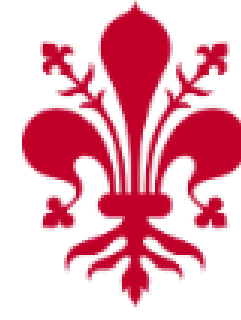




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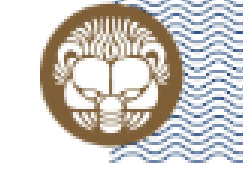
Electric Vehicle noise control by Assessment and optimisation of tyre/road interaction



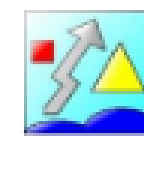
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Tyre role in the context of EV and ICEV

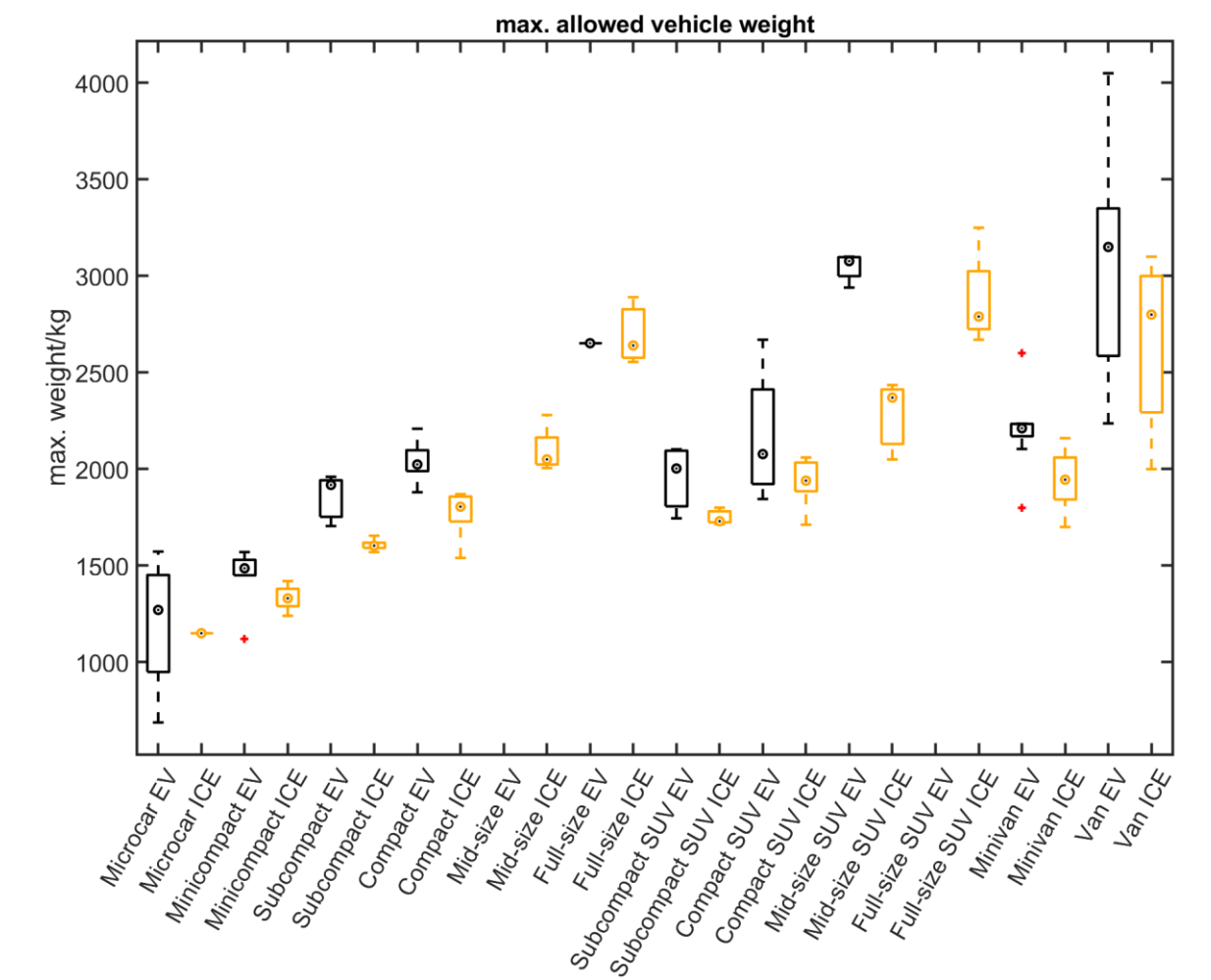
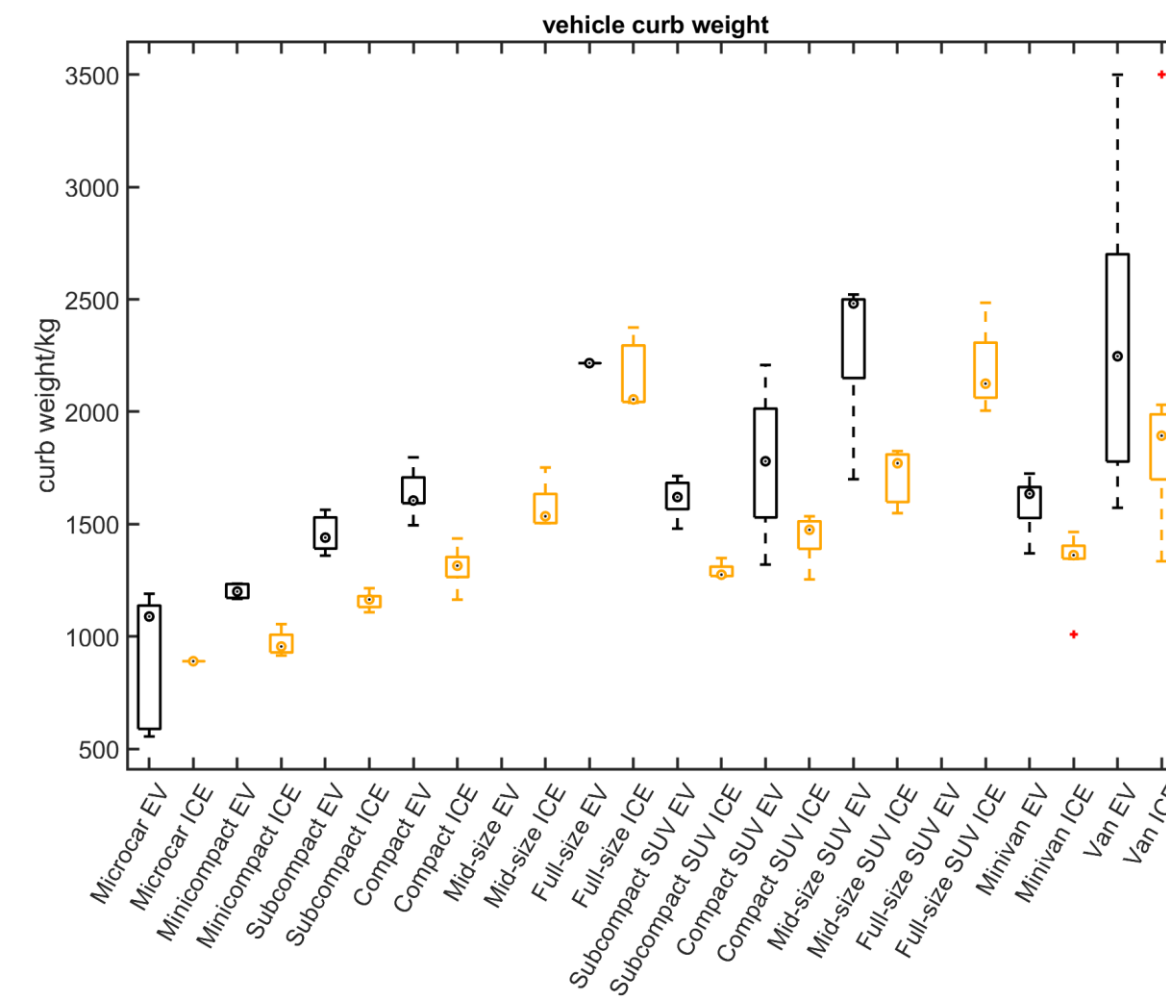
Vehicle weight



Electric vehicles (EV) differ from their traditional internal combustion engine (ICEV) counterparts in many technical or design features. Some of these changes can influence the rolling noise created by the interaction of the tyre with the road. These parameters are for example increased vehicle loads due to the battery weight which is necessary to provide acceptable mileage, special acceleration/deceleration behaviour due to the different torque characteristic of electrical motors and the recuperation, possible new tyre size trends (“tall-and-narrow”) being introduced for mileage, handling or aesthetic reasons, etc. In an analysis of the current and future European EV market it has thus been assessed whether there are systematic differences between EVs and ICEVs which would affect tyre/road noise by any of the previously described mechanisms.

Background: Commonly, an increase in tyre load can be associated with an increase in tyre/road noise. While the extend of this load influence on rolling noise depends on tyre type, speed, road surface and inflation pressure, an increase in SPL of 0.5 dB to 2.5 dB per load doubling is typically reported in literature. If an increase in tyre loads necessitates an increase in tyre inflation pressure or tyre construction, further negative effects on tyre/road noise can be expected.

Observations: The results indicate that on average EVs are between 20 % and 25 % heavier than ICEVs in curb weight and roughly 10 % to 15 % in maximum weight. This will negatively influence tyre/road noise generation. Often this is accompanied by an increase in tyre inflation pressure – either for load carrying or rolling resistance reasons – which will further increase rolling noise.

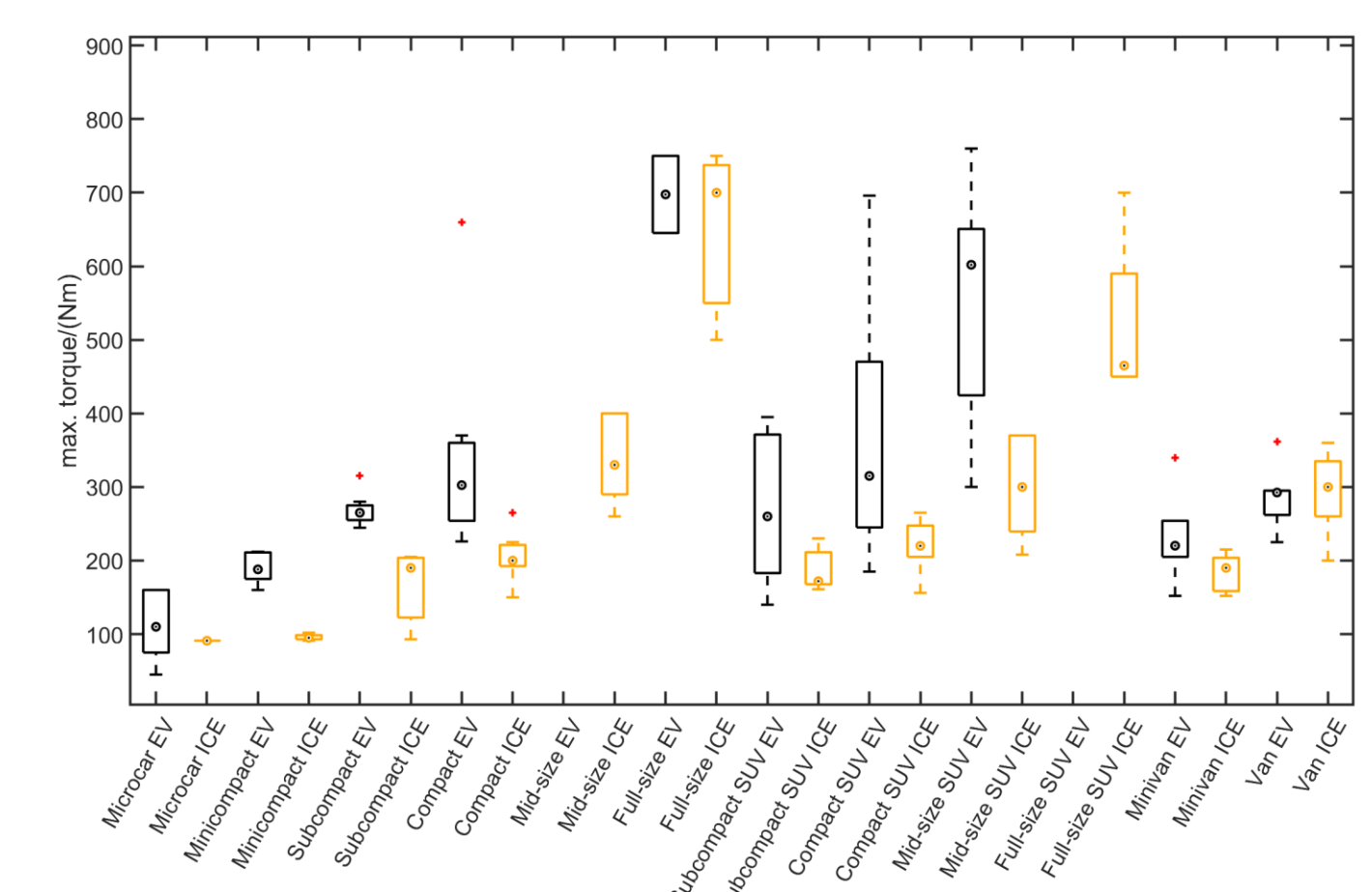
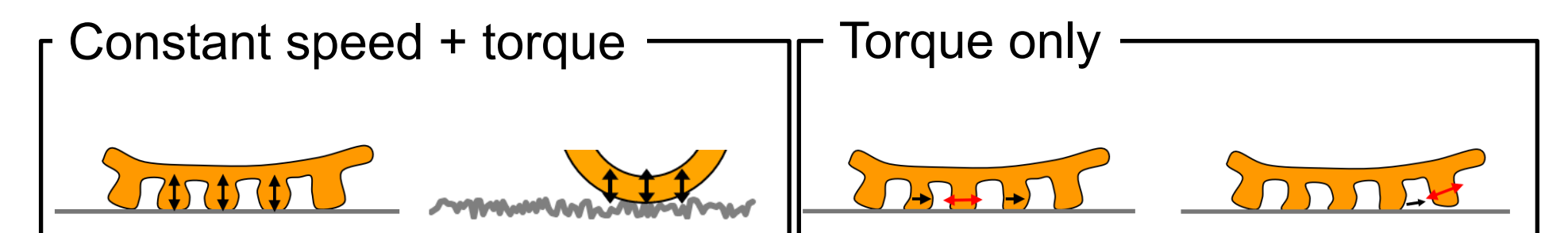


Vehicle torque



Background: Compared to constant speed driving, tyre torque due to acceleration or braking can increase tyre/road noise by several dB. Again, the extend of this increase depends highly on tyre design and operating conditions. This noise increase is caused by micro-scale adhesion and friction mechanisms which are responsible for phenomena like stick/slip and stick/snap which lead to additional tangential vibrations of the tread blocks which are of minor importance under free rolling.

Observations: Definite conclusions regarding EV tyre torque are difficult because of a lack of specific data and the large influence of electronic control systems and driving behaviour. Engine torque is in nearly all cases higher for EVs, both in terms of maximum torque as well as the RPM range where this is available. Assuming similar vehicle control systems and driving behaviour to ICEVs this means that tyre torque is potentially also higher for EVs. Combined with reports that over a third of EV fleet users exhibit a more aggressive driving behaviour a worst-case assumption of increased tyre torque for EVs seems reasonable.

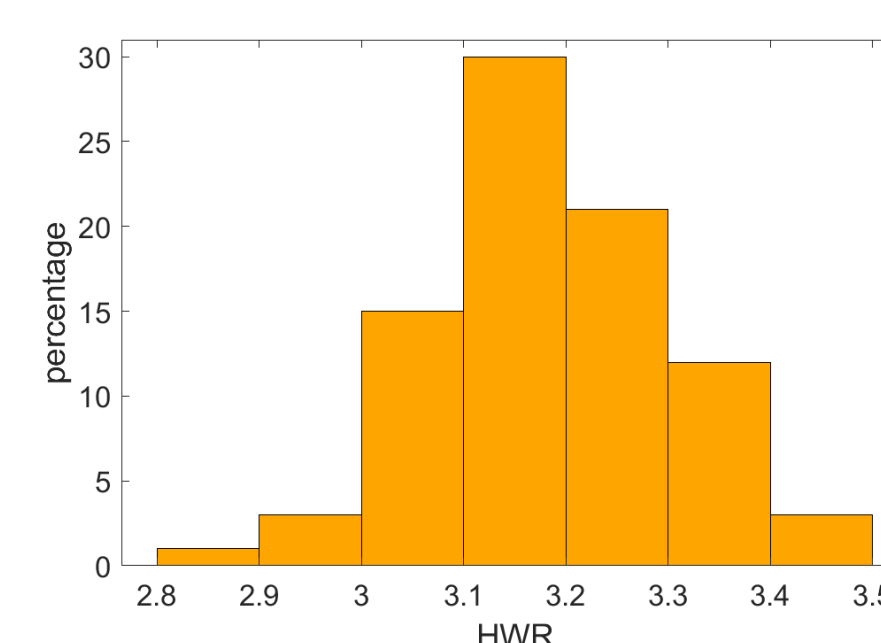


Tyre sizes

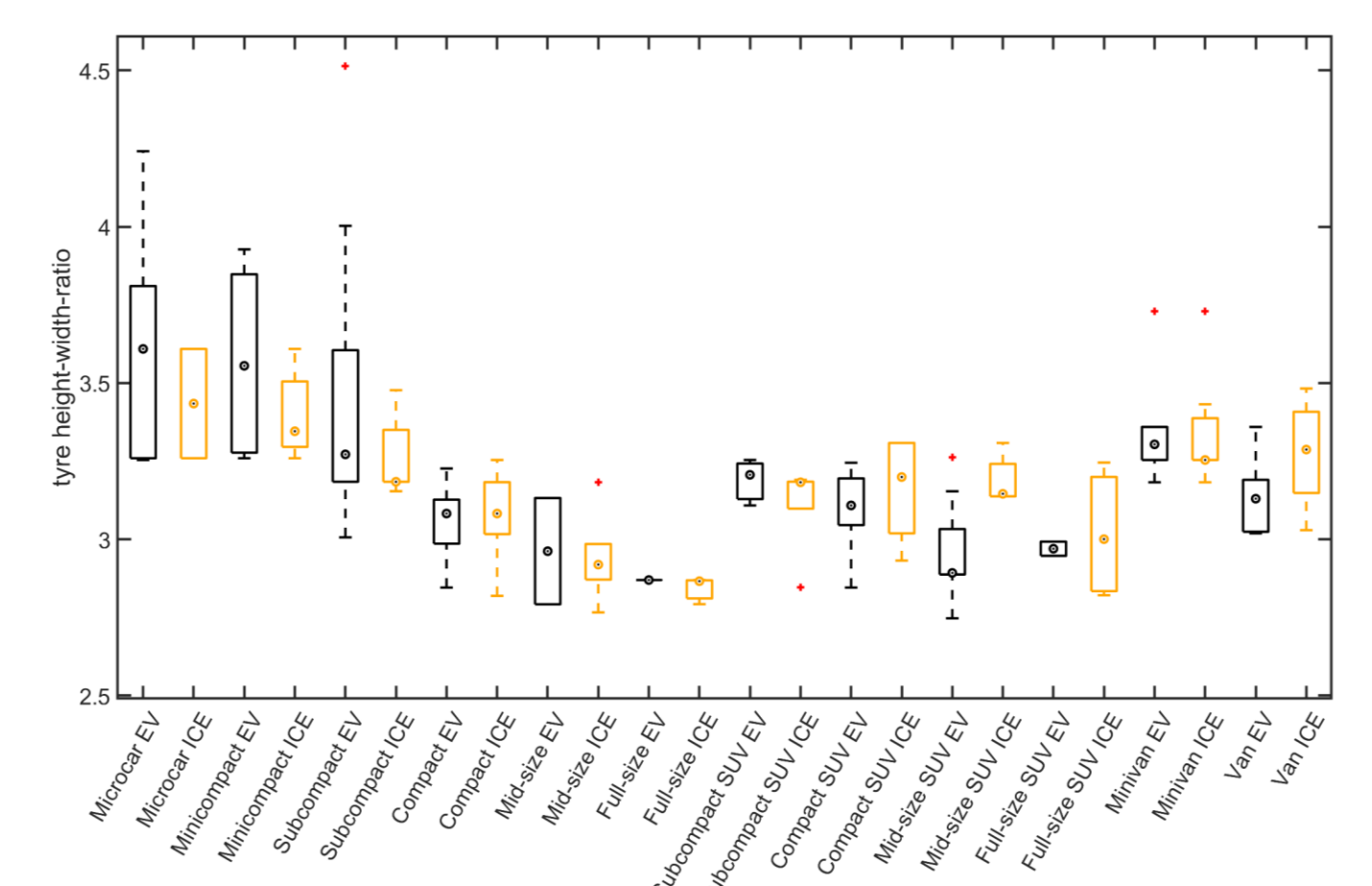
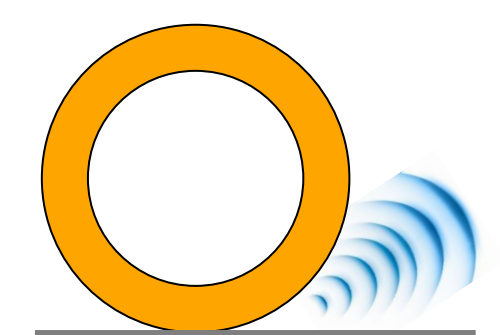


Background: The sound radiation from the area close to the tyre/road contact patch is amplified by the horn-like geometry formed between tyre and road. This amplification is frequency dependent with average amplifications of 5 dB to 12 dB per third-octave band having been reported for complex pass-by situations. The amplification is strongly affected by tyre width, with smaller tyres reducing the amplification effect. Tall-and-narrow tyre concepts as used by some EVs (e.g. BMW i3) have a significant influence on the amplification from the horn effect, affecting both the frequency and the amplitude of the peak amplification.

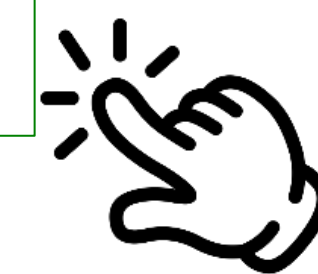
Observations: New tyre size concepts, for example tall-and-narrow, are not widely employed for EVs. Contrary, for EVs based on an ICEV platform usually no changes in tyre size are observed. For new EV platforms often only slight adjustments in tyre sizes are noticeable, typically in form of a small increase in tyre diameter and/or width. The relation between tyre height and width, defined here as height-width-ratio $HWR = \text{tyre diameter} / \text{tyre width}$, which is important for the amplification of the sound radiation, mostly stays in the same range as established for classical ICEV applications.



Height-width-ratio for the typical tyre sizes used by the 50 most sold ICEVs in the European market in 2019.



Web site: <https://life-evia.eu/>



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