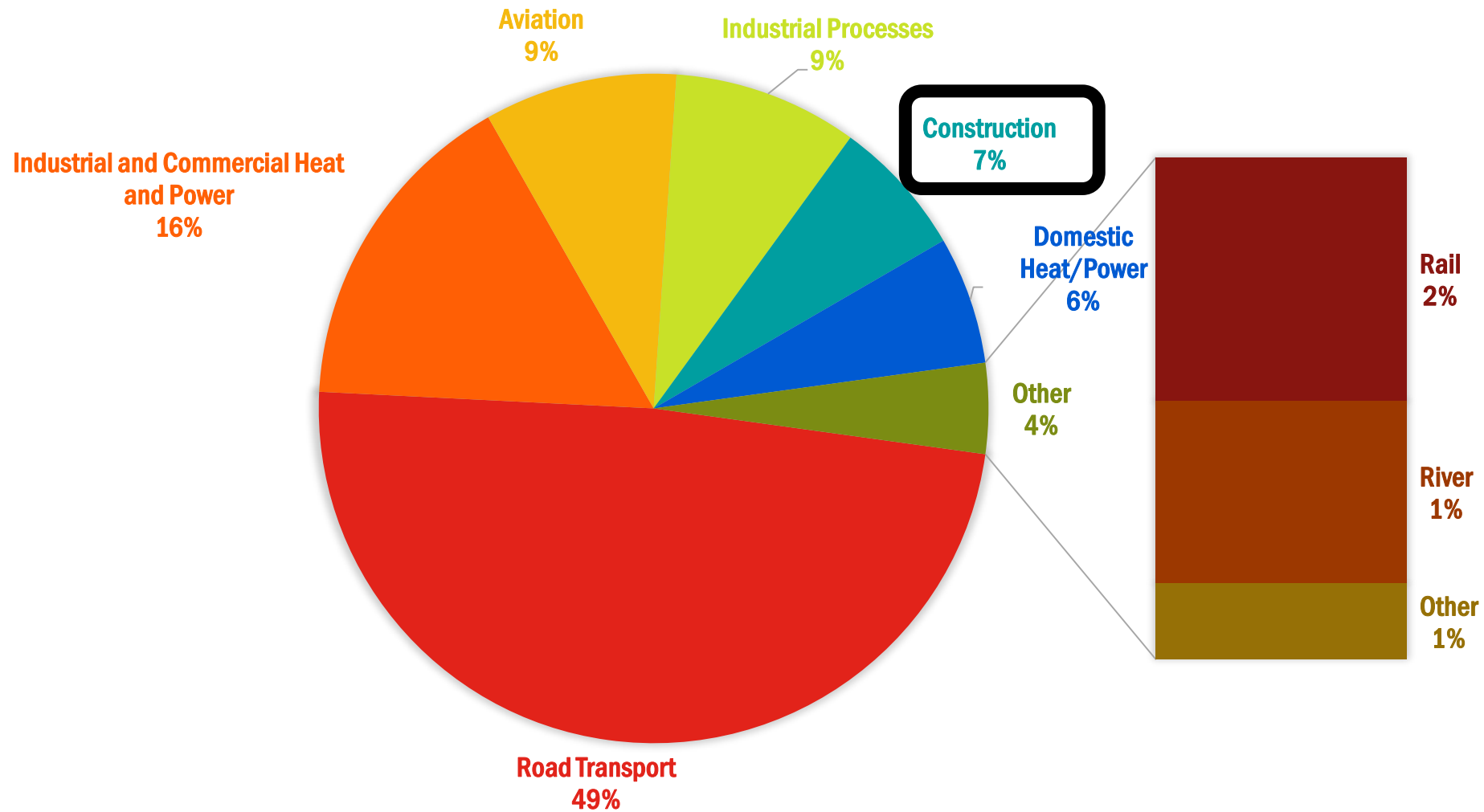
- road transport is expected to decrease
- other sources may increase – relative to road transport
- new sources (e.g. wood burning) may be considered for future inventories



# PM<sub>2.5</sub> Emissions Inventory



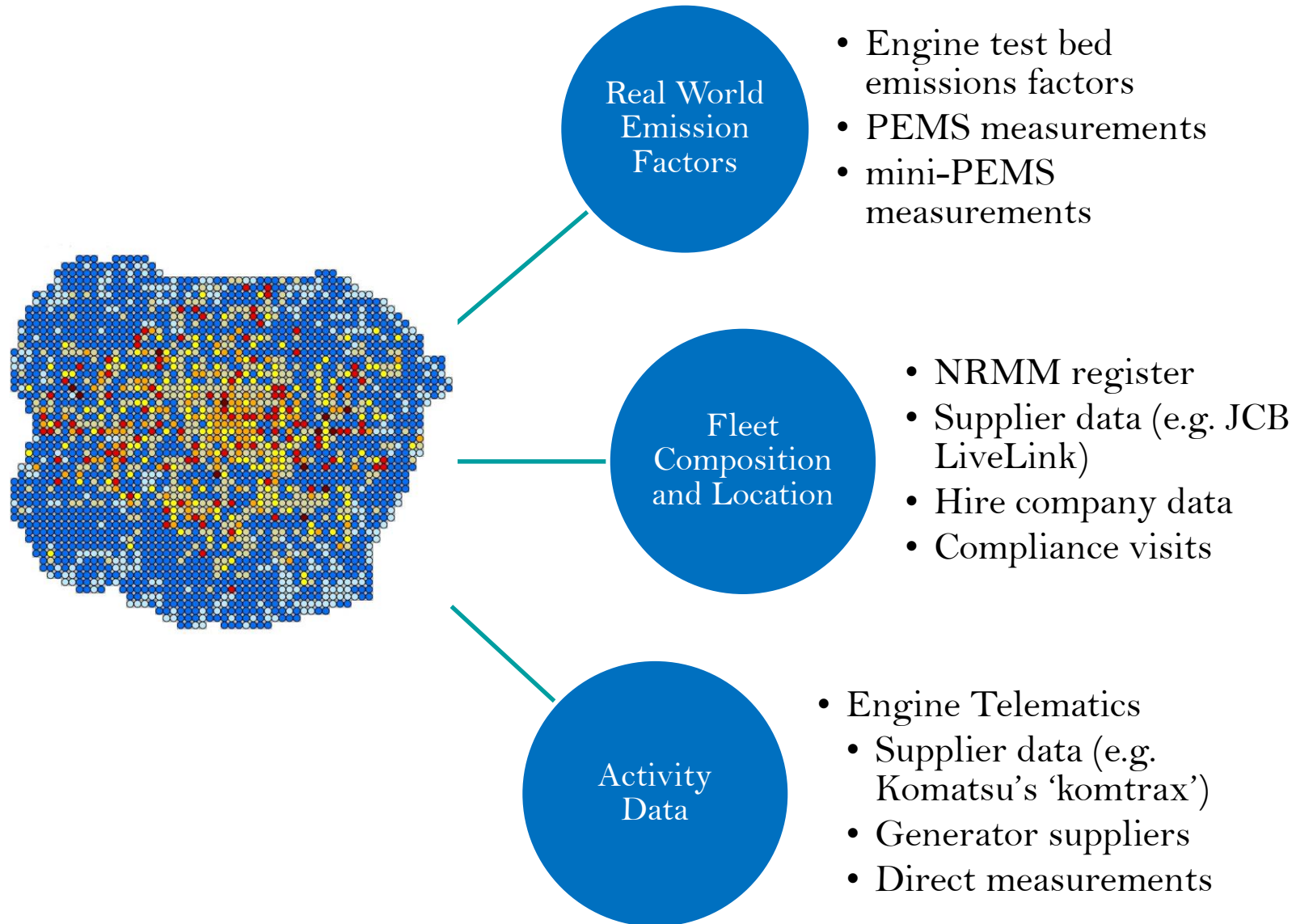
# NO<sub>x</sub> Emissions Inventory





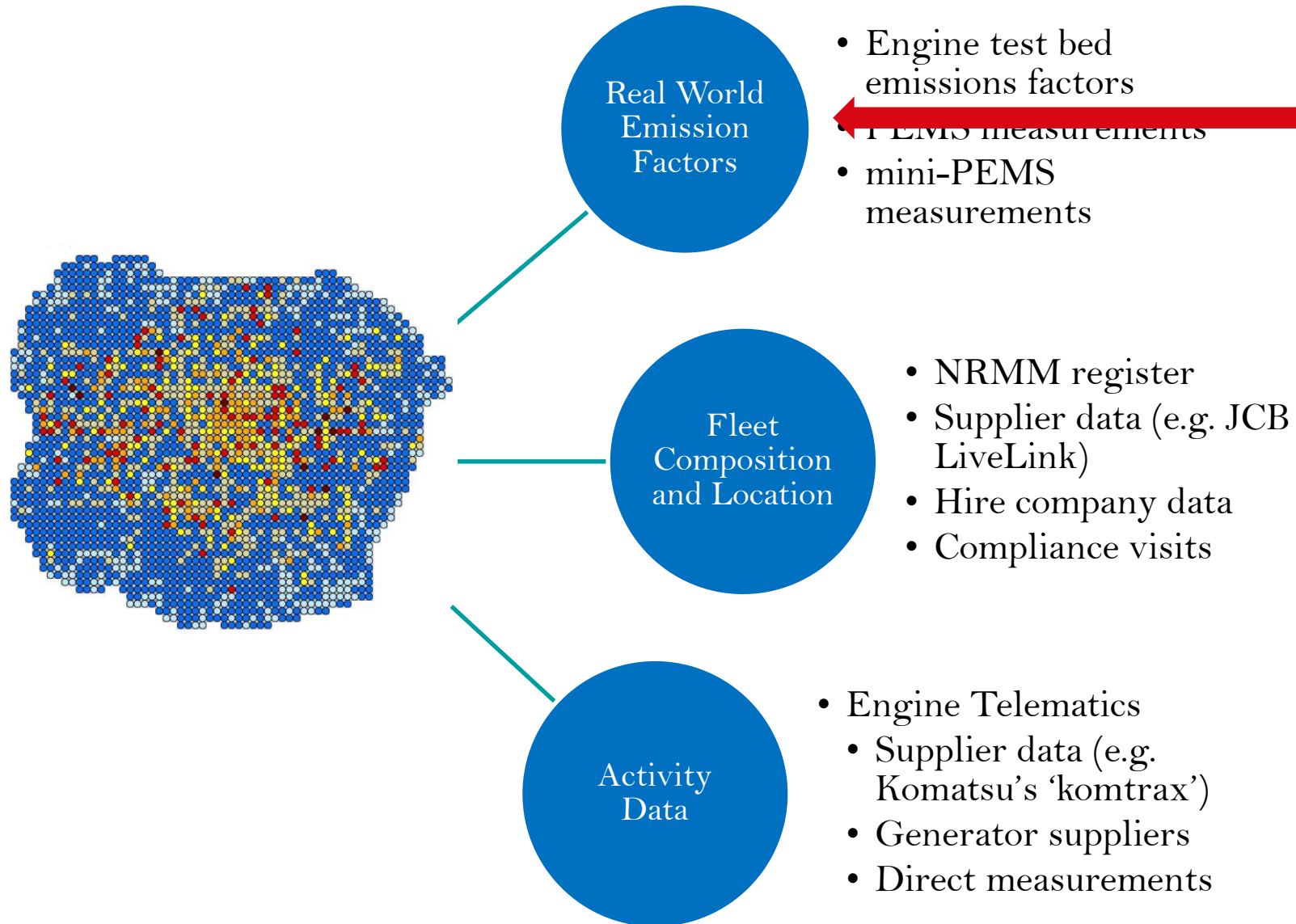
# Spatial and fleet disaggregated emissions inventory

---



# Real-world emission factors

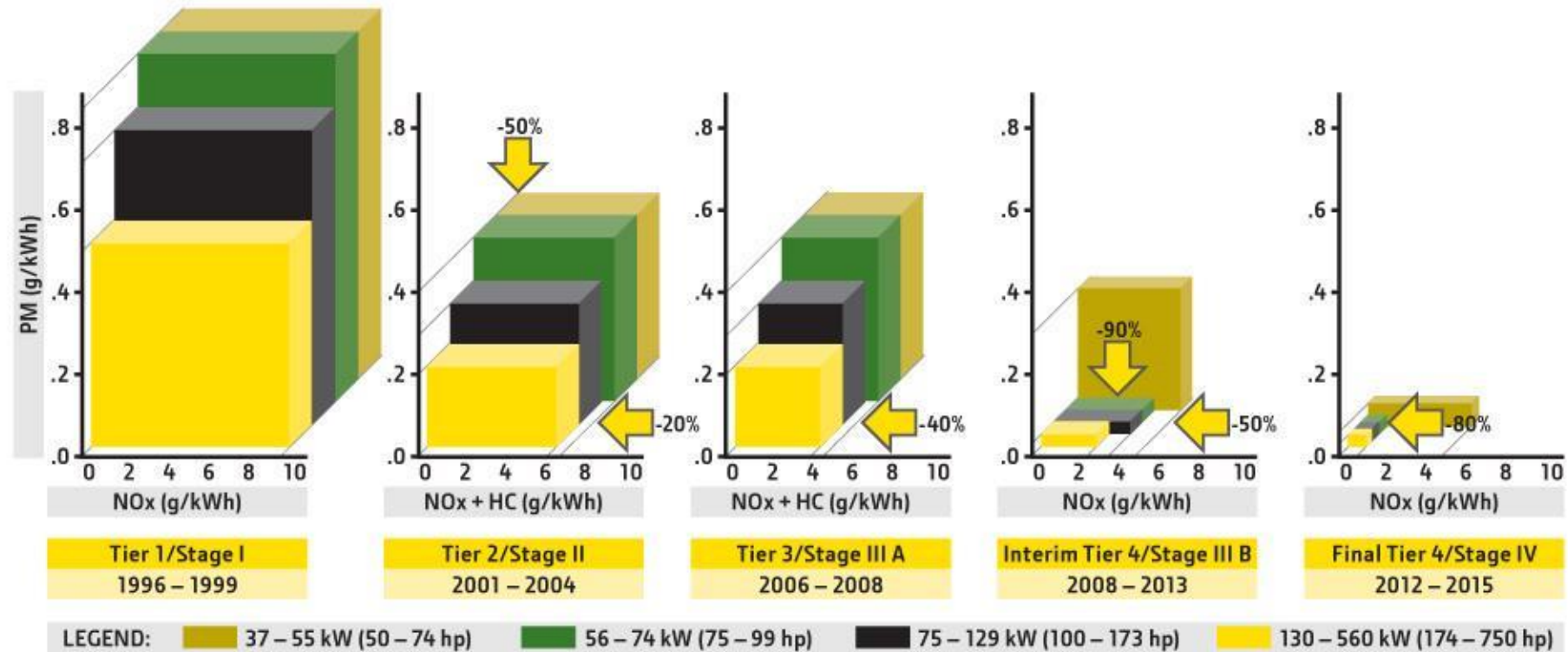
---





# Regulatory NRMM Emissions Standards

EPA and EU nonroad emissions regulations: 37 – 560 kW (50 – 750 hp)



# Portable Emissions Measurement System (PEMS)

---

Why do we need real-world emission factors  
...“Dieselgate”

PEMS is used to measure tail-pipe emissions  
from on-road vehicles.

‘In-use’ real-world emissions measurements.

Measures CO/CO<sub>2</sub>, NO/NO<sub>2</sub>, THC, PM/PN.

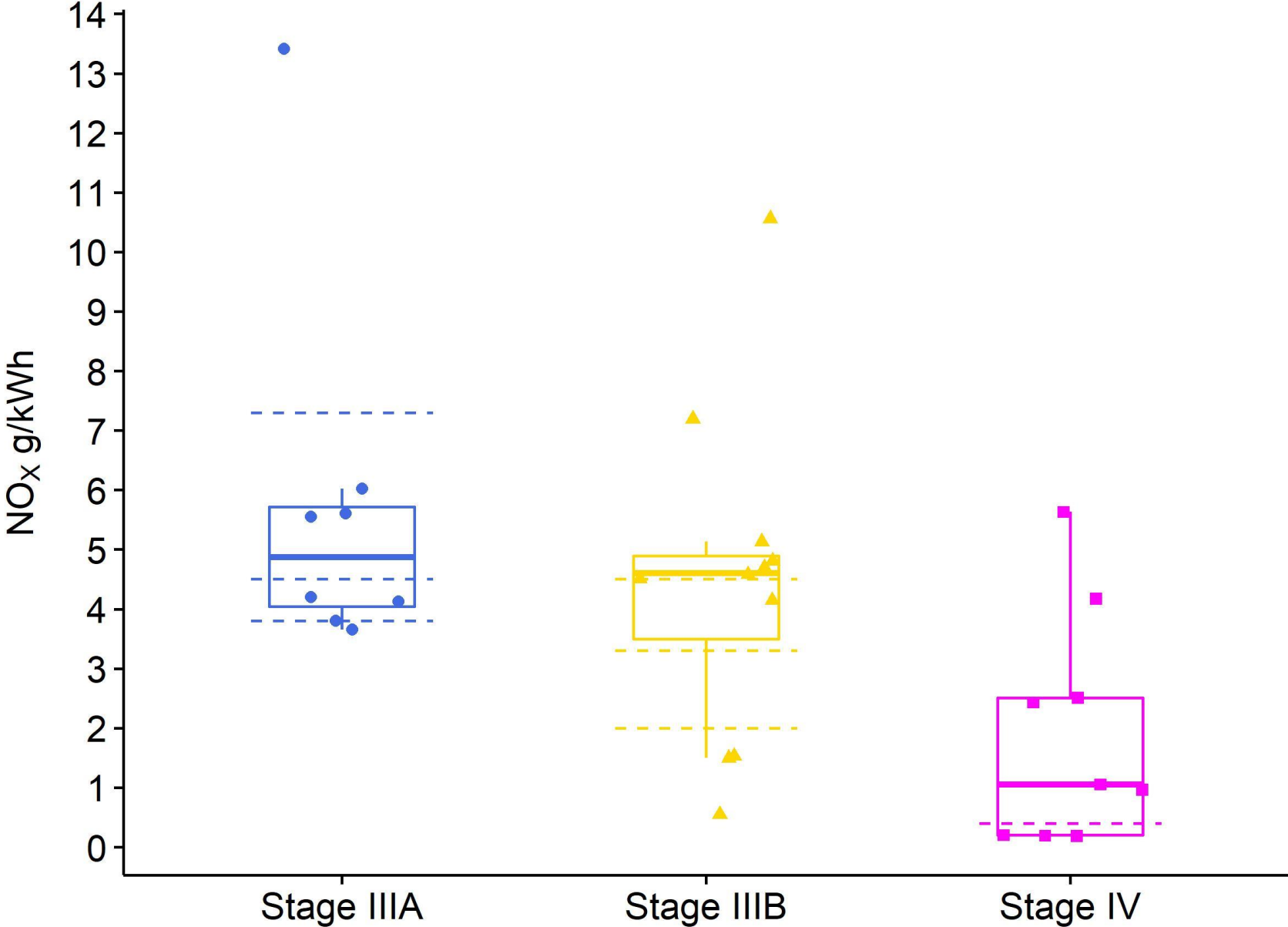
Laboratory grade instruments; conform to UN-  
ECE R-49 and EU No. 582/2011.



# NRMM - PEMS

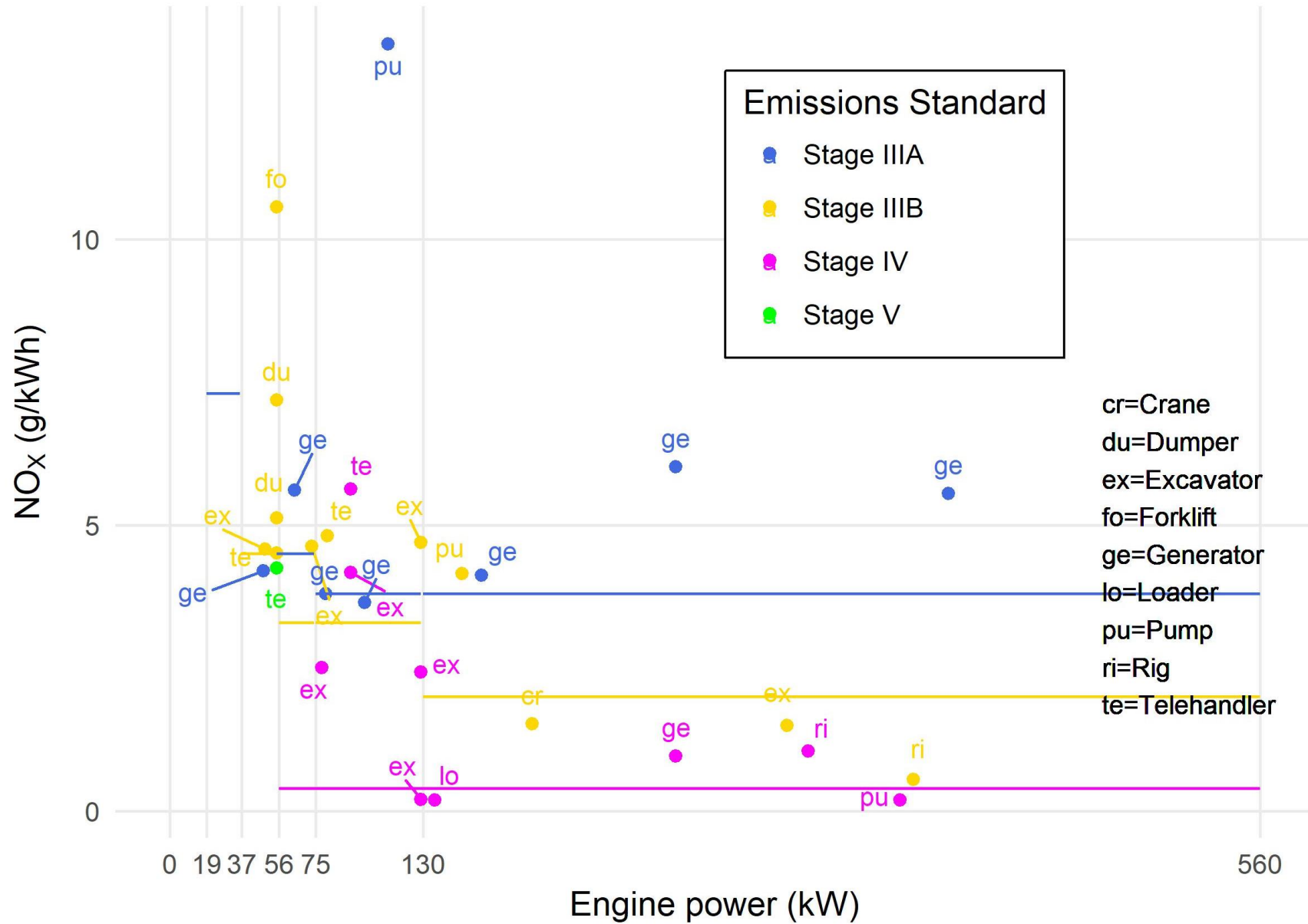


# Measured emission factors (grouped)

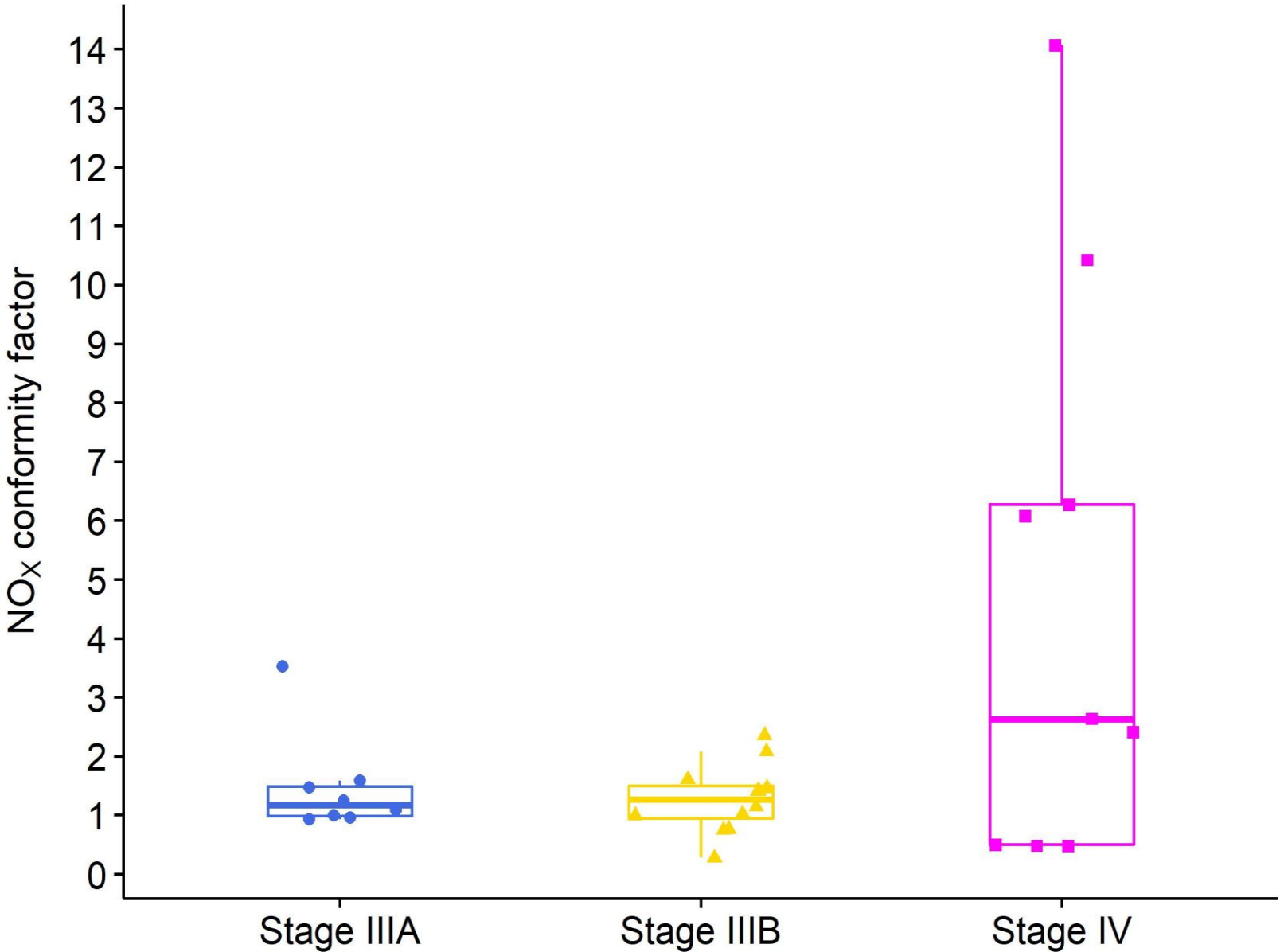




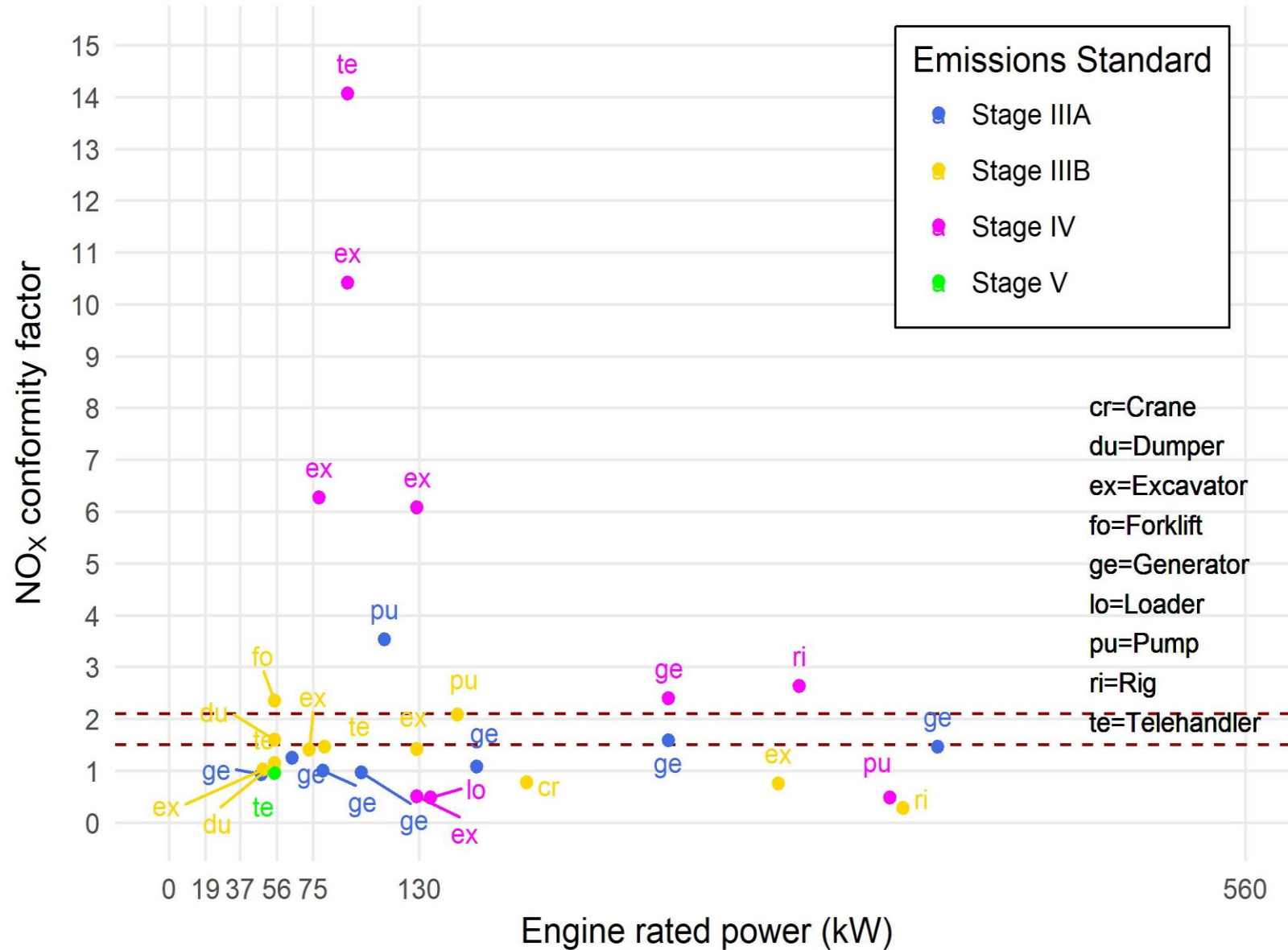
# Measured emission factors (individual NRMM)



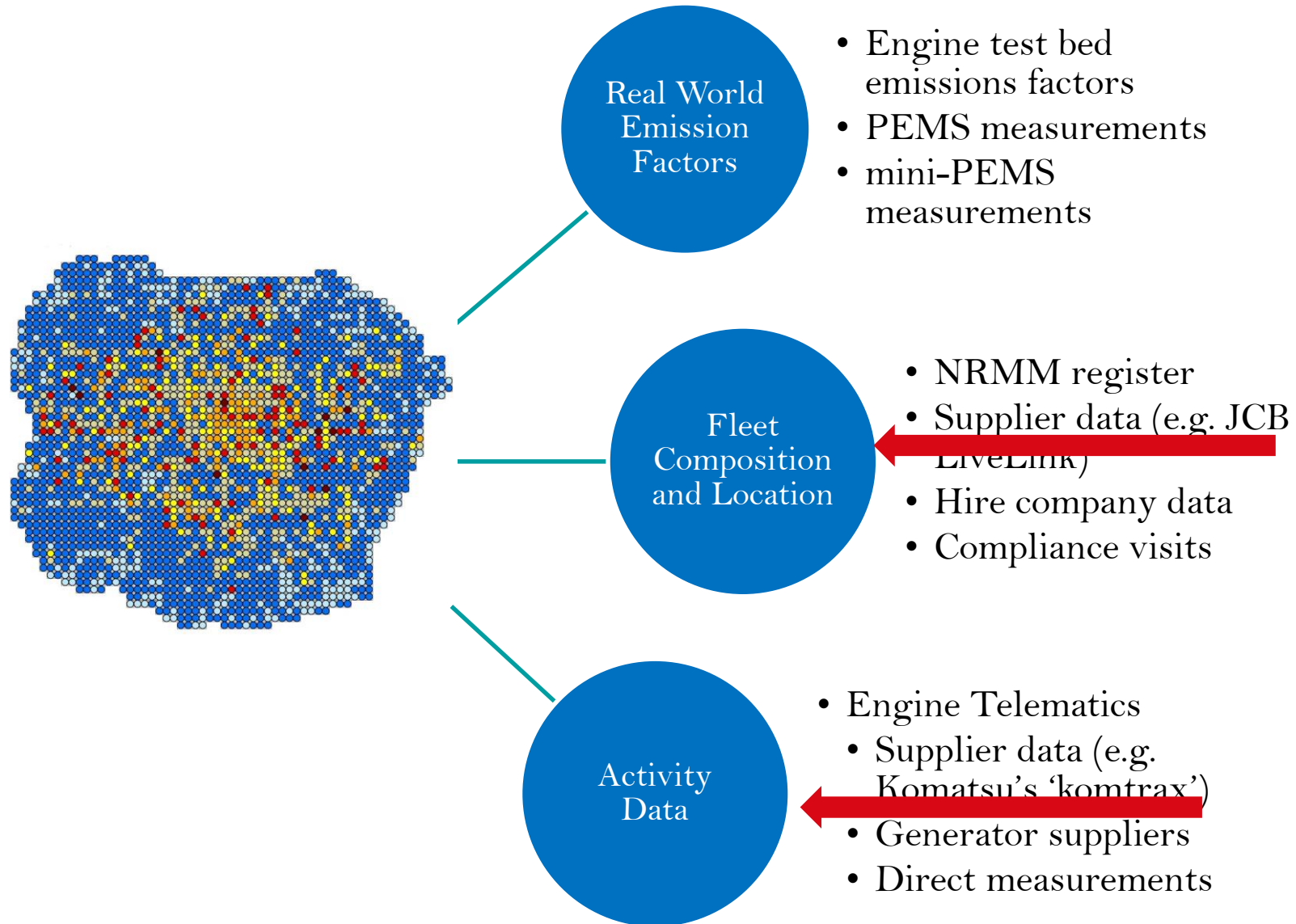
# NO<sub>x</sub> conformity factors (grouped)



# NO<sub>x</sub> conformity factors (individual NRMM)



# Fleet composition, location, and activity





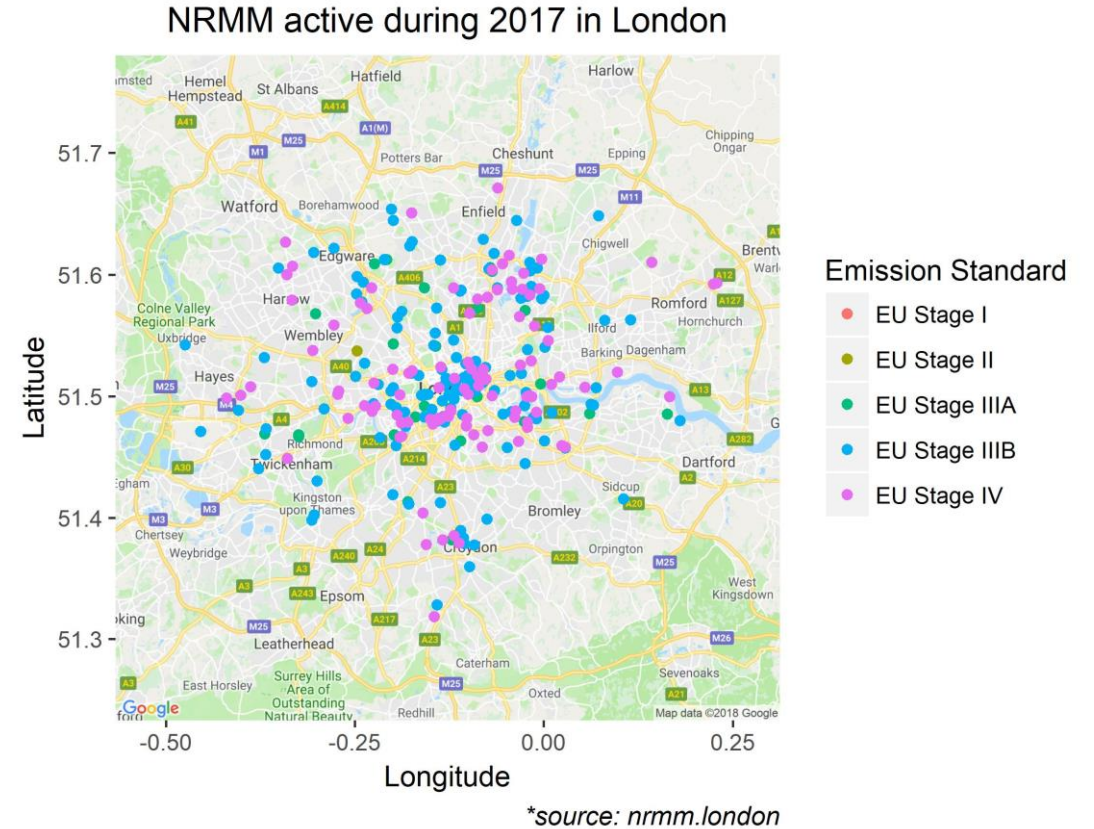
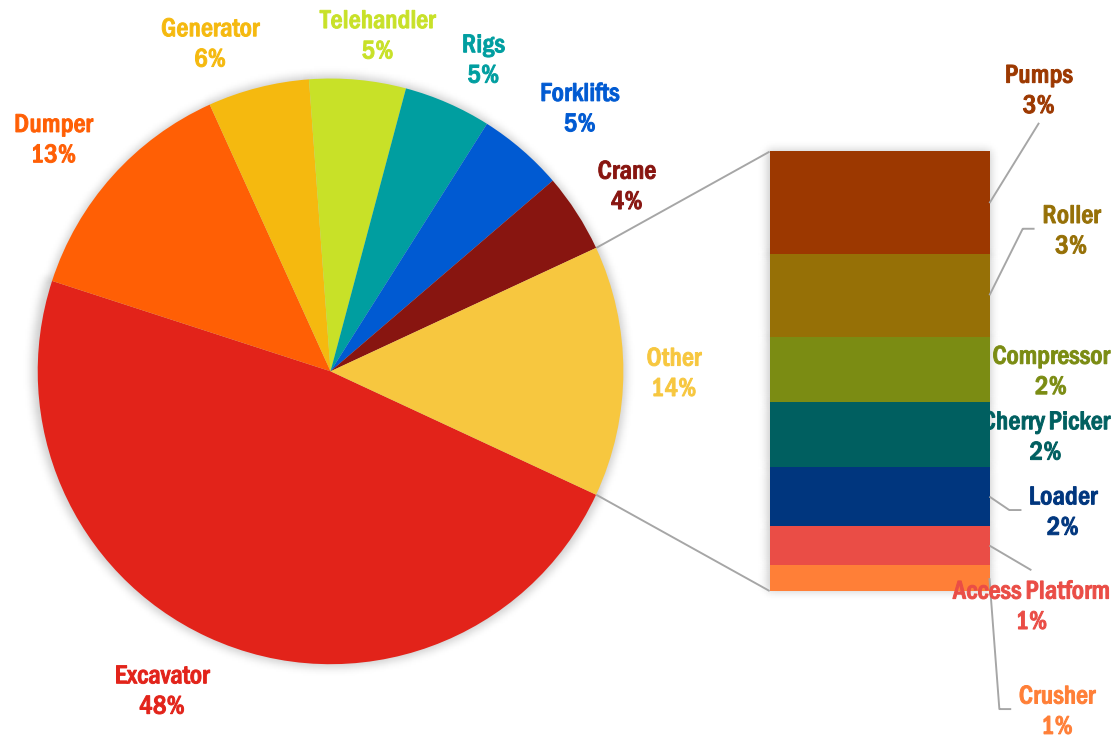
# London's NRMM register

[HOME](#)[ABOUT ▾](#)[NRMM REGISTER ▾](#)[HOW TO USE ▾](#)[GUIDANCE ▾](#)[CONTACT](#)[SITE MAP](#)[LOG IN](#)

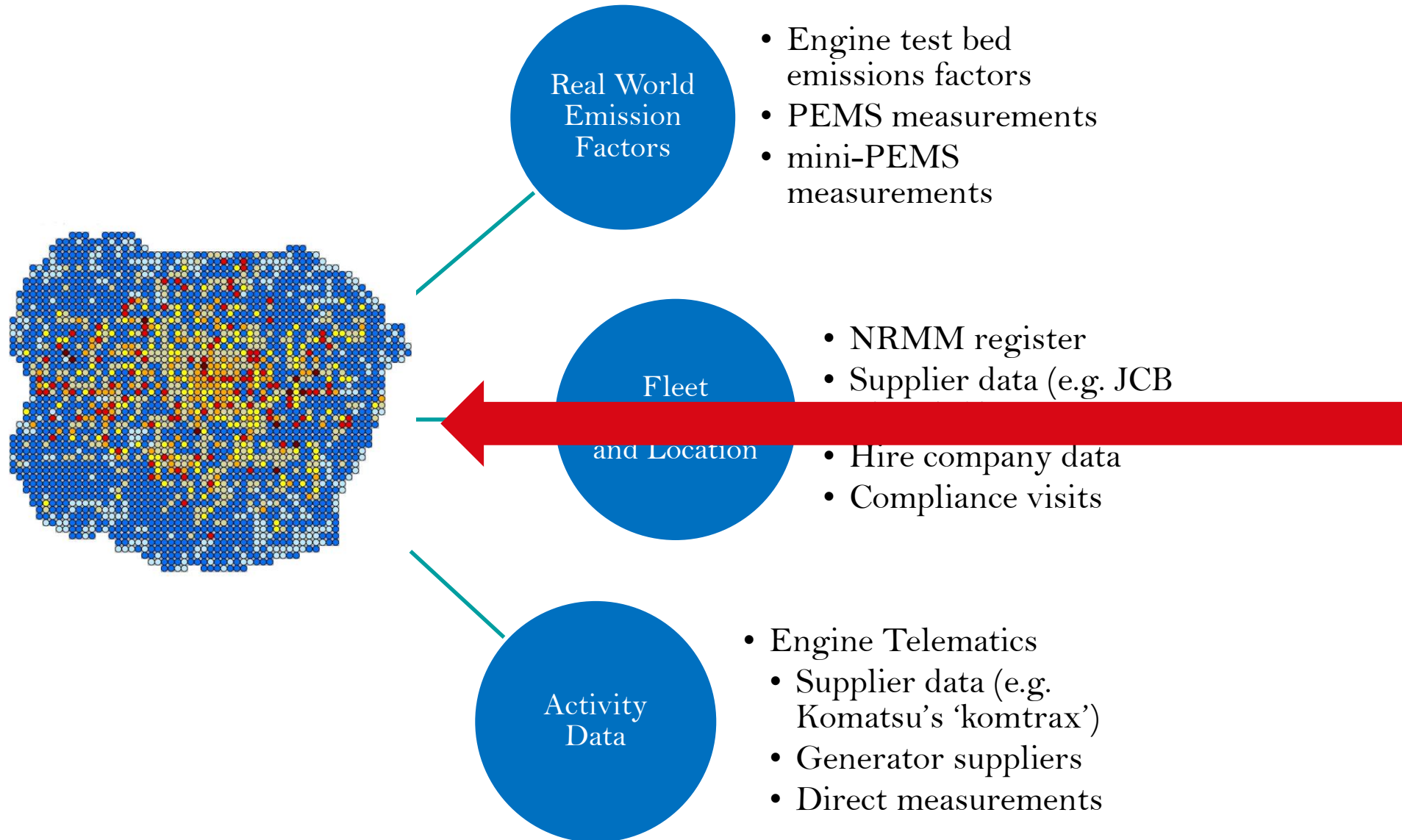
## LONDON'S 'LOW EMISSION ZONE' FOR NON-ROAD MOBILE MACHINERY

Air pollution is one of the most significant challenges facing London. We are in breach of European legal limits for Nitrogen Dioxide (NO<sub>2</sub>) and many areas exceed safe limits for Particulate Matter (PM) as set by the World Health Organisation. Bold new measures have been proposed by the Mayor to tackle emissions from road transport, particularly diesel vehicles, including an expansion of the Ultra Low Emission Zone. However, this is only half the problem – current estimates of emissions from NRMM used on construction sites are shown to be responsible for 7% of NO<sub>x</sub> emissions, 14% for PM<sub>2.5</sub> and 8% of PM<sub>10</sub> emissions across the Capital and this is why the Mayor is determined to take action.

# Different types of NRMM registered in 2017, located in London



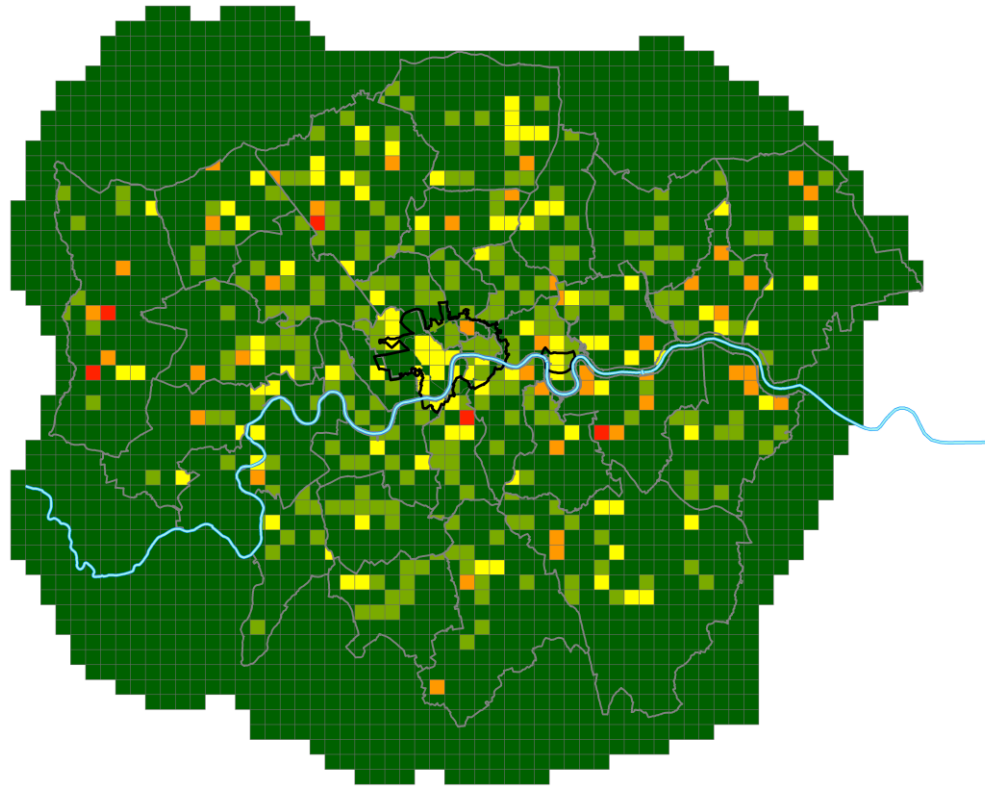
# Emissions mapping



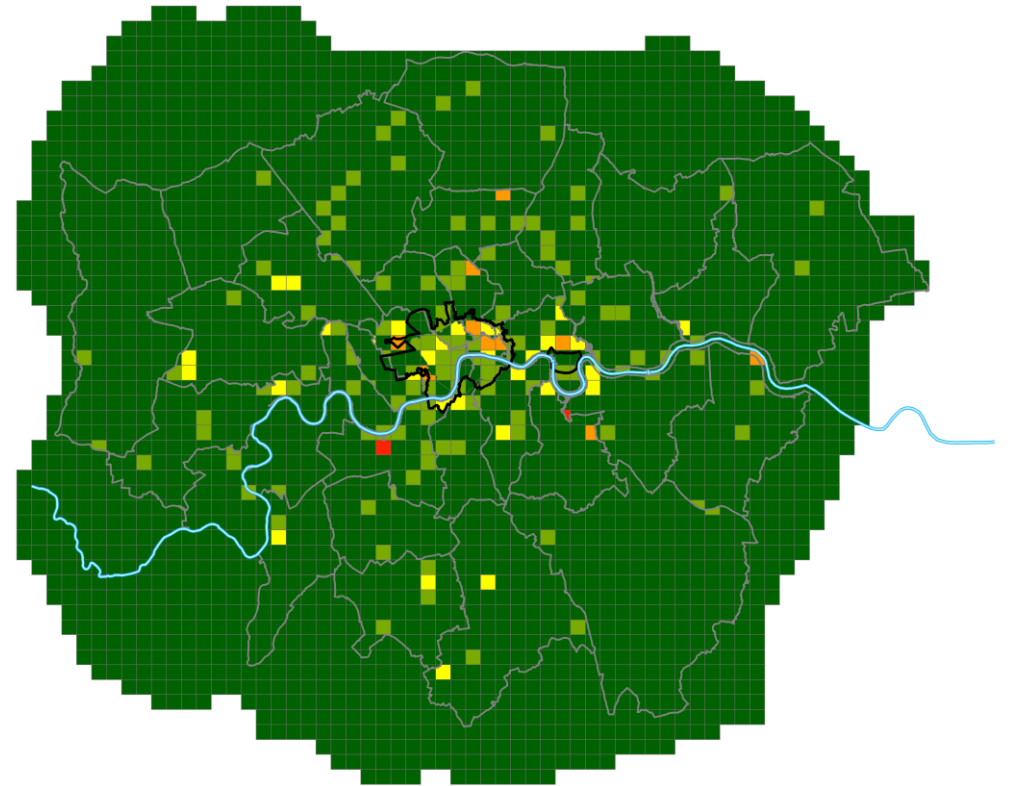
# Emissions mapping

---

LAEI 2016: NO<sub>x</sub> from construction sector



Measured NO<sub>x</sub> from NRMM





# Generators....

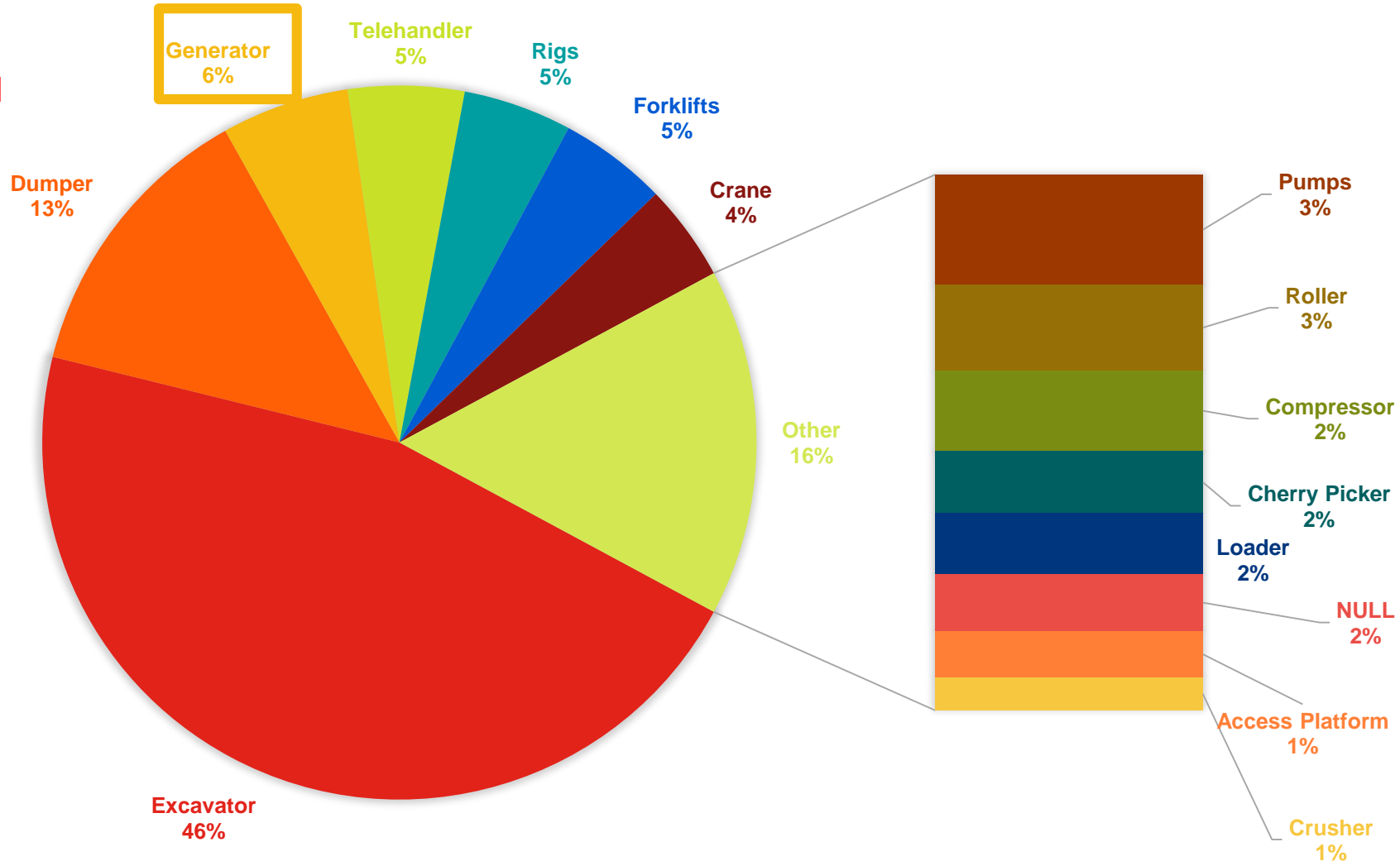
---



Retrofitting older Stage III-A generators used in London with exhaust gas after-treatment technology (current generator standard: Stage III-A)

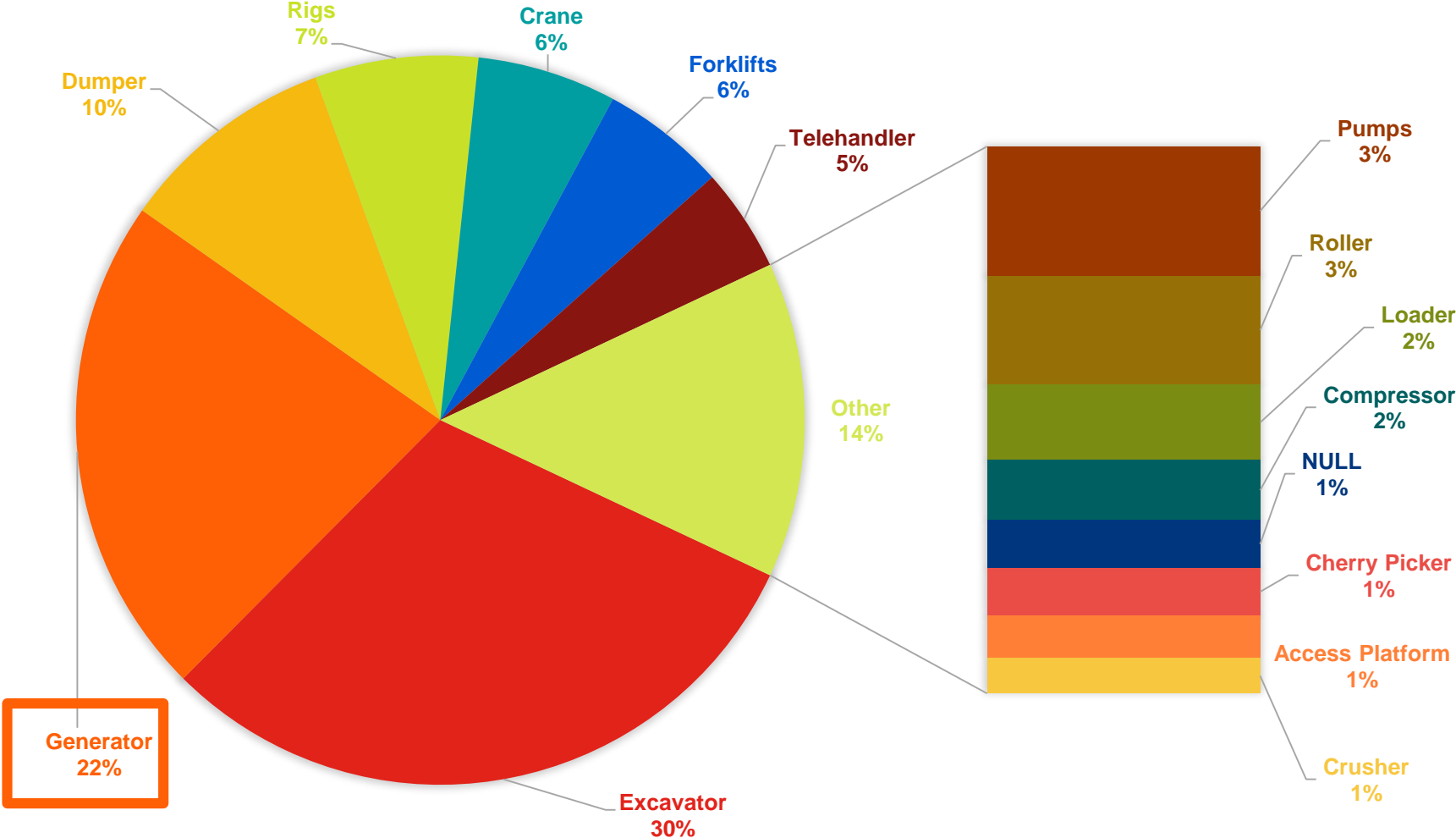
# Why are generators so important?

Stage I: 2  
Stage II: 9  
Stage III-A: 121  
Stage III-B: 28  
Stage IV: 10



source:  
<https://www.nrmm.london>

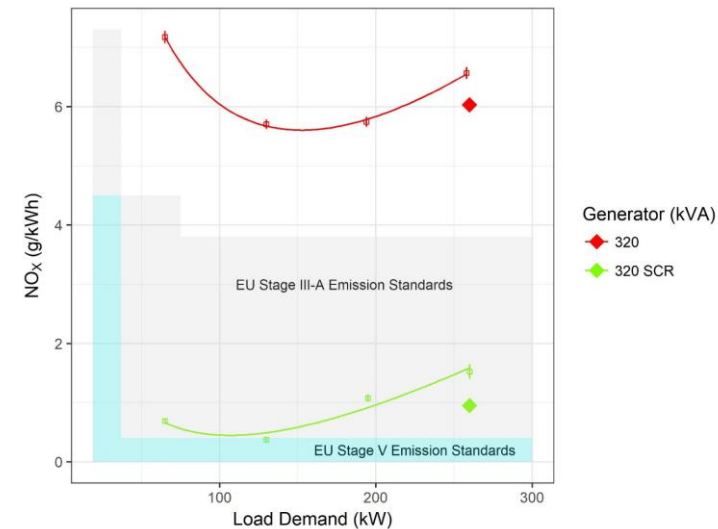
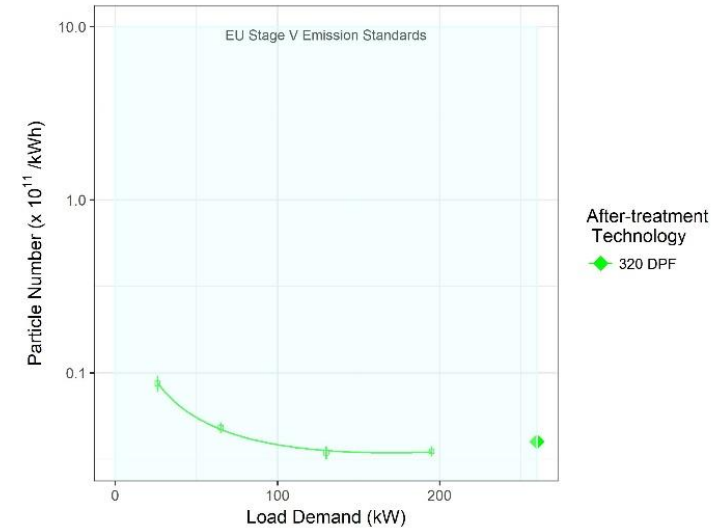
# NO<sub>x</sub> contribution by type of NRMM used in 2017



**source:**  
<https://www.nrmm.london>

# Generator exhaust gas after-treatment

- Diesel Particle Filter (DPF)
  - Stage III-A generator particle number (PN) emissions
  - Tested using standard load cycle
  - Reduction in PN at all loads
- 
- Selective Catalytic Reduction (SCR)
  - Converts  $\text{NO}_x$  to  $\text{N}_2$  and water
  - Reduces  $\text{NO}_x$  emissions at all loads
  - Reduces >III-A emission standard to within III-A emissions standard and just above V emissions standard
- 
- Inventory analysis
  - ~120 Stage III-A generators registered.
  - 85% reduction in  $\text{NO}_x$
  - If all Stage III-A generators were retrofitted, 3% reduction in overall  $\text{NO}_x$
  - 2 orders of magnitude reduction in particle number, using DPF.





# Summary

---

- Construction is an important part of the inventory, as an emissions source:
  - 15% of PM<sub>2.5</sub> and 7% of NO<sub>x</sub>
- There are large uncertainties in the way the current inventory is developed:
  - emission factors: fuel use
  - activity data: employment in the construction sector
- This spatial and fleet disaggregated approach is more robust and detailed:
  - emissions factors: real-world measurements
  - activity data: NRMM register and data loggers
- The emissions inventory gives us the ability to test future policy scenarios.
- Feedback to the industry (machinery use) as well as the government (policy).
- Enables us to identify and develop policy, based on the results from our findings.
- “Road-to-zero (tailpipe)”: there is potential for electric-NRMM.

# Acknowledgements

---



SUPPORTED BY  
**MAYOR OF LONDON**



# Further information



Carl Desouza  
[carl.desouza@kcl.ac.uk](mailto:carl.desouza@kcl.ac.uk)

David Green  
([david.c.green@kcl.ac.uk](mailto:david.c.green@kcl.ac.uk))

Daniel Marsh  
([daniel.j.marsh@kcl.ac.uk](mailto:daniel.j.marsh@kcl.ac.uk))

**KING'S**  
*College*  
**LONDON**

