

Pathway to Net-Zero Construction

Decarbonizing the construction industry

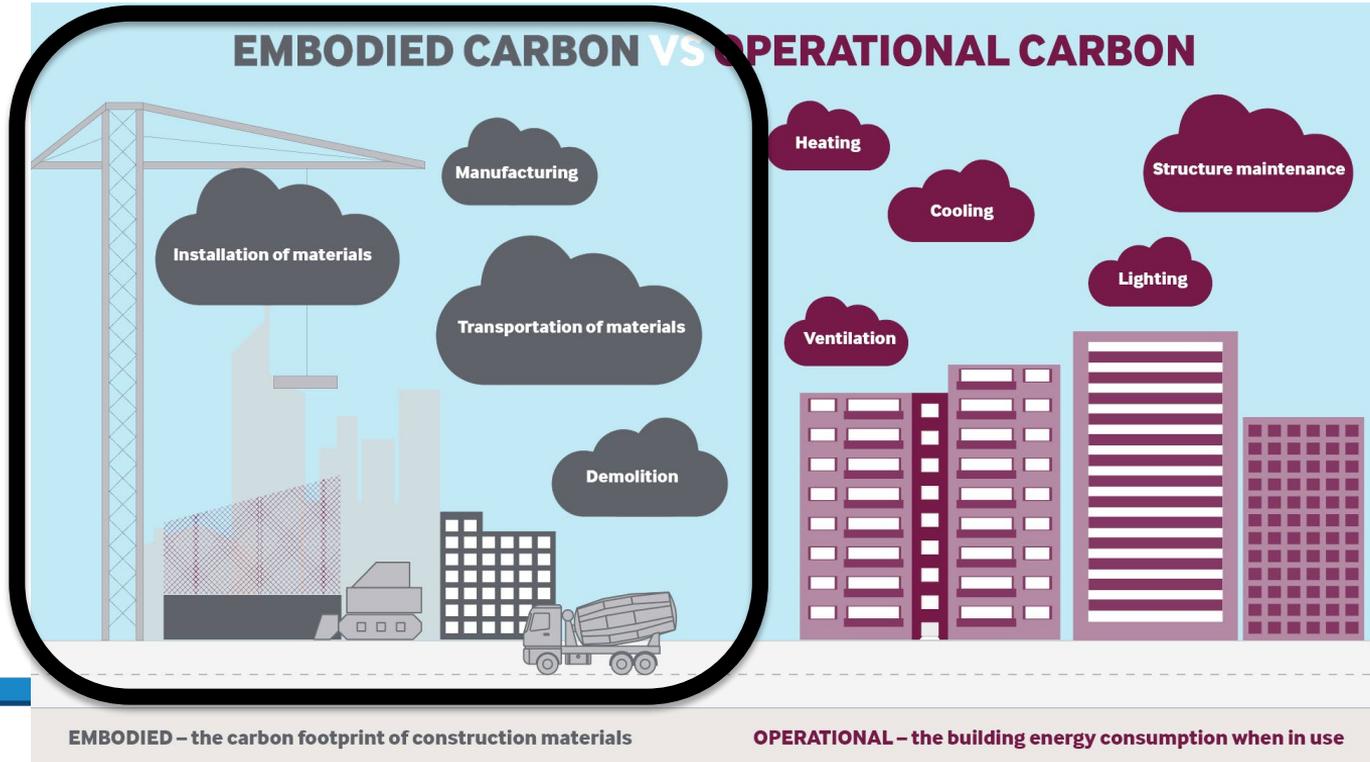
Dr. Carl Desouza

The centre for low emission construction

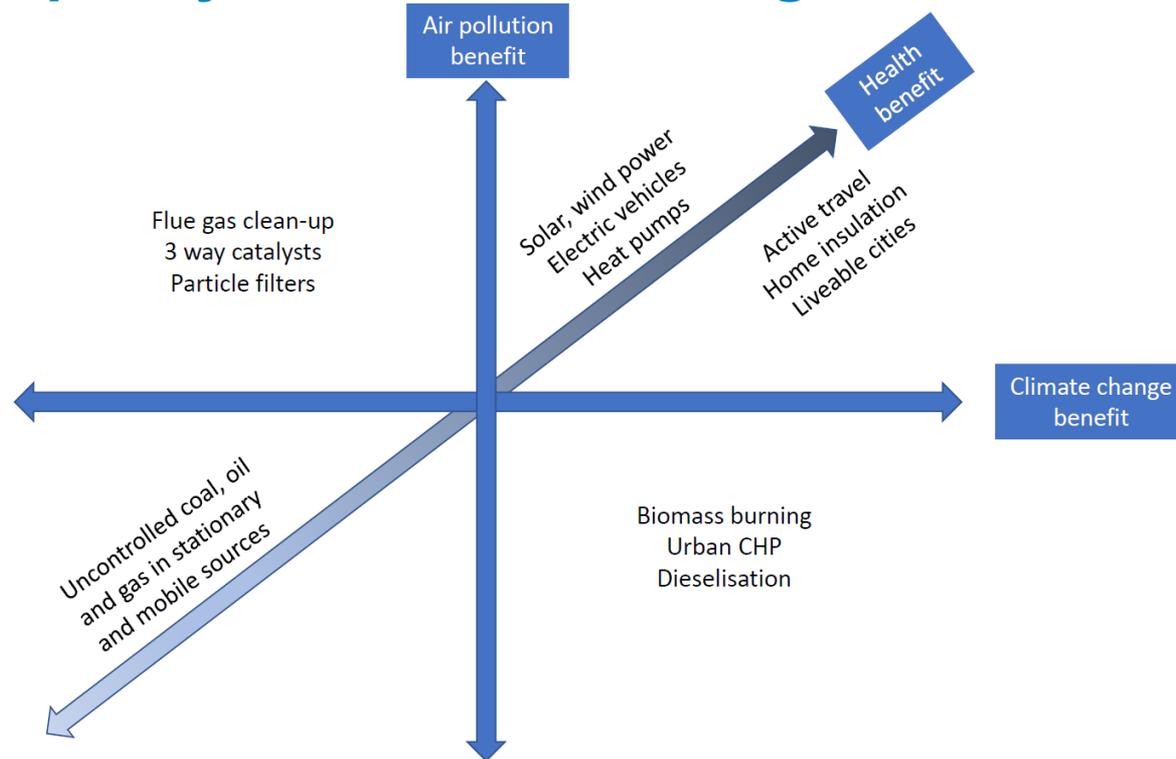
- Raising awareness of air quality impacts from construction and demolition
- Providing high quality scientific research to inform policy development
- Working with manufacturers to develop low emission technologies
- Quantify the health impact of exposure to emissions for the public and people working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



Construction as a source of emissions



Tackling air quality and climate change

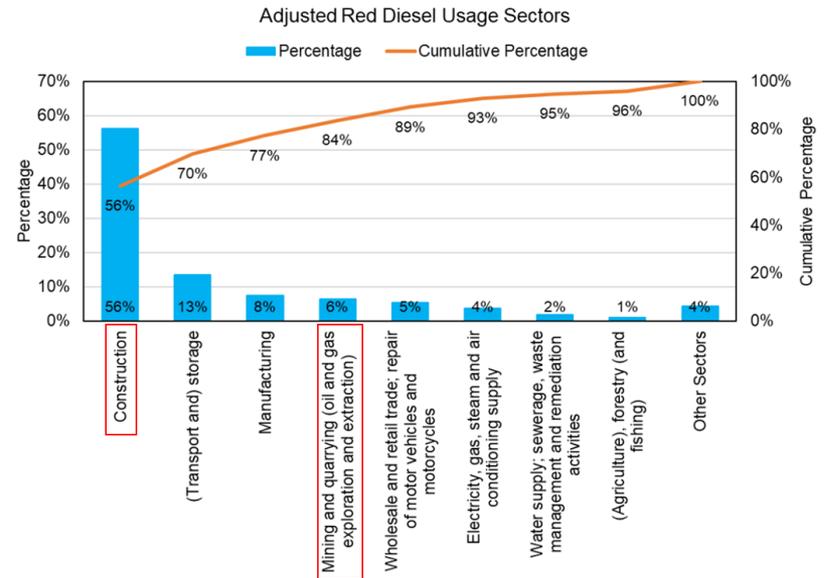


Air Quality, Climate Change, and Health



AQ and GHG emissions from machines used on sites

- > 300,000 items of machines used in the UK construction sector
- 2.5 million tonnes of diesel used on UK construction in 2020
- 2 million tonnes of diesel used for on-site generators
- AQ and CO₂ emissions associated with burning diesel
- 6 million tonnes CO₂e in 2019



It is not all about carbon

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, 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 Anup, 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).²⁰ 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

Dementia and cognitive decline
Impacts on the central nervous system (PM)

Irritation of eyes, nose
and throat

Breathing problems
(O₃, PM, NO₂)

Ischaemic heart disease,
stroke, heart failure (PM, O₃)

Metabolic effects (PM, O₃)

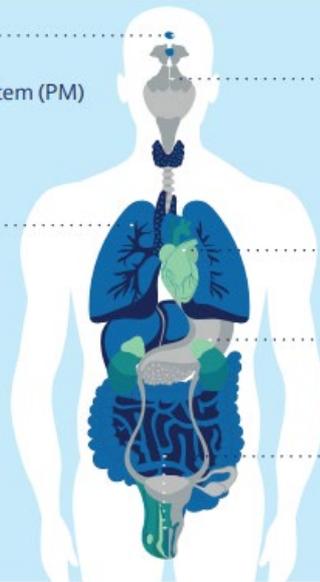
Impacts on the reproductive
system (PM)

Irritation, inflammation
and infections

Asthma and reduced lung
function (NO₂, O₃)

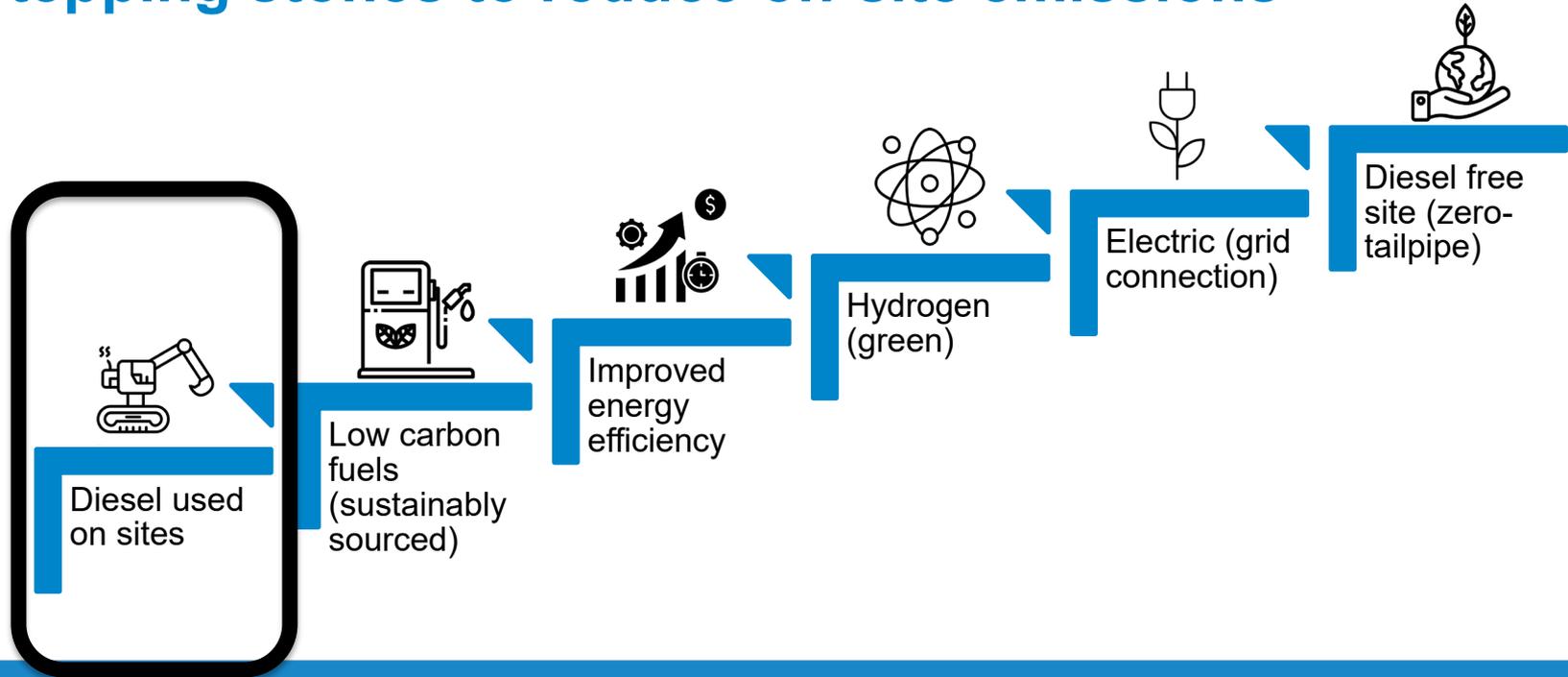
Chronic obstructive
pulmonary disease (PM)

Lung cancer (PM)



Source: Adapted from EEA (2020)²⁰

Stepping stones to reduce on-site emissions



Diesel used on sites

Low carbon fuels

Improved efficiency

Hydrogen

Electric

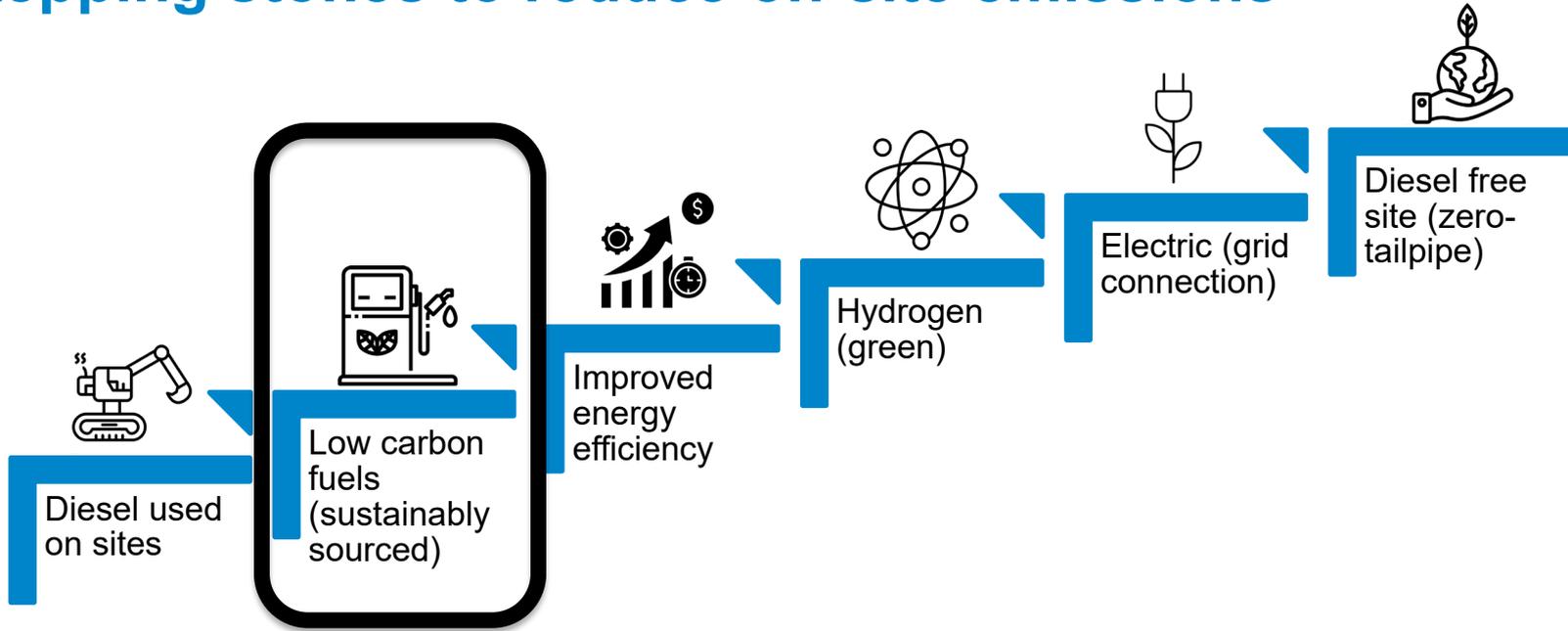
Diesel-free sites

Baseline – diesel fuel

- Measure emissions from current fleet
 - PEMS / iPEMS / on-board sensing?
- Inspect high emitters
- Baseline emission factors / model emission factors for unavailable machines
- Develop fleet inventory for OEMs / hire companies / London / UK
- Provide baseline evidence for policy development and test scenarios



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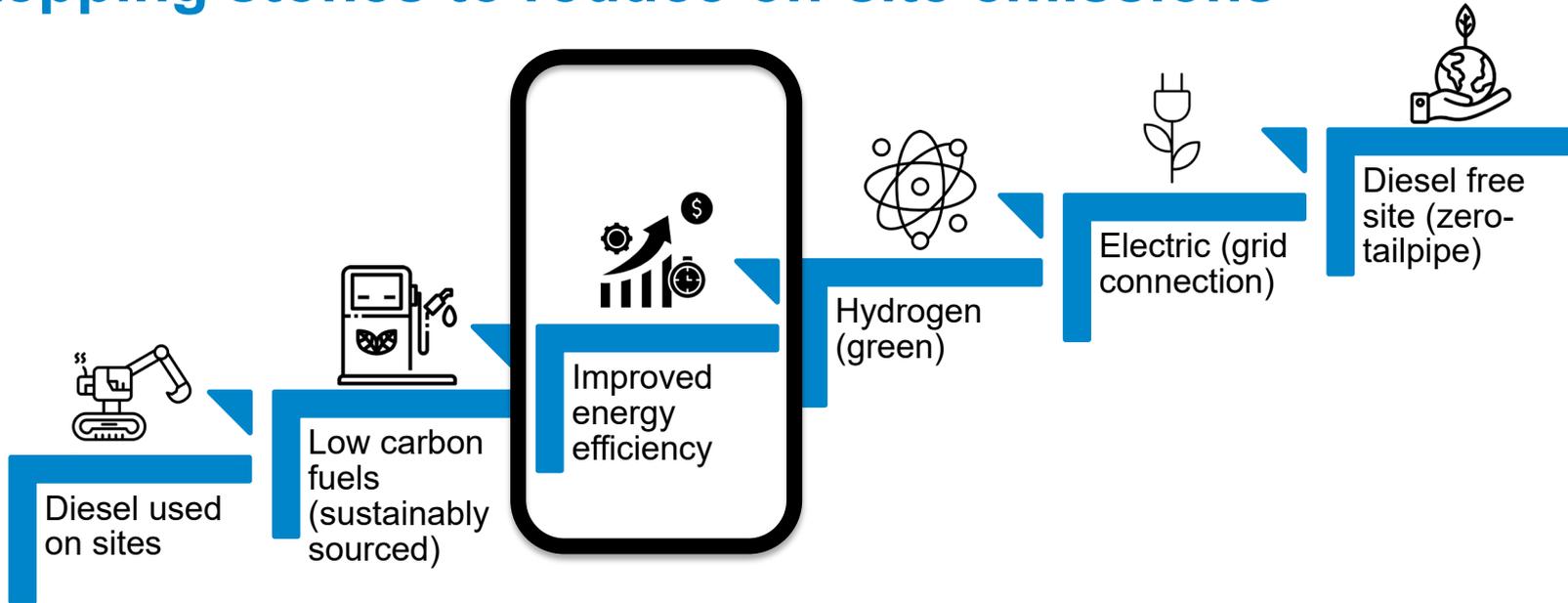
Diesel-free sites

Low carbon fuels

- Trial biofuels such as hydrotreated vegetable oil (HVO) & gas-to-liquid (GTL)
- Measured minimal reduction in tailpipe emissions
- Inform fuel strategy for Government + Infrastructure projects + OEMs + Contractors
 - Department for Transport [online publication](#)
 - HS2 contractor groups & Environment Agency
 - Department for Energy Security & Net Zero
 - Department for Environment, Food & Rural Affairs
 - Department for Business Energy & Industrial Strategy



Stepping stones to reduce on-site emissions



Diesel used on sites

Low carbon fuels

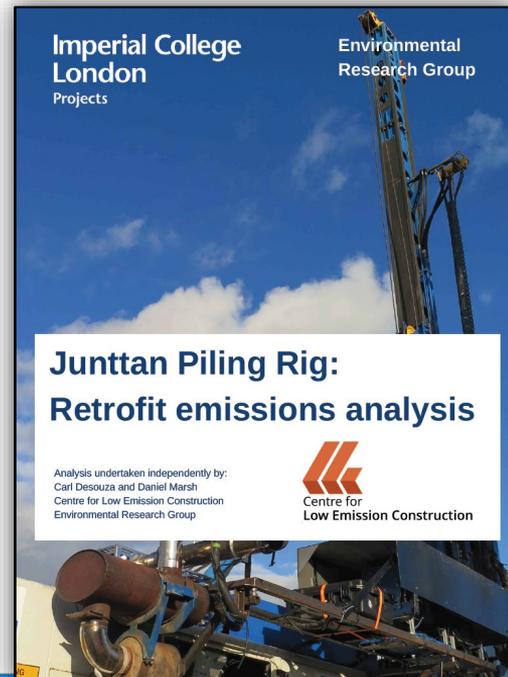
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Diesel-free sites

Improving efficiencies: retrofit technology



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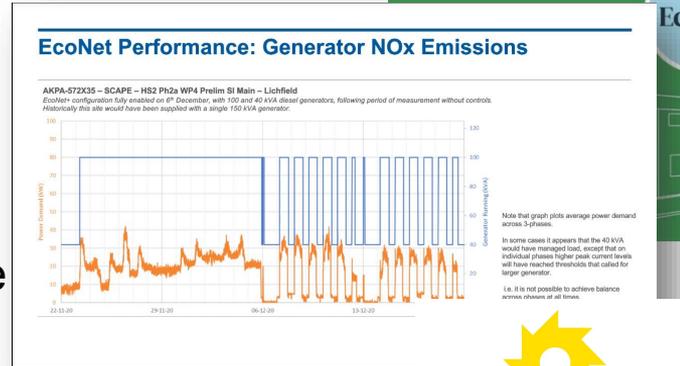
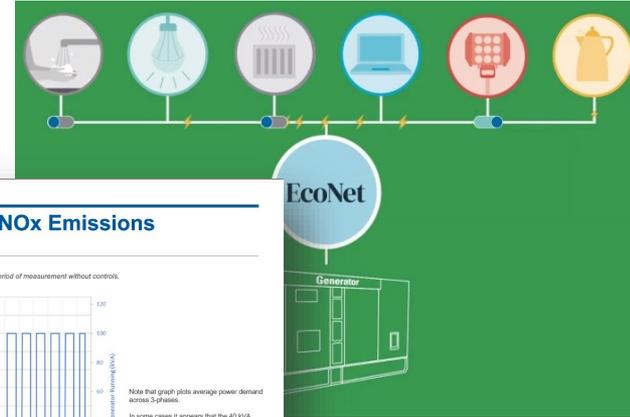
Improving efficiencies: energy storage recovery system

- Technology used to capture energy from an engine that is normally wasted and stored in a high-speed flywheel
- Rapid ramping of power (dynamic range)
 - Paired with tower crane load cycle
- Down-sizing generator reduces hire and fuel costs
- Reduces emissions



Improving efficiencies: energy management system

- ‘EcoLink’ actively manages energy demand avoiding unnecessary peaks
- Intelligently switches off non-essential assets when energy demand spikes
- Smaller generators are used more efficiently
- Other power saving measures are implemented

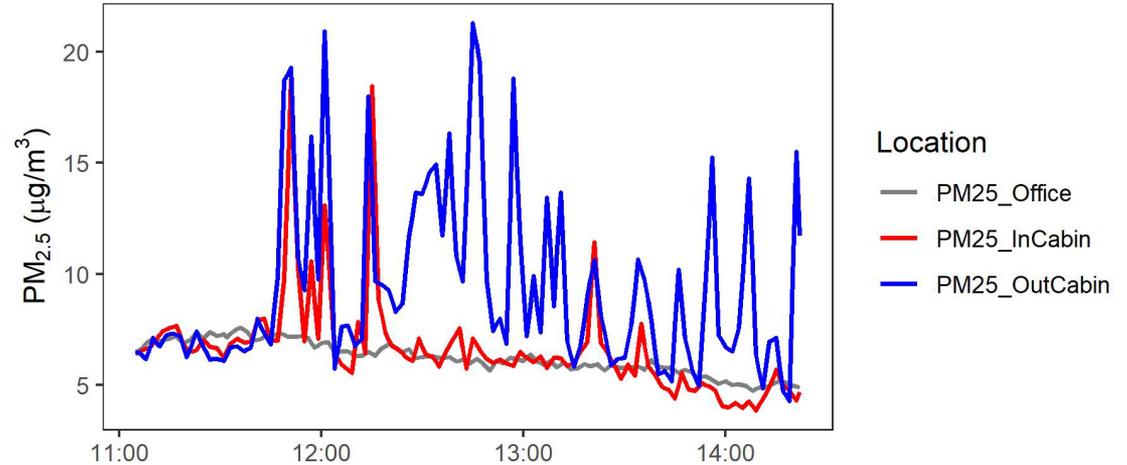


Improving efficiencies: behavioural change

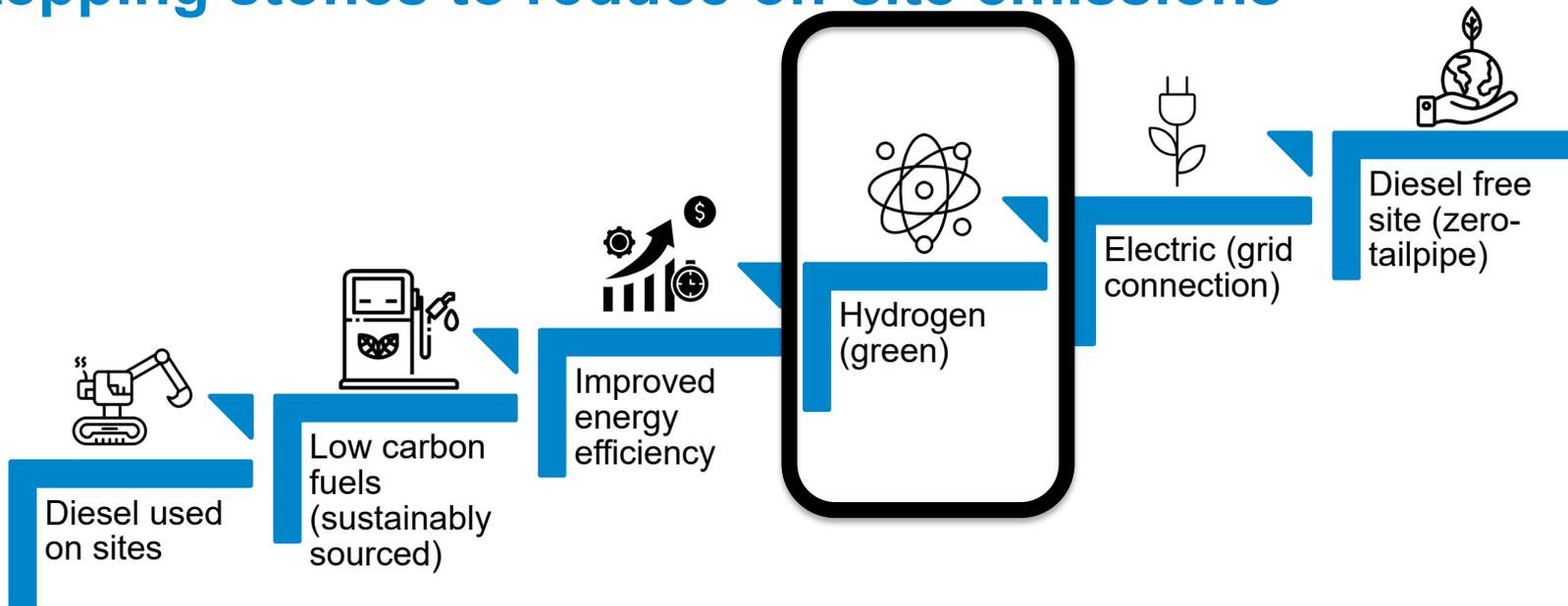
23-Aug-2022

- Anti idling
- Personal exposure

Date	Working Status	Working Hours	Actual Working Hours	ATT Working	Fuel	Water Temp.
11-30-2015		7.0 H	6.0 H	4.4 H		
11-29-2015		0.0 H	0.0 H	-		
11-28-2015		3.1 H	2.1 H	1.4 H		
11-27-2015		7.5 H	4.9 H	3.3 H		
11-26-2015		4.0 H	3.4 H	1.5 H		
11-25-2015		5.4 H	4.4 H	1.8 H		
11-24-2015		4.6 H	2.3 H	0.8 H		
11-23-2015		4.6 H	1.9 H	0.8 H		
11-22-2015		0.0 H	0.0 H	-		
11-21-2015		3.2 H	2.6 H	1.3 H		



Stepping stones to reduce on-site emissions



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Electric

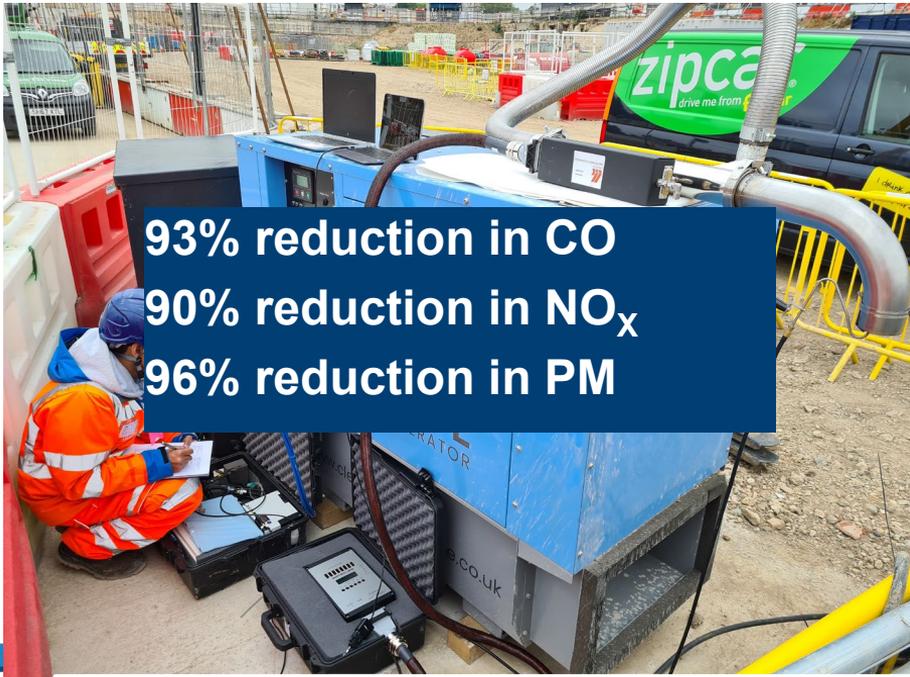
Diesel-free sites

Hydrogen combustion: Clean air gas engine

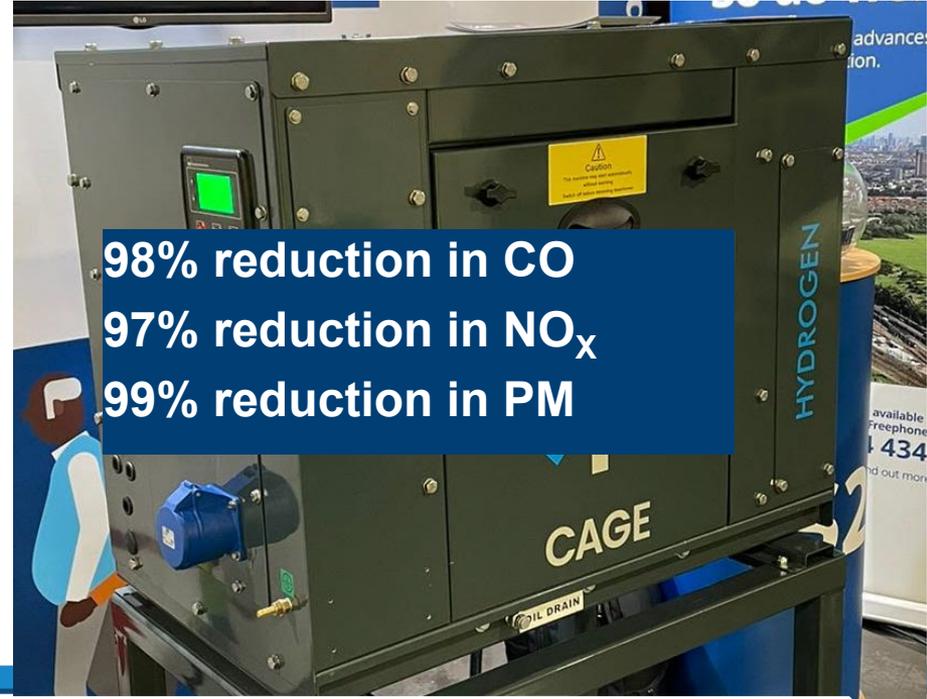
- CAGE engines run on LPG and H₂
- In-field tests have demonstrated significant reductions in NO_x and PM/PN emissions
- InnovateUK and BEIS RDR innovation project



Cleaner alternatives: LPG & Hydrogen



93% reduction in CO
90% reduction in NO_x
96% reduction in PM



98% reduction in CO
97% reduction in NO_x
99% reduction in PM

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Hydrogen dual-fuel vehicles

- Retrofitting existing on-road fleet to run on diesel and H₂ combustion
- Demonstrating safe H₂ use in the construction sector
- Technology transferable to NRMM
- UK-wide H₂ refuelling infrastructure

ULEMCo

ultra low emission mileage company limited



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Hydrogen fuel cell power generator

- Demonstrating use of H₂ on construction sites
- Developing safe protocols
- Fuel cell generator run on H₂
- 2x250kVA generator replaces traditional 500kVA diesel genset



Hydrogen fuel-cell generator (results)

- 4-month on-site trial demonstrated an annual reduction potential of 486 tonnes of CO₂ and 2.3 tonnes of NO_x
- Using the US-EPA's GHG equivalencies calculator, carbon saved equates:

			
1,811,845 miles driven in a diesel car	39,751 UK gallons of diesel saved	61 homes' energy use for 1 year	Switching 18,420 light bulbs to LEDs

Applications of Hydrogen

BBC Sign in Home News Sport Weather iPlayer Sounds

NEWS

Home Cost of Living War in Ukraine Coronavirus Climate UK World Business Politics Tech
Business Your Money Market Data Companies Economy Technology of Business CEO Secrets Global Trade

The race to make diesel engines run on hydrogen

11 hours ago

Climate change



Converting mining industry vehicles to hydrogen could mean big savings in CO2 emissions

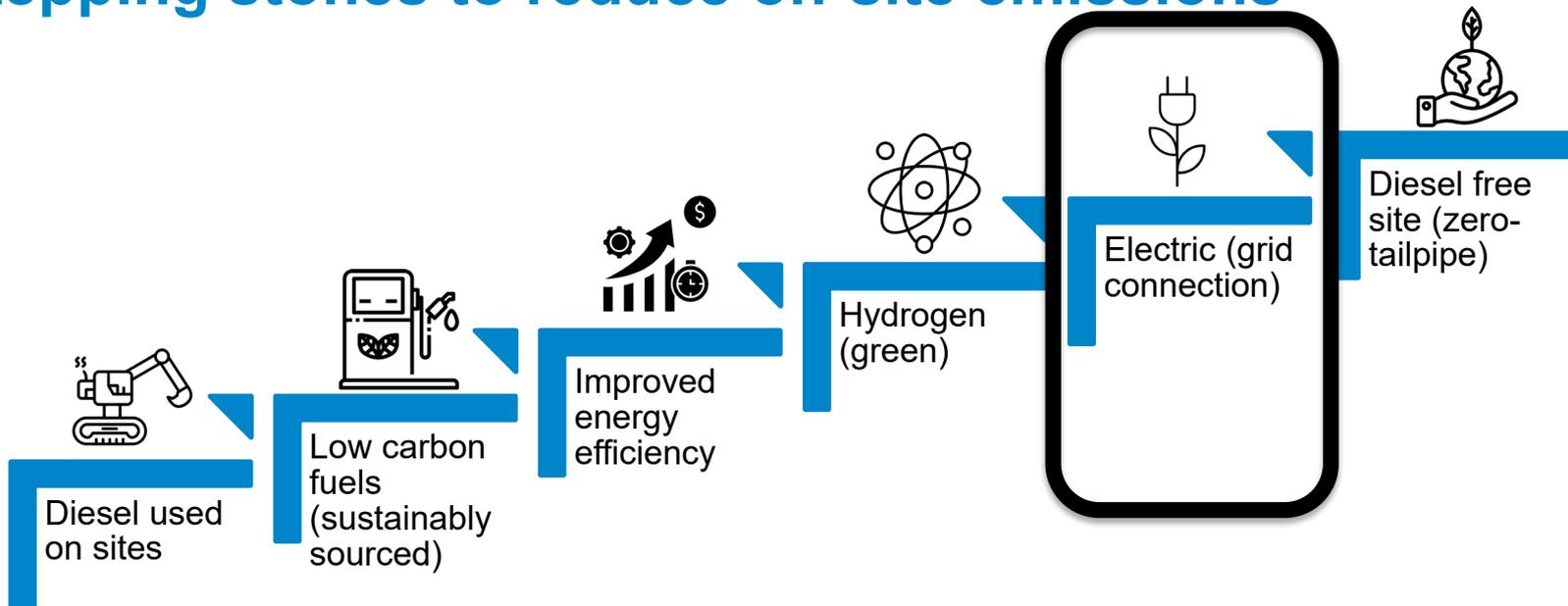


The future of hydrogen

- 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



Stepping stones to reduce on-site emissions



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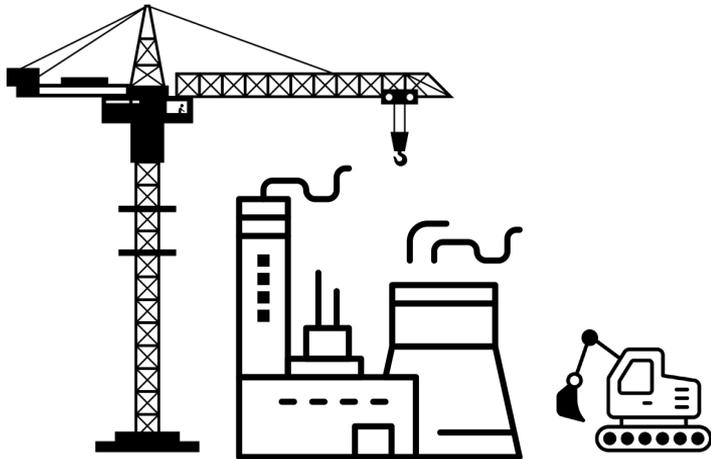
Electric machines

- Battery technology already exists for small to medium NRMM
- Larger machines likely to be hydrogen or hybrid
- Requires better site energy efficiency measures
- Early planning for site electrification
- Clean off-grid power generation essential as numbers of electric machines increase

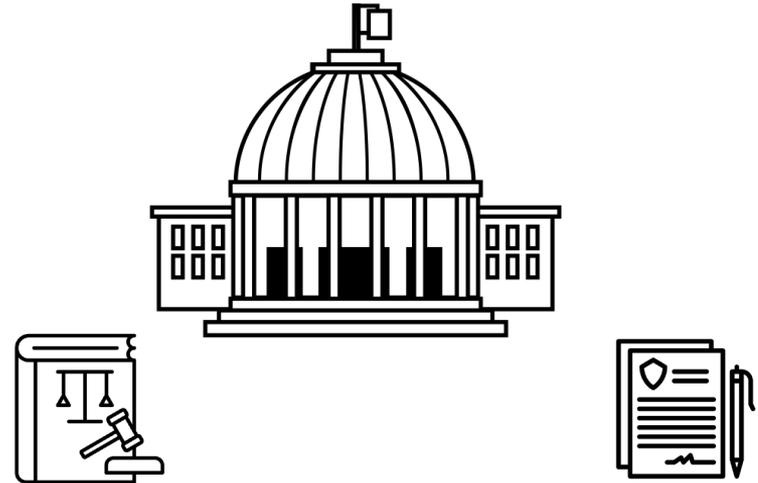


Accelerating uptake to decarbonise construction

Industrial approach: Incentivise through grants?



Governmental approach: Mandate through policy?



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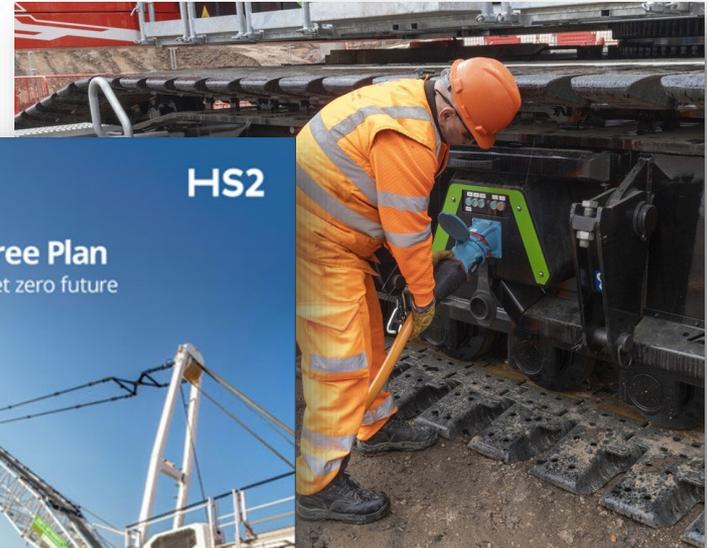
Hydrogen

Electric

Diesel-free sites

Diesel free construction sites

- Through evidence produced in these measurement trials HS2 achieved their first diesel free site in May 2022
- They now have ten similar sites
- Committed all sites diesel free by 2029
- Combination of low emission solutions
- Green demand drives supply chain and innovation
- Knowledge shared through 'Learning Legacy' process

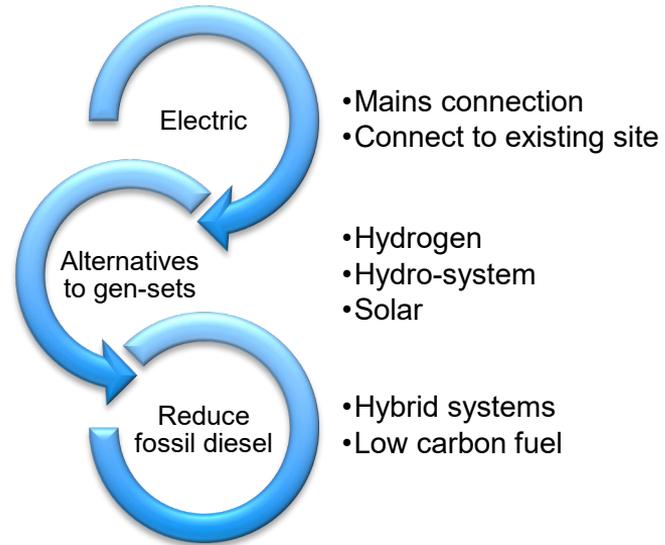


HS2

Mandate through policy

- Greater London Authority low emission zone for construction machinery
- Department for Net Zero funded Red Diesel Replacement competition to accelerate innovation
- Removal of diesel tax incentives and global fuel cost increases drives innovation

Environment Agency: Lowest carbon energy provision option for their sites, June 2022



Imperial College
London



Questions?



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Centre for Low Emission Construction