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Construction emissions Exemplar sites

Construction Emissions Tool - User Guide



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Tool Change log

Version	Date	Details of changes
1	– June 2023	– Released with NRMM Emissions Tool v2.0

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Introduction

This Non-Road Mobile Machinery Emissions (NRMM) Tool user guide has been compiled by Arup. This user guide should be used in conjunction with Version 2.0 of the tool.

Arup has been commissioned by Impact on Urban Health to undertake an update to a previously created tool in partnership on their ‘Exemplar construction sites for air quality’ project¹. The original tool (Version 1.0) was created to calculate the emissions from Non-Road Mobile Machinery (NRMM) that was used by construction companies taking part in the exemplar sites project.

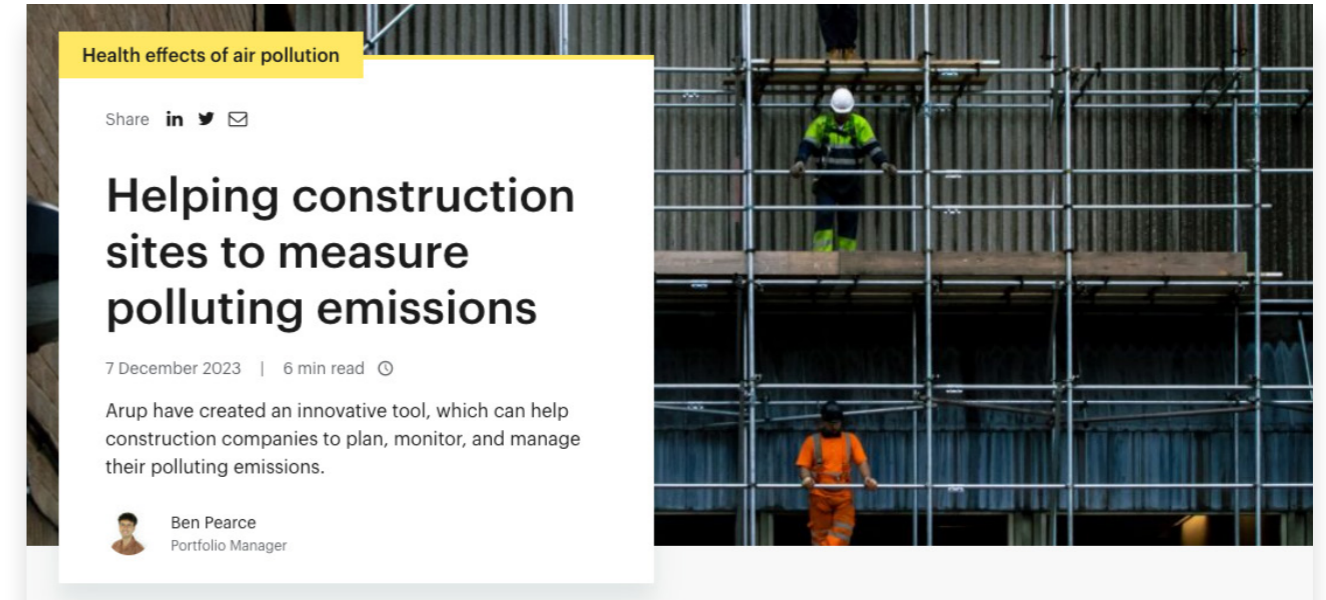
The tool calculated the emissions from the proposed NRMM (specifying the Euro Stage and fuel type) and compare it against a baseline (calculated from the minimum requirements of NRMM on-site) to determine the ‘emission saving’.

Since the creation of the tool, there has been positive feedback from the construction industry, including how the original tool could be improved in terms of the functions within it to increase the applicability of the tool.

This updated tool has been developed in partnership with Impact on Urban Health, following consultation with relevant stakeholders, reviewing emission factors and the current NRMM market. Figure 1 illustrates the work undertaken.



Figure 1. Workflow of the Version 2 tool update



Purpose

The overarching purpose of this tool is to facilitate the reduction of NRMM emissions at construction sites. There are four key areas where the tool is expected to be used:

1. Environmental procurement teams: Developers or organisations wishing to introduce environmental procurement requirements for reducing emissions from NRMM can use the tool as a tender response requirement to demonstrate how a potential contractor can demonstrate emissions reductions. The tool can be included as part of the evidence requirements and can support future auditing against progress.
2. Contractors during operation: Contractors managing site works, planning and NRMM use can use the tool to calculate the emissions from the work and per phase of works. This will help calculate which phases are most intensive and what equipment choices can be made to reduce emissions and meet any tender requirements. The tool can be used to demonstrate best practice for planning and to supplement internal carbon air emissions-based reporting. It could also be used for forecasting and testing which equipment choice to make in order support site emissions reductions.

3. Meeting policy requirements or tracking emission reductions: Local authorities or other bodies such as developers could use the tool to review if they are meeting minimum policy requirements such as the GLA NRMM policy where applicable. It would be possible to use the tools across multiple sites to aggregate up emissions savings at a local or borough level.
4. Audit teams: The tool can be used to request evidence for NRMM reporting and audit purposes. Either through existing schemes such as those managed by the GLA or other local authority or client requirements.

The data collected by the tool (not collected externally) has significant value and could be used to report on emission reductions at a local authority, company or regional level. This is a point for future consideration. The tool can also be used more widely by those outside of the construction sector as equipment such as generators have a range of uses.

About the Tool

The latest tool can be obtained from the Impact on Urban Health. It calculates total emissions of nitrogen oxides (NO_x), particulate matter (PM₁₀) and embodied carbon (CO₂e) from NRMM fleets entered.

The tool takes into consideration the following information available:

- London’s ‘Low Emission Zone’ for NRMM²;
- The European Monitoring and Evaluation Programme and European Environment Agency (EMEP/EEA) air pollutant emission inventory guidebook 2019³;
- Centre for Low Emission Construction⁴ (CLEC) resources;
- The Department for Energy Security and Net Zero (DESNZ) greenhouse gas reporting conversion factors⁵; and
- Various construction equipment manufacturer information sheets.

The tool uses the methodology detailed in the EMEP/EEA guidebook to determine emission factors for diesel and Liquefied Petroleum Gas (LPG) powered NRMM. The tool also uses assumptions on the emissions of biodiesel (including Hydrogenated Vegetable Oil (HVO)) from CLEC resources⁶.

Assumptions have also been made on hybrid emission savings of NO_x and PM compared to diesel comparatives. Information sheets were gathered from manufacturers of hybrid construction equipment and a trend analysis of the fuel savings has been incorporated into the tool, which assumed at least a 16% saving in both NO_x and PM, increasing with the power rating of the NRMM equipment. Figure 2 illustrates the flow of data in the tool.

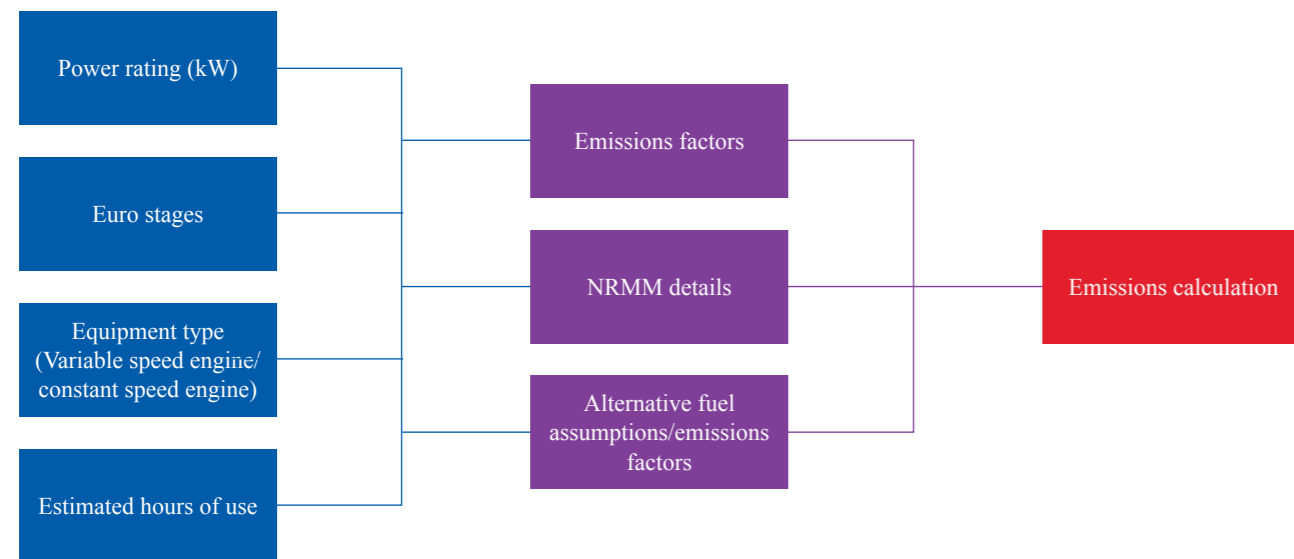


Figure 2.
Flow of data in the tool



Using the tool

In order to use the tool, save the tool in a local drive (for example C: drive). You must enable macros in your Microsoft Excel security settings before opening the spreadsheet. When using Excel 2013, this can be found under the “Developer tab” in the ribbon. Then:

Macro Security > Macro Settings > Enable All Macros

For versions of Excel prior to 2010, this can be found in:

Tools > Macros > Security Level > Medium

Getting Started

The first input sheet is ‘Site details’. Many of the details are for filing purposes. However, the ‘Type of project’ is required to set the construction phases as shown in Figure 3. The tool is set as ‘Building’ as default.

The choice of ‘Building’ or ‘Infrastructure’ will influence the project phases available as shown below.

USER INPUTS	
Is the site located in the Central Activity Zone or an Opportunity	
Development name:	
Landowner:	
Principal contractor:	
Site address:	
Site postcode:	
Type of project:	Building
Type of construction:	Building Infrastructure
State of current site:	

Building project

Construction phases
Site setup and demolition
Basement excavation and piling
Sub-structure
Super-structure
Cladding
Fit-out, testing and commissioning

Infrastructure project

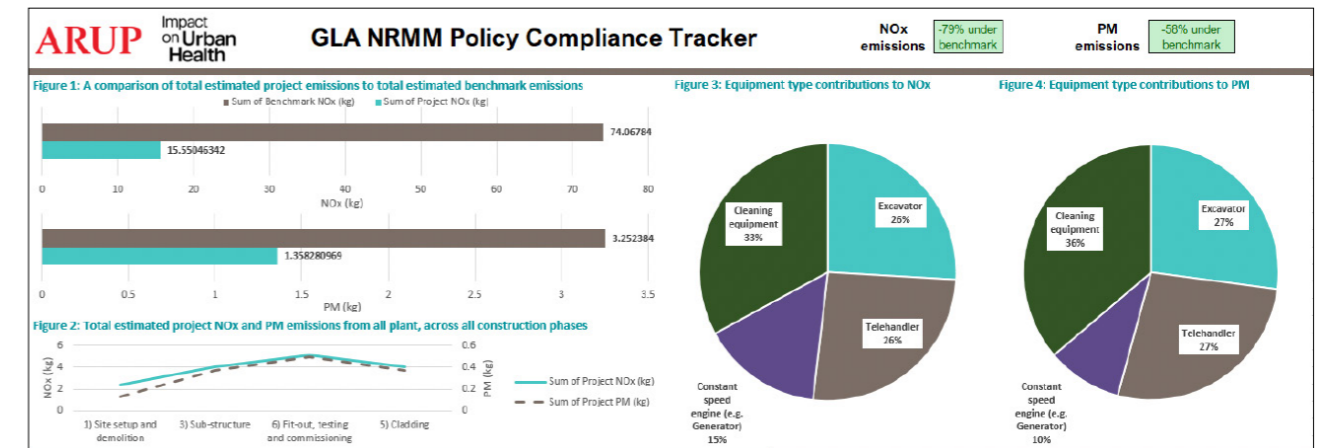
Construction phases
Site establishment, clearance & alterations
Excavation and foundations
Sub-structure
Super-structure
Services & systems installation
Fit-out, testing and commissioning

Figure 3. User inputs on ‘Site details’ sheet

GLA Compliance

The ‘GLA Compliance’ sheet calculates the NOx and PM emissions from your entered NRMM and compares with the ‘benchmark’.

The benchmark is the emissions from the NRMM fleet, assuming it is all meeting the minimum GLA NRMM policy requirements.



Input									
GLA NRMM policy area: Other areas of Greater London									
Construction year: 2023									
Unique ID	Construction Phase	Equipment type	Estimated usage (hrs)	Power rating (kW)	Technology/fuel type	EU Stage	Abatement technology	Resultant EU Stage	Com chet
31	1) Site setup and demol	Constant speed eng	100	72	Hybrid	EU Stage V		n/a	Con
32	3) Sub-structure	Excavator	100	100	Diesel	EU Stage IV		n/a	Con
33	5) Cladding	Telehandler	100	100	Diesel	EU Stage IV		n/a	Con
34	6) Fit-out, testing and co	Cleaning equipmen	100	10	Hybrid	EU Stage V		n/a	Con
35									
36									

1. Enter the GLA NRMM policy area, in which the project resides:

- Central Activity Zone and Canary Wharf
- Opportunity Area
- Other area of Greater London

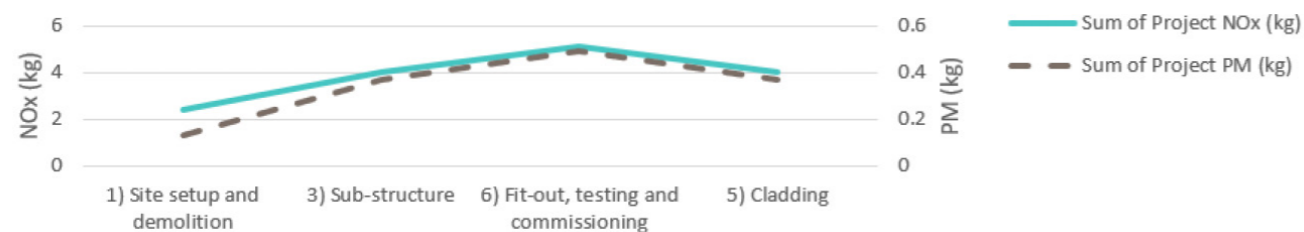
2. The GLA website² includes a map showing these area. Also, when registering a new site on the GLA NRMM register, you will be able to drop a pin on the site location to identify which zone your site is in.

3. Enter the year of construction. This dictates which set of NRMM Low Emission Zone standards will be in place in the future, as the standards will get progressively stringent over time:

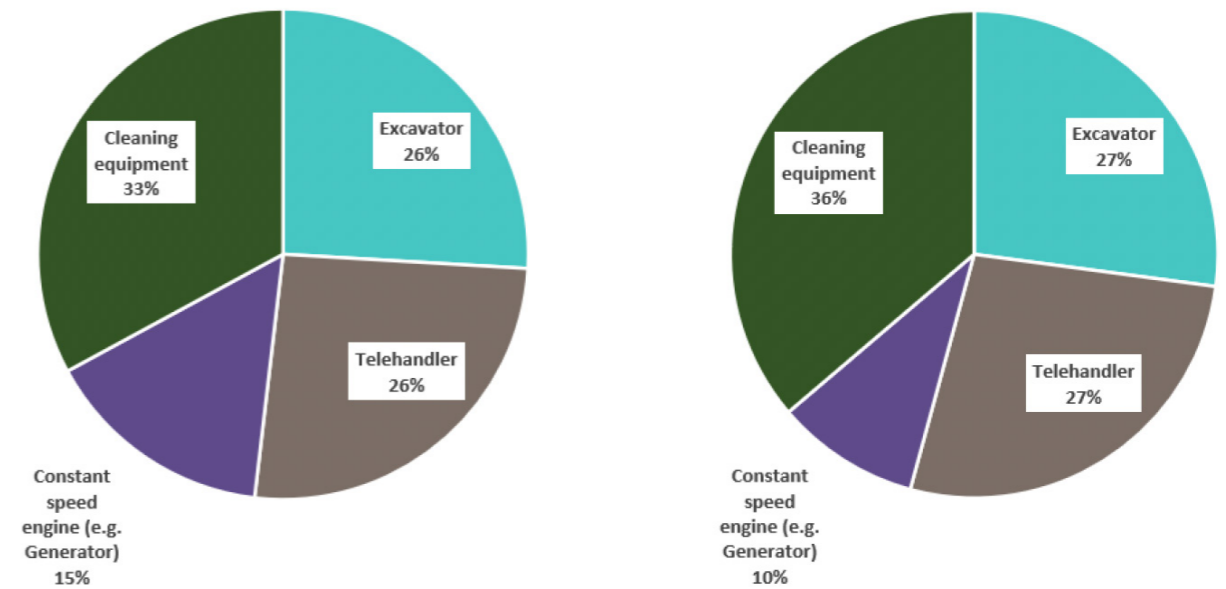
- From 1 January 2025 the standards will be stage IV throughout London (regardless of zone);
- From 1 of January 2030 the standards will be stage V throughout London;
- From 1 of January 2040 only zero emission machinery will be allowed.

4. Unique ID. This is your equipment unique identifier. To add more rows to the tables, enter a Unique ID in the empty row below and the table should expand.

5. Construction Phase. This allows the emissions to be split across phases in the line chart to help visualise how emissions will be spread across the phases.



6. Equipment type. This allows the emissions to be attributed to equipment types to allow the key contributors to be visualised.



7. Estimated usage. This input is the number of hours the equipment will be in operation. This is the activity data used to calculate the emissions. Estimations can be calculated, for example, by predicting the number of days the equipment will be on site and multiplying it by the number of working hours of that site (e.g. 10 days x 8 hour working days = 80hrs).

8. Power rating. This input is given in kilowatts (kW) and is the rated power of the equipment.

9. Technology/fuel type. The default type is diesel. However, the alternatives included are LPG, biodiesel (select this if using HVO), hybrid and electric or battery.

Technology/ fuel type	EU
Hybrid	
[Select type]	
Diesel	
LPG	
Biodiesel	
Hybrid	
Electric/battery	

10. EU Stage. This is the emission standard with which the NRMM complies. To be able to identify the EU Stage, please refer to the CLEC and GLA 'Practical Guide', available at the GLA NRMM policy website².

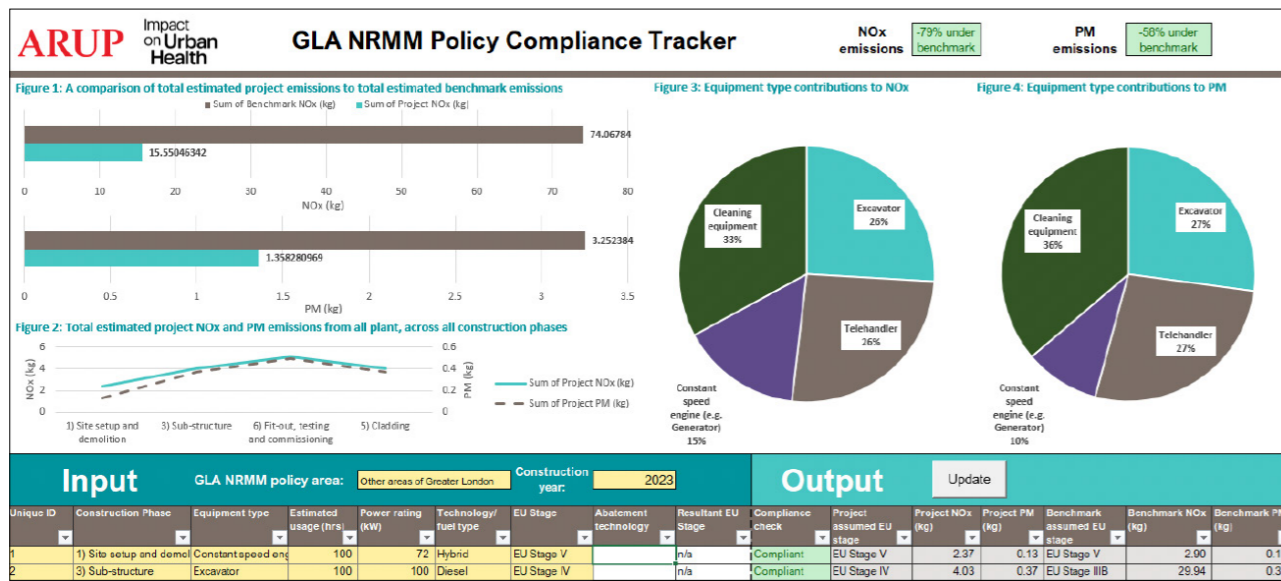
- There are options to enter abatement technology that would result in the NRMM meeting a more stringent EU Stage emission standard (to be entered in the 'Resultant EU Stage' column). If there is plant with abatement technology retrofitted, please refer to the Energy Saving Trust guidance⁸ on resultant EU Stage from certified abatement. If your equipment is not fitted with abatement, you do not need to fill these cells.

Abatement technology	Resultant EU Stage
	n/a

- Once you have populated the inputs, click on the 'Update' button and the Output calculations will update along with the information dashboard.

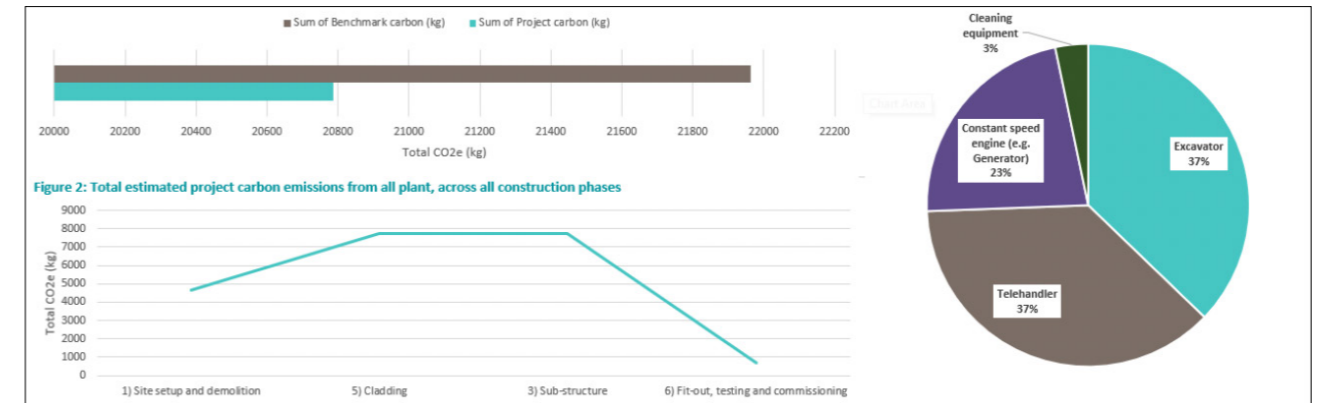
Output
Update

- You should now have a dashboard showing the comparison between project (your site) and benchmark (GLA NRMM policy minimum requirements) emissions, emissions through the phases, key contributors and the % of NO_x and PM under or over the benchmark.



Carbon Breakdown

The input procedure is the same for the 'Carbon Breakdown' sheet. However, the output is embodied carbon (CO₂e).

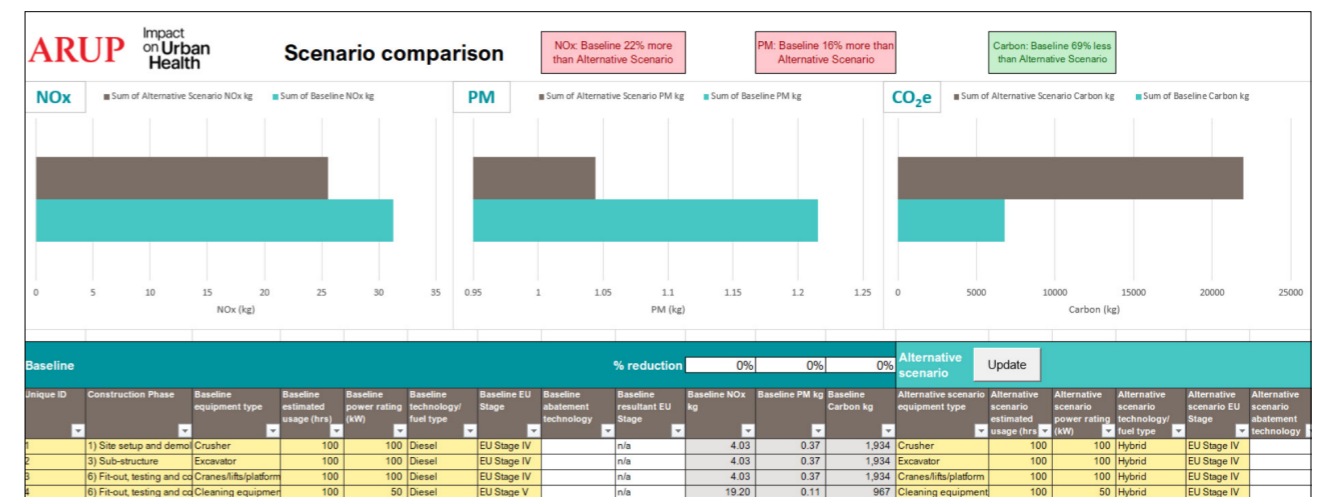


Scenario Comparison

Being able to compare the proposed equipment and total emissions with a future alternative scenario is highly valuable as it allows the user to test which equipment options need to be changed or improved in order to reach a set emission reduction goal.

The sheet will populate the baseline scenario with the information from the previous tabs and the user can alter the selections in the alternative scenario to calculate the changes in emissions.

The input procedure is also the same for the 'Scenario Comparison' sheet, but is doubled up for the baseline and future scenario to be able to set a second scenario that is not automatically set at the minimum GLA NRMM policy requirements. This sheet calculates the emissions for NO_x, PM and carbon for comparison.



There is also an option to apply a blanket % emission reduction for each pollutant, for each scenario to be able to test scenarios.

% reduction

Baseline Baseline NOx Baseline PM kg Baseline Carbon kg

Limitations



Some alternative fuel options have not been included. For example, Hydrogen as a combustion fuel has not been included in this version due to the limited data on NO_x and PM emissions on the combustion of this fuel in NRMM.

For carbon emissions, assumptions would need to be made on the production of the Hydrogen fuel, which could significantly vary the CO₂e.

The emission calculations in the tool apply EMEP/EEA emissions guidebook methodology. It should be noted that the basis of this are the emission standards for NRMM and that real-world emission from NRMM will vary in conformity to the emission standards (below and above), as studies suggest (C.D. Desouza et al. 2020⁹).

Therefore, there is inherent uncertainty in the emissions calculated and assumptions made. However, the purpose of the tool is to support equipment users with making choices which will reduce emissions and allow a comparison of emissions between scenarios, rather than providing estimates for detailed reporting purposes and therefore should be used with due consideration.

Glossary and Definitions

Abbreviation	Details
Arup	Ove Arup & Partners Ltd
CLEC	Centre for Low Emission Construction
DESNZ	Department for Energy Security and Net Zero
CO ₂ e	Embodied carbon
EMEP/EEA	European Monitoring and Evaluation Programme and European Environment Agency
GLA	Greater London Authority
HVO	Hydrogenated Vegetable Oil
kW	Kilowatts
LPG	Liquefied Petroleum Gas
NO _x	Nitrogen Oxides
NRMM	Non-Road Mobile Machinery
PM ₁₀	Particulate matter

Disclaimer

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Endnotes

- 1 <https://urbanhealth.org.uk/partnerships/current-partnerships/exemplar-air-quality-construction-sites>
- 2 <https://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/pollution-and-air-quality/nrmm>
- 3 EMEP/EEA air pollutant emission inventory guidebook 2019 — European Environment Agency (europa.eu)
- 4 <https://clec.uk/>
- 5 Greenhouse gas reporting: conversion factors 2023 - GOV.UK (www.gov.uk)
- 6 CLEC (2019) 'Best in Class' Guidance on Dust and Emissions from Construction: LLECP BIC Guidance_FINAL.pdf (clec.uk)
- 7 Or go to File > Options > Customise ribbon and tick the Developer box on the right hand side menu
- 8 <https://energysavingtrust.org.uk/service/non-road-mobile-machinery-certification/>
- 9 C.D. Desouza, D.J. Marsh, S.D. Beevers, N. Molden, D.C. Green, Real-world emissions from non-road mobile machinery in London, Atmospheric Environment, Volume 223, 2020, 117301, ISSN 1352-2310, <https://doi.org/10.1016/j.atmosenv.2020.117301>.

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