

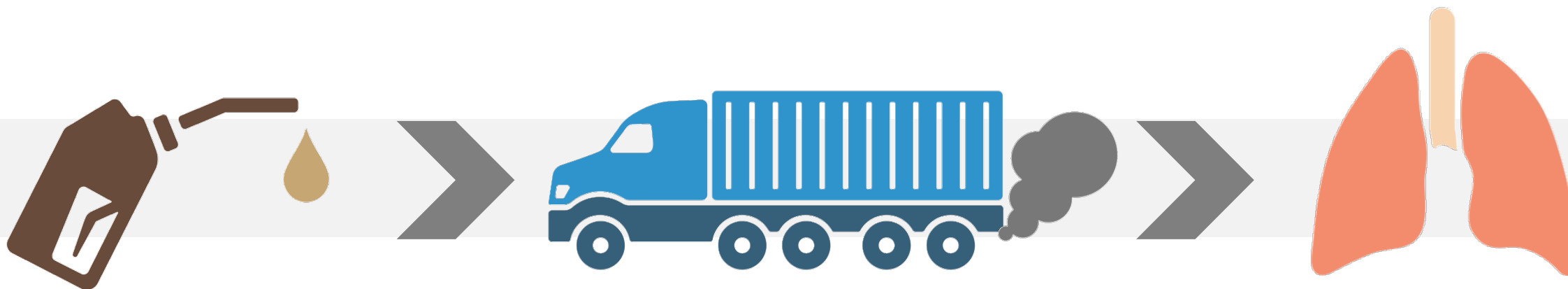


UK Health
Security
Agency



Understanding how low blend ratios of SME biodiesel changes the toxicity of exhaust particulates and impacts human health.

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Outline

Alternative Fuels in the Present and Future

Public Health Impact

Particle Sizes and Polyaromatic Hydrocarbons

PAHs and Metabolism in the body

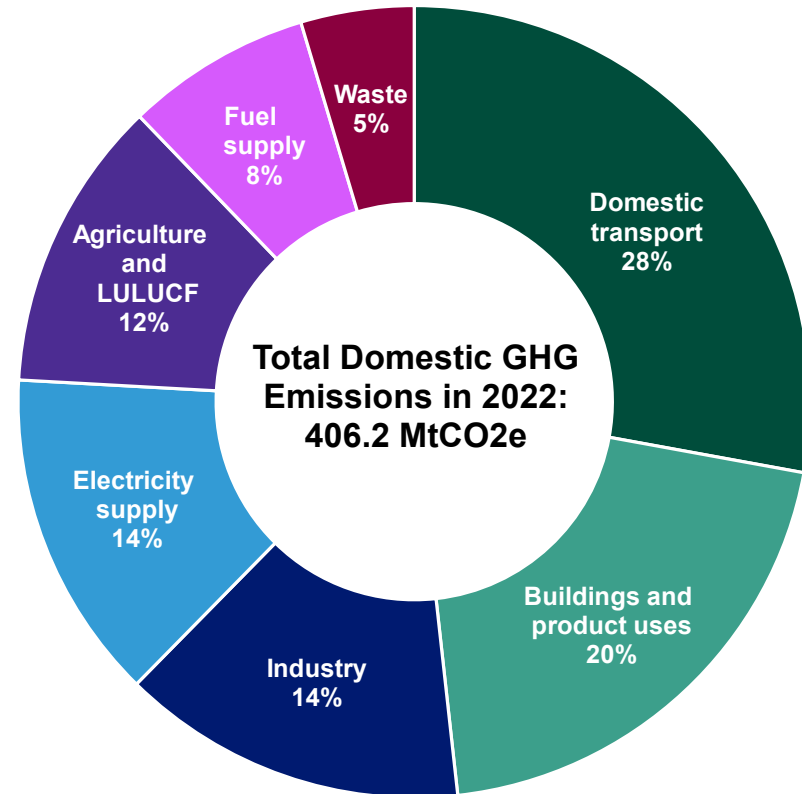
Methods

Magnitudes of Toxicity

Conclusions

Public Health Impact

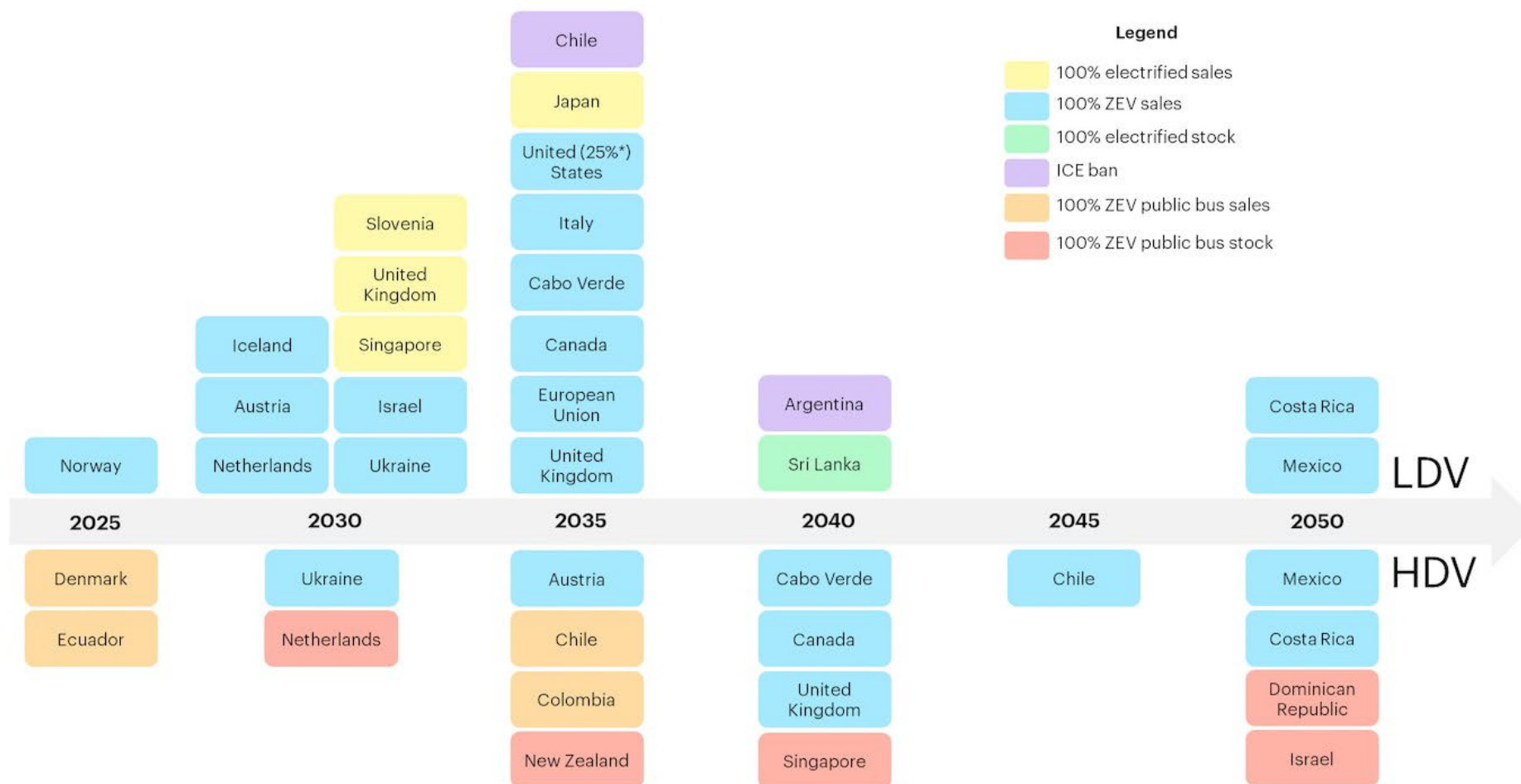
- “Up to **36,000** deaths per year in the UK can be linked directly to air pollution.”¹
- “Health and social care costs of air pollution in England could reach **£5.3 billion** by 2035”¹
- In 2022, transport was responsible for 22% of PM2.5 emissions²



1. GOV.UK [Internet]. [cited 2024 Dec 11]. Air pollution: applying All Our Health. Available from: <https://www.gov.uk/government/publications/air-pollution-applying-all-our-health/air-pollution-applying-all-our-health>

2. GOV.UK [Internet]. [cited 2024 Dec 11]. Transport and environment statistics: 2024. Available from: <https://www.gov.uk/government/statistics/transport-and-environment-statistics-2024>

Alternative Fuels in the Present and Future



Currently:³

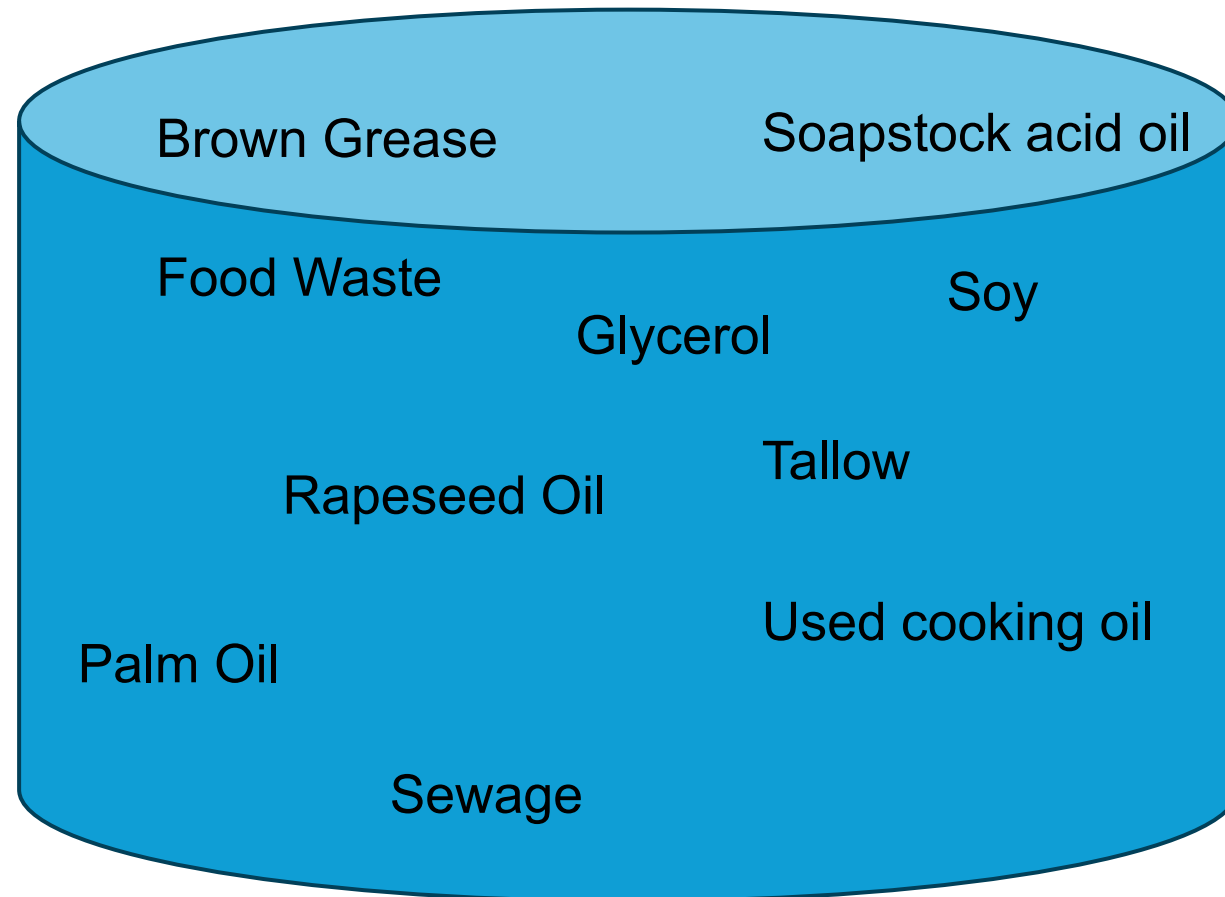
- No projected ban of ICE
- 11 years away from 100% “Zero” emission vehicle sales
- 6 years away from 100% electrified sales (this counts hybrids)
- No current plan for bus stocks

Urgent need to decarbonise transport

3. IEA [Internet]. [cited 2024 Dec 11]. Policy developments – Global EV Outlook 2023 – Analysis. Available from: <https://www.iea.org/reports/global-ev-outlook-2023/policy-developments>

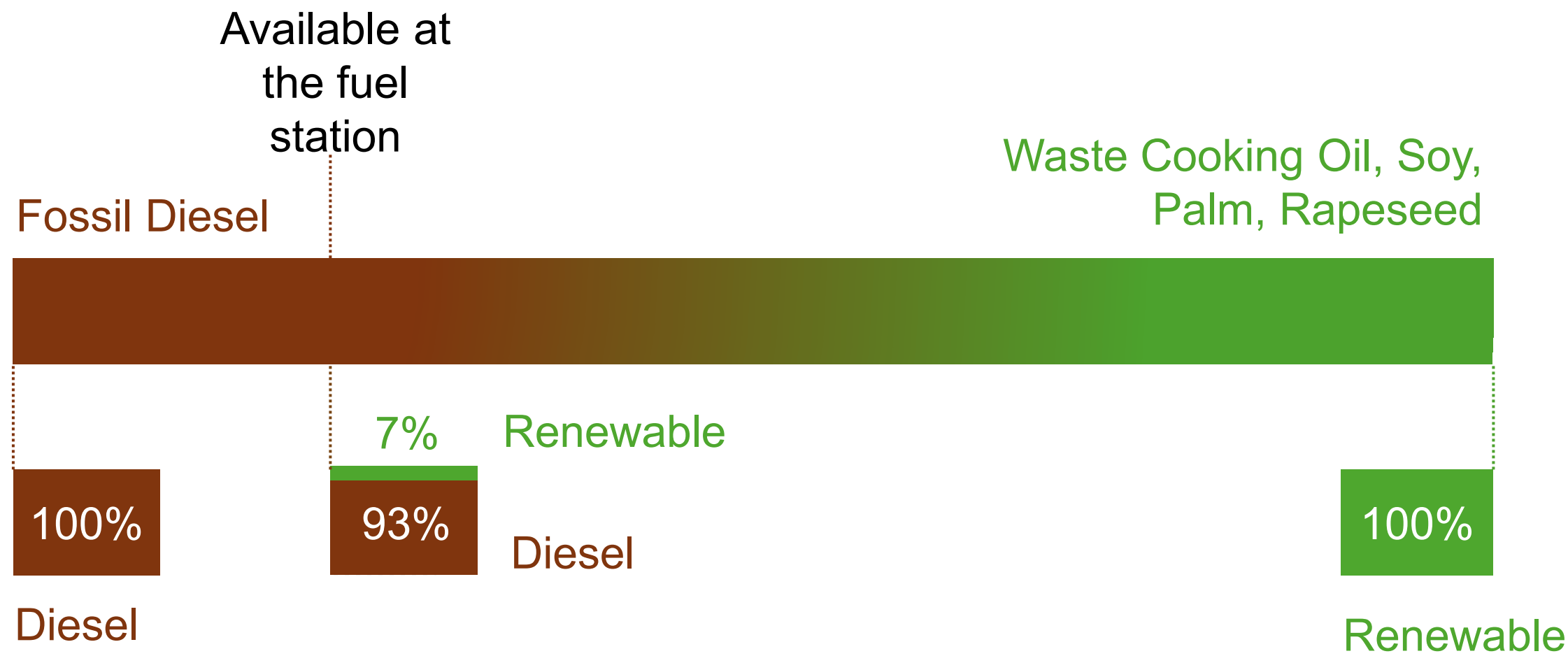
Alternative Fuels in the Present and Future

What is currently being used in 2024?⁴

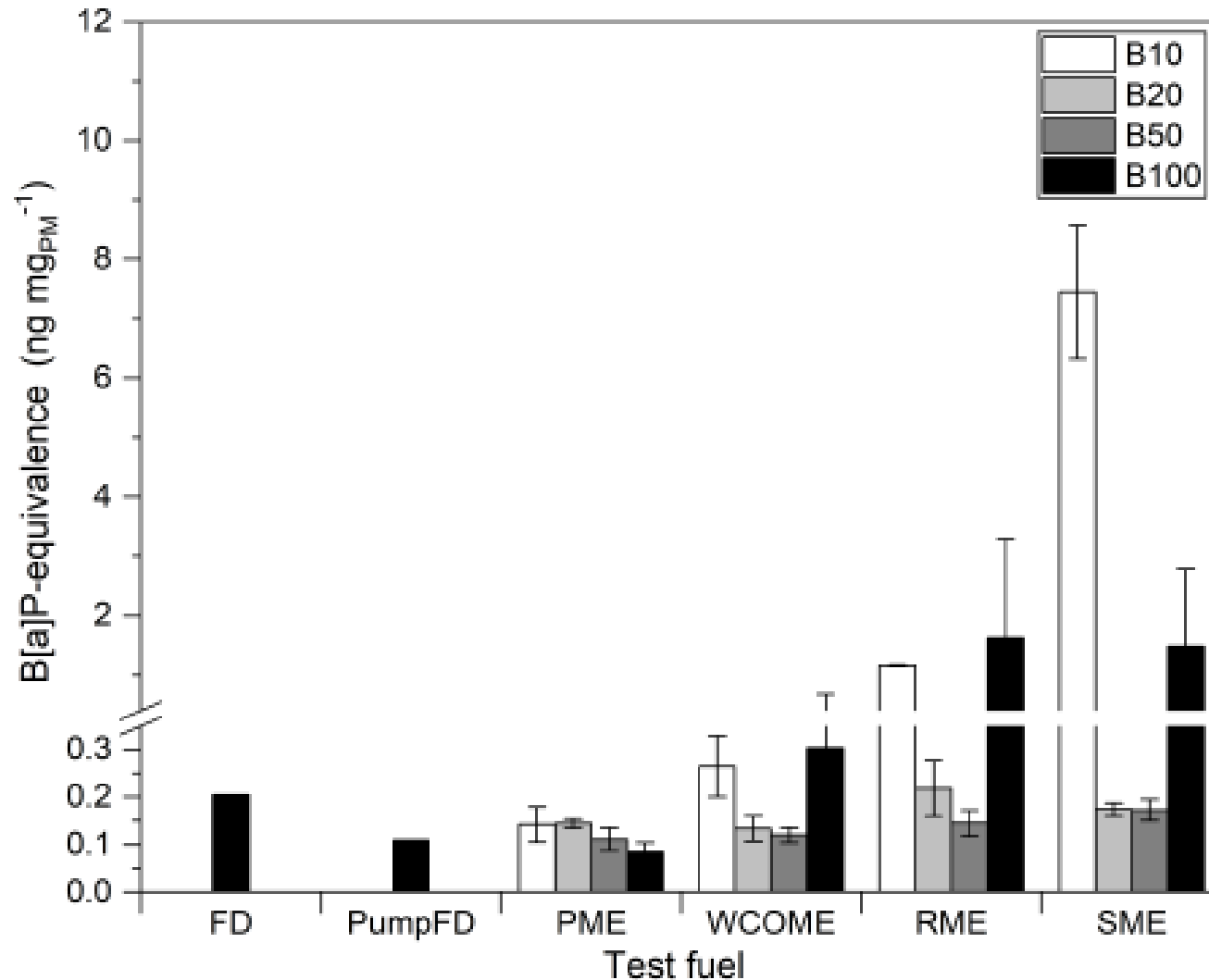


4. GOV.UK [Internet]. [cited 2024 Dec 11]. Renewable fuel statistics 2024: First provisional release. Available from: <https://www.gov.uk/government/statistics/renewable-fuel-statistics-2024-first-provisional-release>

Alternative Fuels in the Present and Future

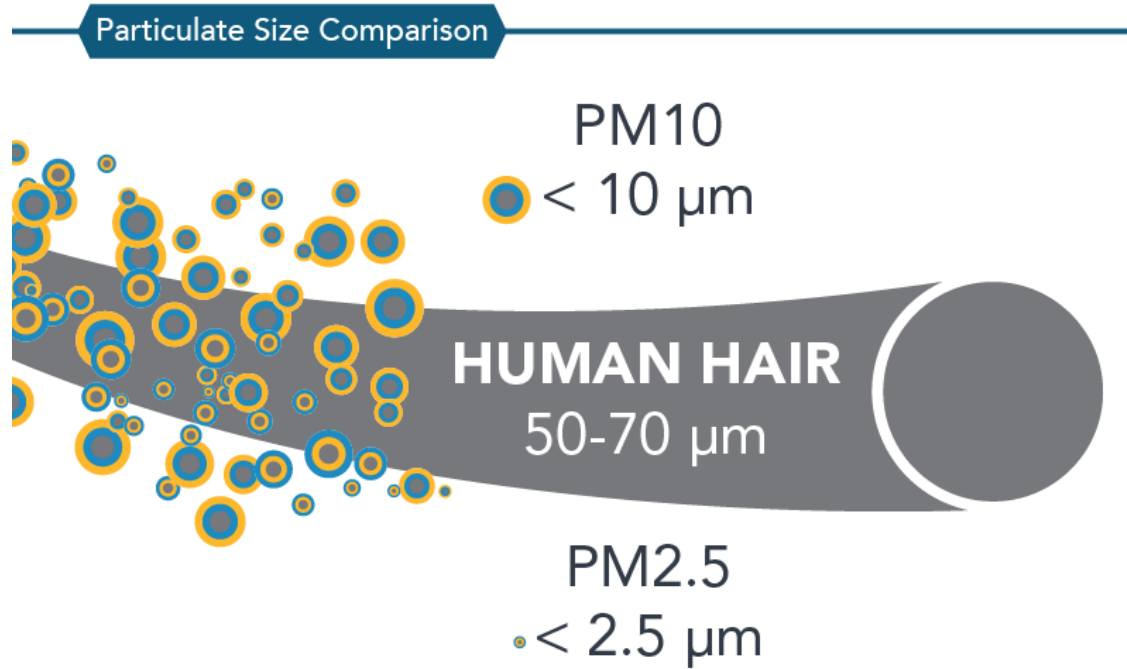


Why SME?



- Rising use and availability for UK and other countries
- Cheap crops
- Has the greatest toxic effect of all fatty acid methyl ester (FAME) fuels....

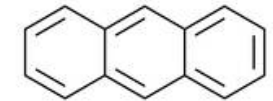
Particle Sizes and Polycyclic Aromatic Hydrocarbons



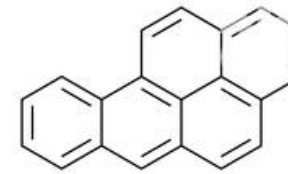
Acenaphthene



Acenaphthylene



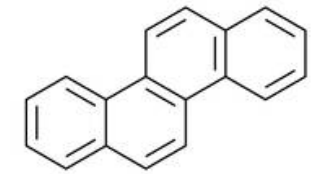
Anthracene



Benzo[a]pyrene



Benzo[ghi]perylene

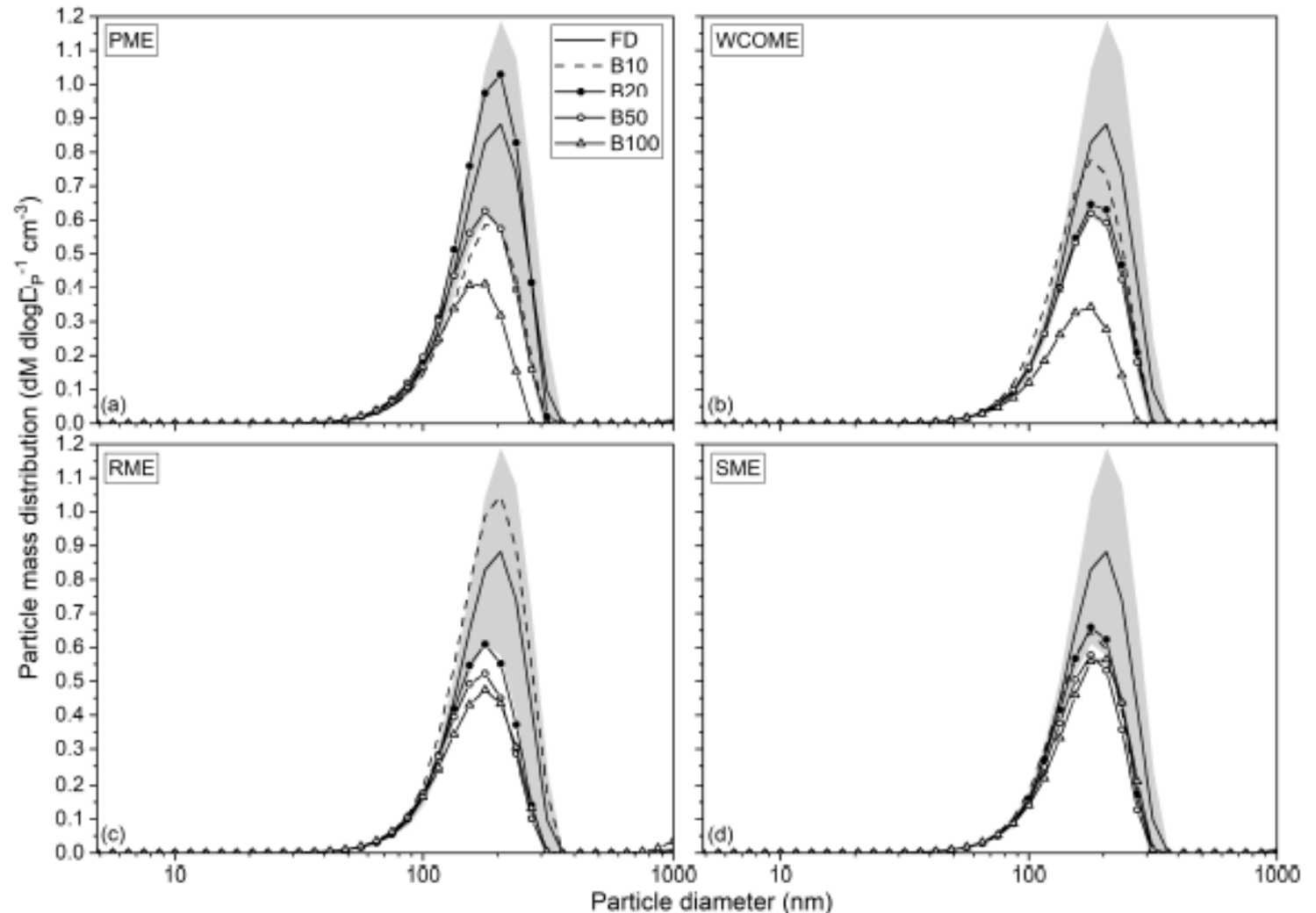


Chrysene

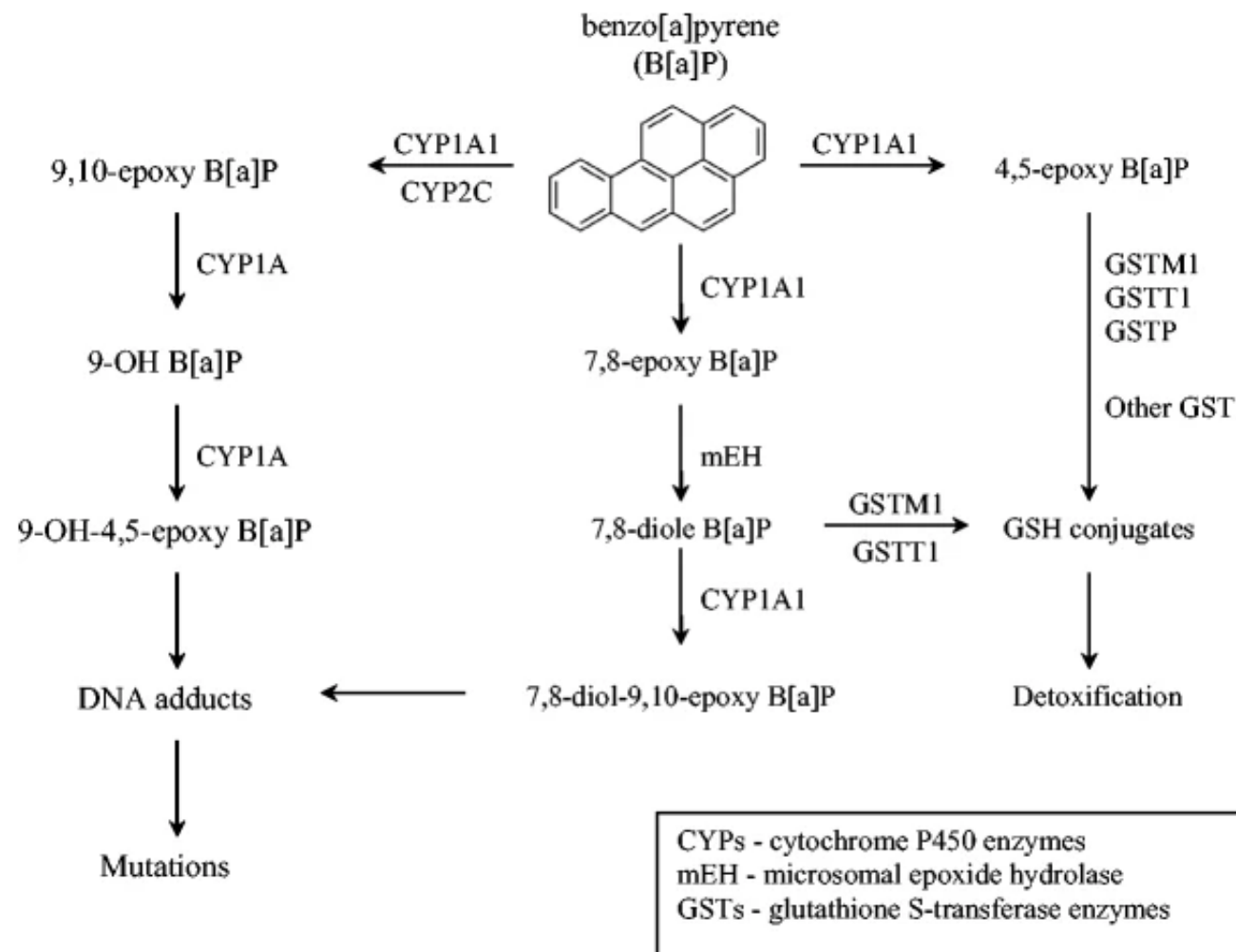
Well over 24 different species present
in exhaust emissions...

Particle Sizes and Polyaromatic Hydrocarbons

When observed through
a DMS...



PAHs and metabolism in the body



Health Impacts

Short term:⁸

- Irritation, exacerbation of asthmas and respiratory illness

Long Term:⁸

- COPD, lung cancer, coronary heart disease, strokes

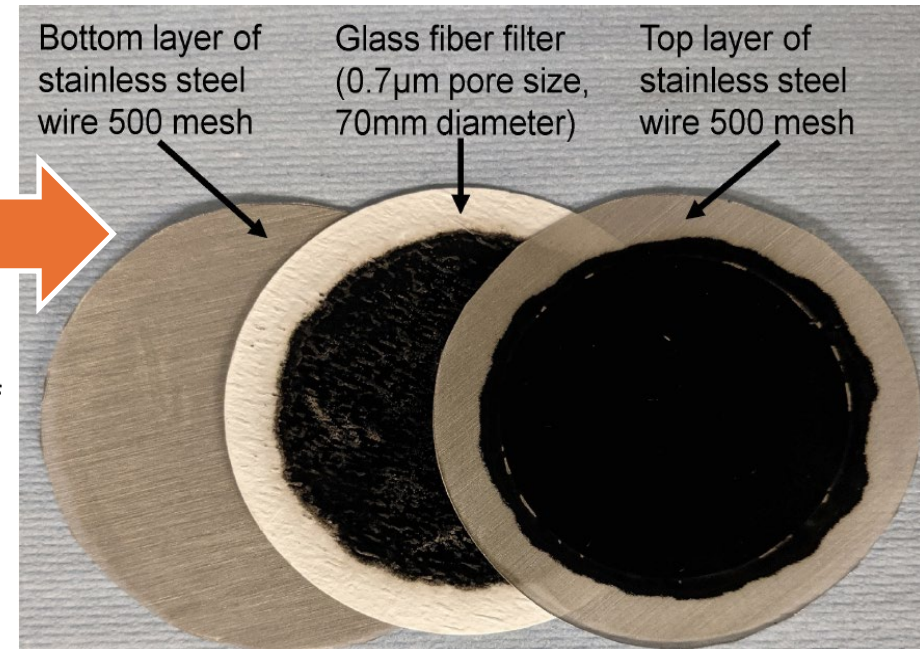
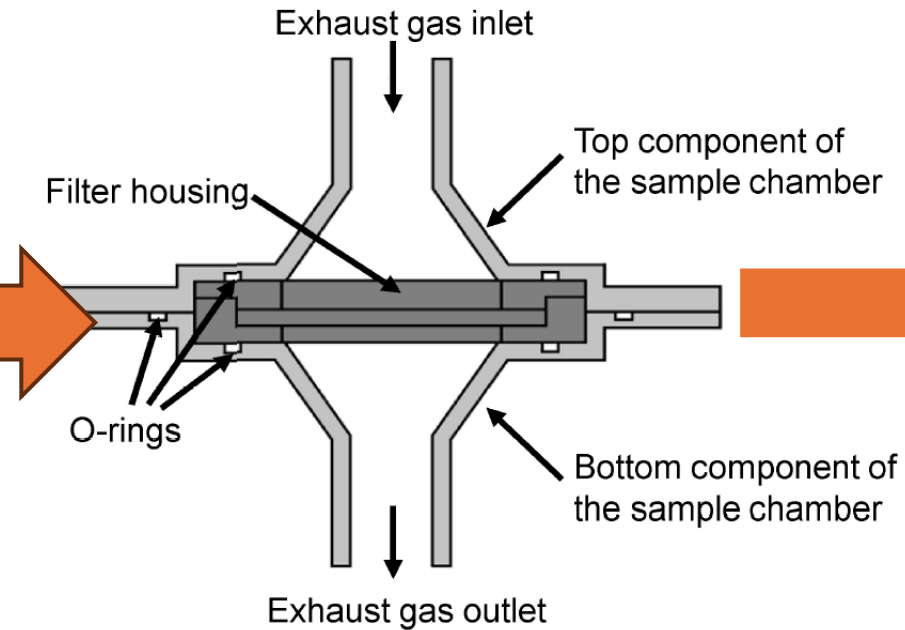
Main Research Questions:

- Do SME blends contain a greater amount of PAHs than other alternative fuels?
- Does the emissions contain more toxic PAHs?
- Does this correlate to a higher toxic effect?

Methods

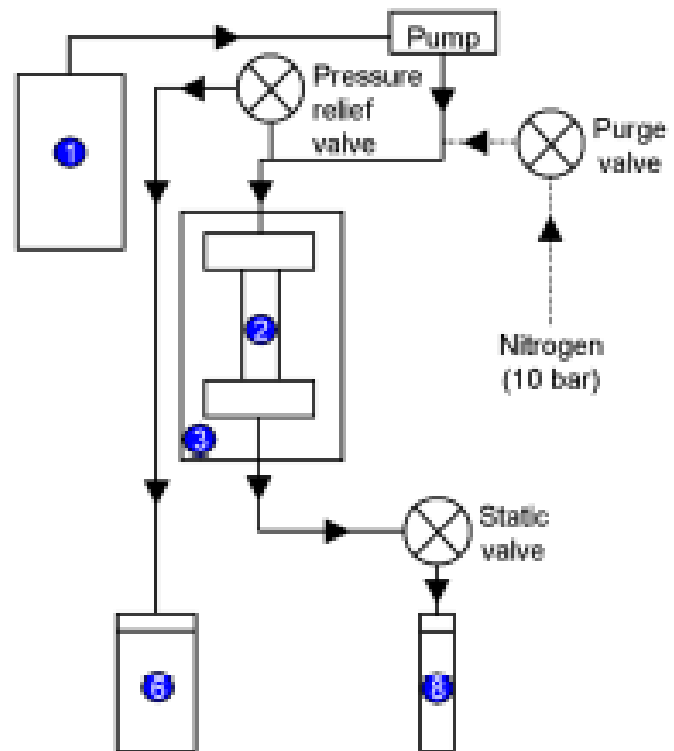


Engine Load: 7 bar IMEP
Injection pressure: 550 bar
Engine Speed: 1200 rpm



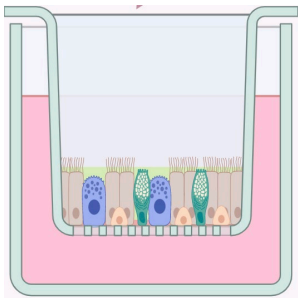
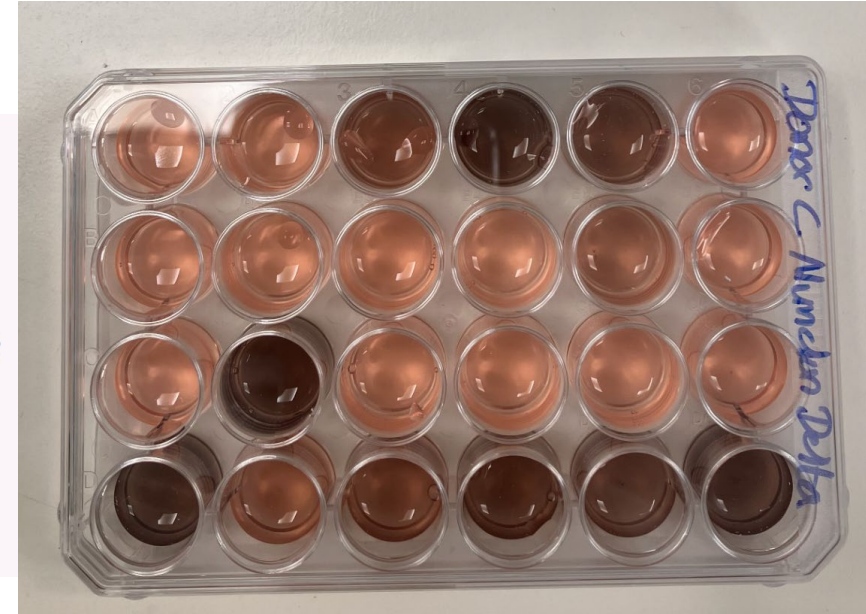
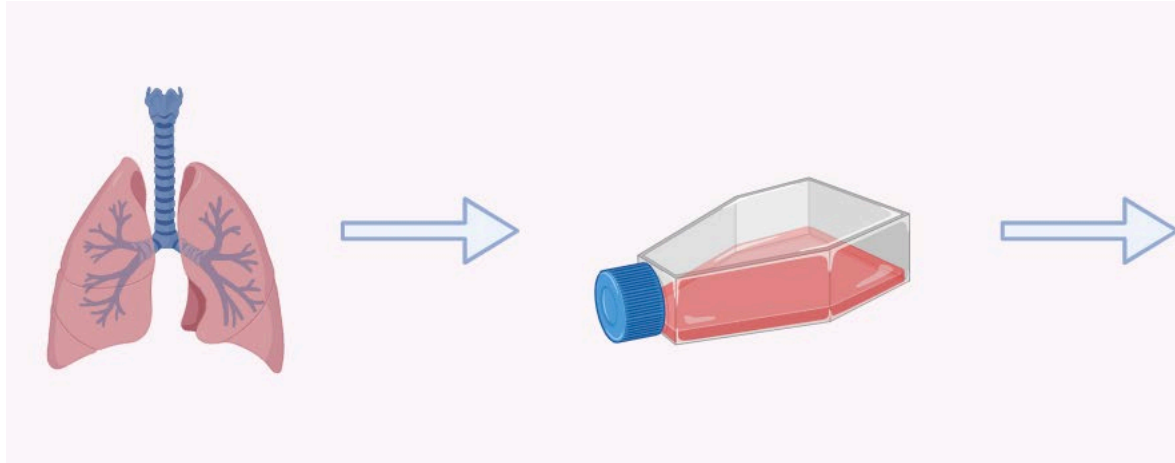
20 minutes duration with vacuum pressure

Methods

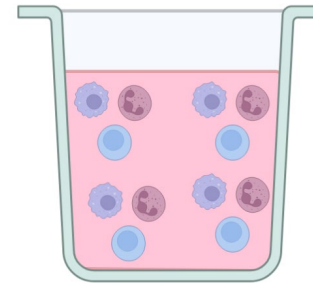


- 1 Solvent reservoir
- 2 Sample cell
- 3 Oven
- 4 Control panel
- 5 Door open/close lever
- 6 Waste bottle
- 7 Needle up/down switch
- 8 Collection vial
- 9 Drip tray

Methods

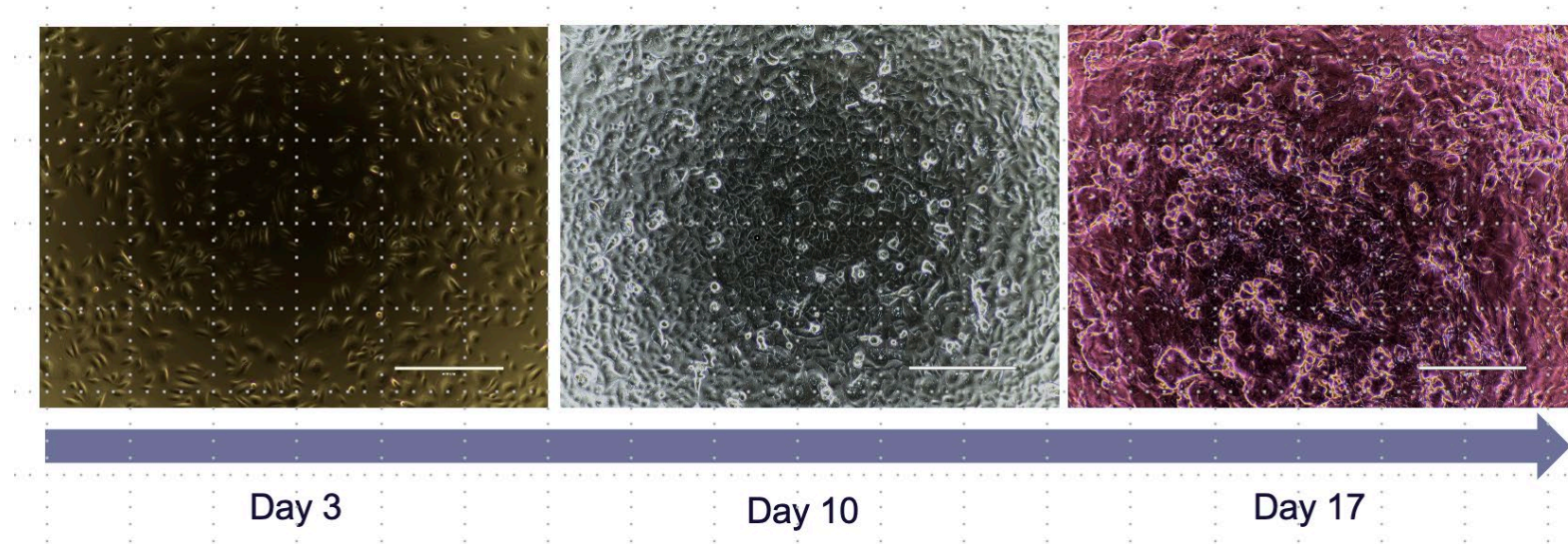


Air-Liquid Interface
(ALI) hSAEC



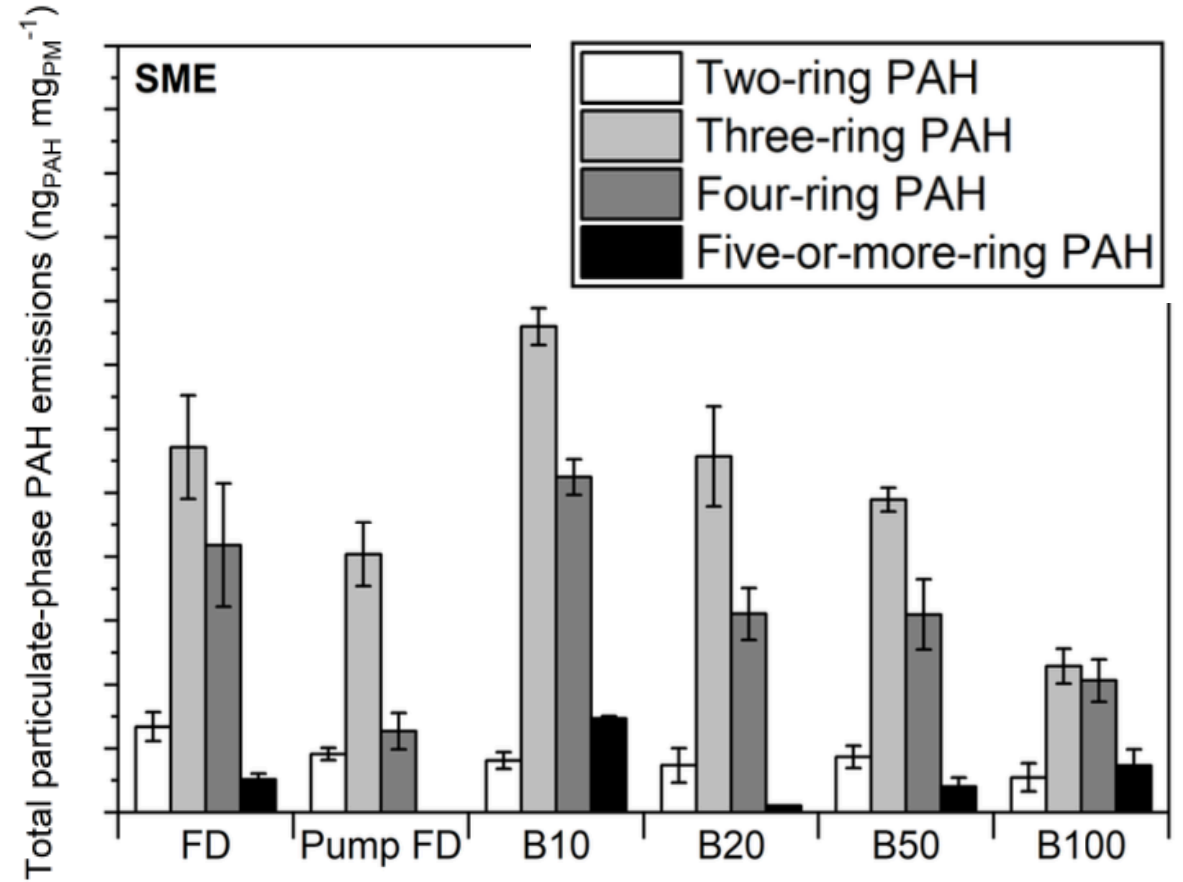
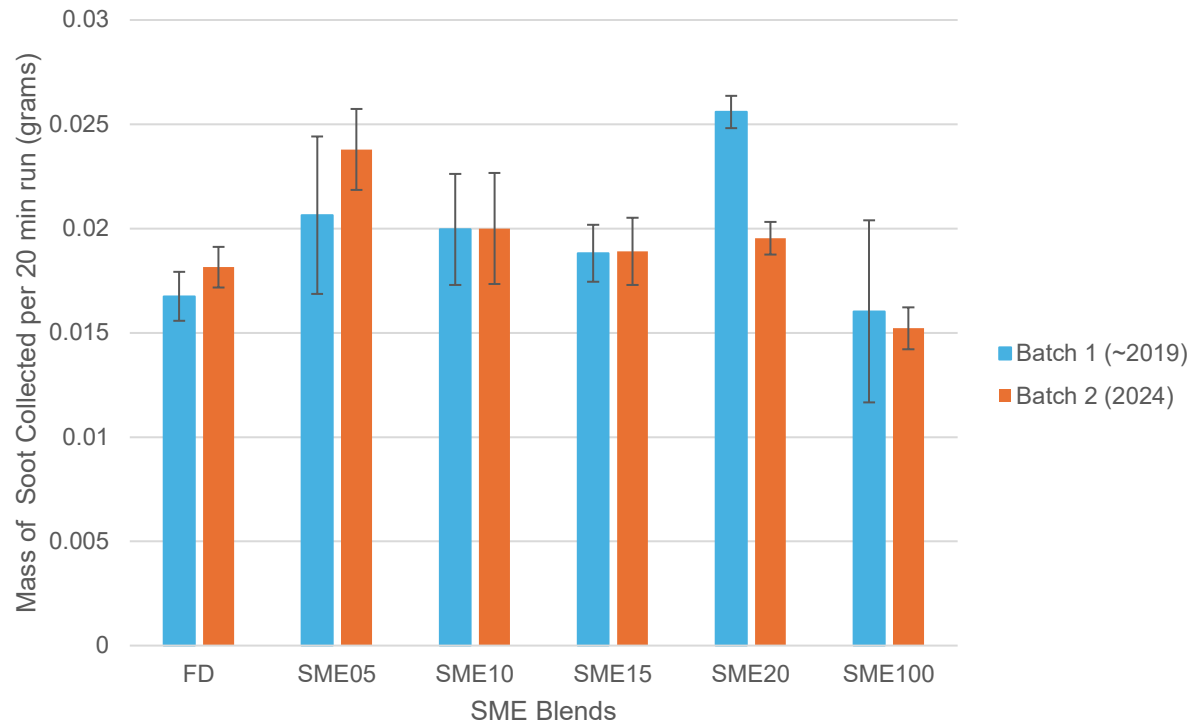
Suspension Immune
Cells

Methods



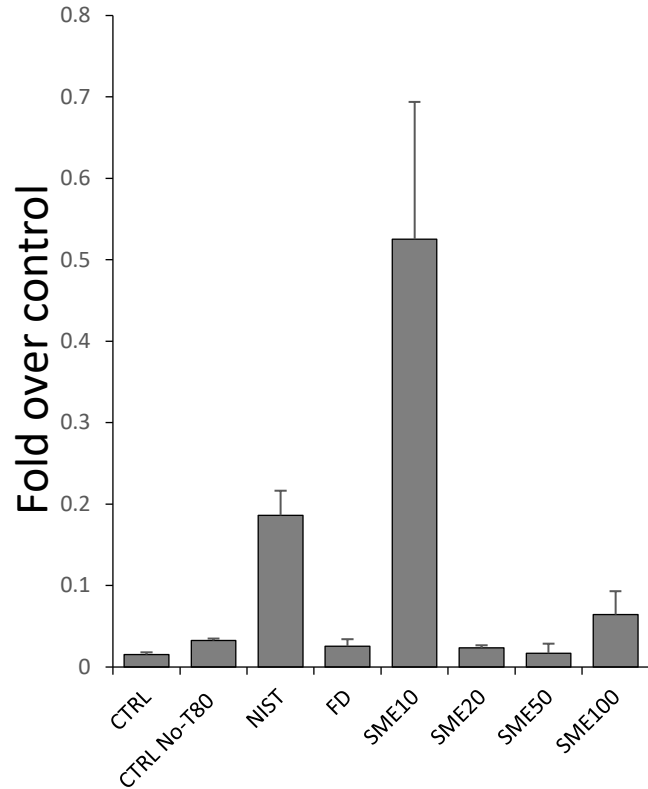
Results

Experimental Procedure for soot collection with different batches in a light duty vehicle

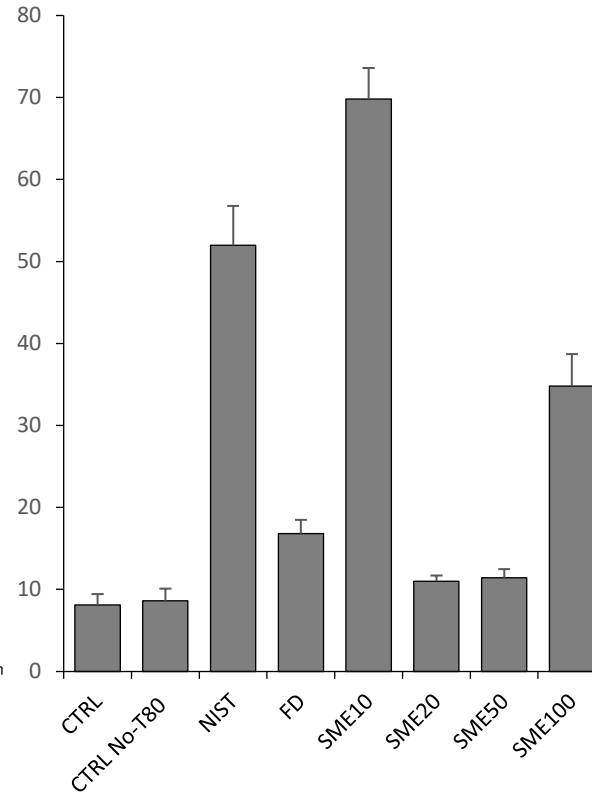


Results

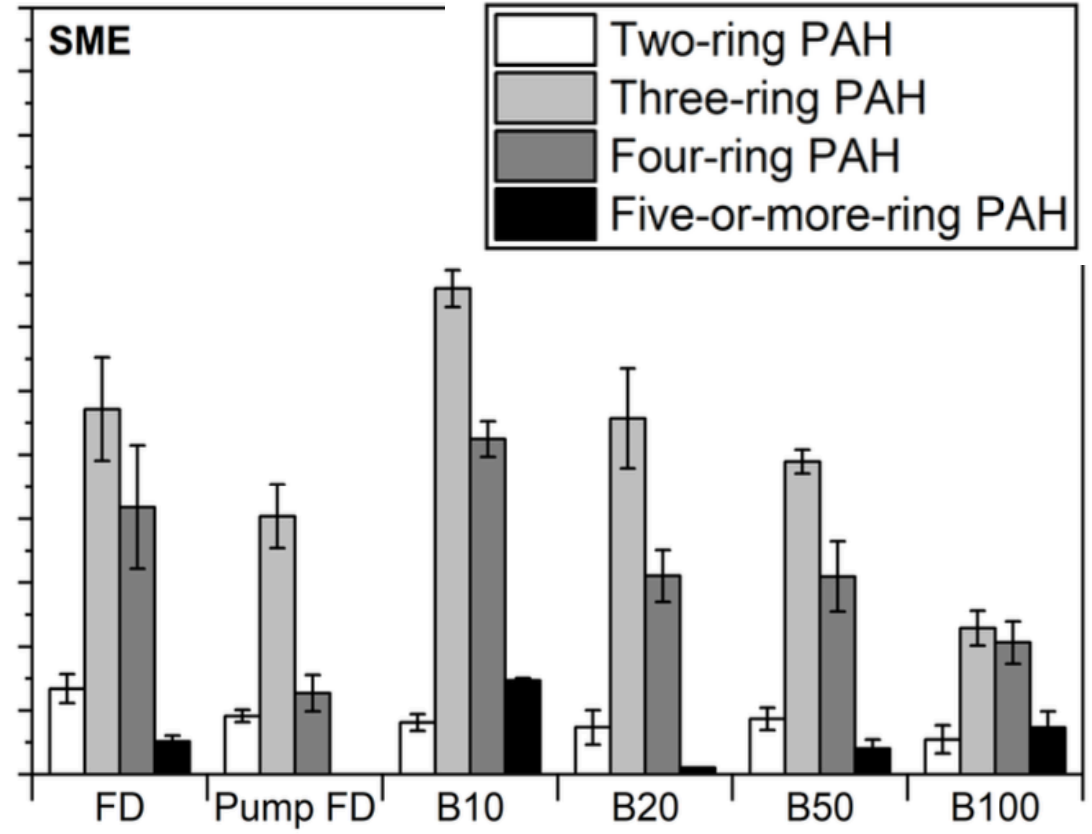
CYP1A1



CYP1B1



Total particulate-phase PAH emissions ($\text{ng}_{\text{PAH}} \text{mg}_{\text{PM}}^{-1}$)



Conclusions

- Biodiesel alternatives are required for decades to come, especially for heavy duty vehicles
- PAHs are a serious cause for concern and their presence in soot emissions from transport needs to be understood fully
- Lower blending ratios appear to have a positive effect on soot production and ultimately a higher amount of toxic PAHs