To:	Transport & Health Policy Makers, & Practitioners
From:	Prof Adrian Davis, TRI, Edinburgh Napier University
Date:	January 17th 2024
Subject:	Essential Evidence 4 Scotland No 79 Non-exhaust airborne particles: EVs & Internal Combustion Engines

Top line: Non-exhaust particle emissions from the equivalent EVs are likely to be more than all particle emissions from Internal Combustion Engine passenger cars, including exhaust particle emissions.

The number of electric vehicles (EVs), especially electric passenger cars, has increased significantly recent years because the policies of many governments steadily incentive electrification of the vehicle fleet. The electrification of vehicles has been considered a solution to air pollution, which provides zero emissions and promising cleaner urban air. These advocates often, however, neglect the particulate matter (PM)[1] emissions from the non-exhaust emissions, including brake wear, tyre wear, road wear, and resuspension of road dust. In fact, non-exhaust emissions have been considered as a critical contributor to ambient PM as tailpipe emission standards for internal combustion engine vehicles (ICEVs) have become more and more stringent. In 2009 research also revealed that non-exhaust emissions would contribute up to 90% to total PM emissions from motor traffic.[2]

To evaluate the additional non-exhaust emissions due to the electrification of cars causing an increase in vehicle weight, a comparative estimation was needed between the weights of various types of ICE cars and corresponding EVs.[3] Emission factors (EFs) from Euro 6 cars reported in UK's Road Transport Emissions Inventory were used. The non-exhaust PM_{10} and $PM_{2.5}$ EFs for ICEVs and EVs on urban, rural and motorway environments were calculated according to the relationships between the EFs and vehicle weight to identify whether the electrification of these cars could effectively reduce levels of PM as much as expected.

The researchers' results indicate that non-exhaust particle emissions from the equivalent EVs are likely to be more than all particle emissions from ICE passenger cars, including exhaust particle emissions, which are dependent mainly upon the extent of regenerative braking, road type, and passenger car type. For instance, PM_{10} EFs from all the equivalent EVs without regenerative braking on all road types are all higher than the particle emissions from ICE passenger cars, including exhaust particles. Especially on motorway environment, all the equivalent EVs except for small petrol EVs even with fully regenerative braking still have larger EFs than the corresponding conventional petrol and diesel cars. As for $PM_{2.5}$, most of the equivalent EVs on most road types have to require different regenerative braking to reduce brake emissions to make total $PM_{2.5}$ in line with all particle emissions from relative ICE cars. Only small and medium petrol equivalent EVs on motorway roads and small diesel equivalent EVs on all road types without regenerative braking emit less PM relative to the ICE cars.

The total $PM_{2.5}$ and PM_{10} EFs of the EVs with 0%, 50%, and 100% regenerative braking would reduce by up to 33.32% and 32.33% than those of the ICEVs when the ICEVs and EVs have the almost same weight of 1130 kg within the fleet. The authors conclude that their data are useful for the regulatory authorities and policy makers to design the mitigation strategies and to compute their individual contributions and impacts on public health and local air quality.

[1] See Emissions of air pollutants in the UK – Particulate matter (PM10 and PM2.5) - GOV.UK (www.gov.uk)

[2] Squizzato, S., Masiol, M., Agostini, C., et al., 2016 Factors, origin and sources affecting PM1 concentrations and composition at an urban background site. *Atmospheric. Research*, 180, 262–273.

[3] Liu, Y., et al, 2021 Comparative analysis of non-exhaust airborne particles from electric and internal combustion engine vehicles, *Journal of Hazardous Materials*, 420: 126626.