



Electric Motorcycles: Technology vs Reality

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Introduction

Powered two-wheelers dominate urban transport across Asia and contribute significantly to city emissions (Eccarius and Lu, 2020). Battery electric motorcycles are widely promoted as a cleaner alternative, and the technical case is strong. However, a consistent gap exists between test performance and real-world outcomes. This poster examines two halves of the problem, the technical case, where the evidence favours electrification and the deployment reality where progress stalls. For engineers, this matters because design priorities are set against test-cycle assumptions that can understate real-world impact.

The Environmental Case

Lifecycle Assessment (LCA) measures total environmental impact from manufacture to disposal not just emissions (figure 1). Cox and Mutel (2018) compared ICEV, BEV and FCEV motorcycles across four size categories:

- BEVs on renewables cut lifecycle CO₂ by up to 80% vs gasoline
- BEVs on coal still outperform conventional powertrains
- Environmental benefits hold across all realistic grid scenarios
- Future BEV ownership costs projected to fall below ICEV as battery costs drop to ~150 \$/kWh by 2030

On-Road Emissions

Ghaffarpasand et al. (2020) measured emissions from 94,940 vehicles, comparing results against EURO standards (figure 3). NOx emissions exceeded EURO test values. Motorcycles had the highest proportion of pre-EURO or unclassified vehicles in the fleet, reflecting historically weaker regulation. This reinforces the case for electrification. For motorcycles the combustion baseline is worse than policy models tend to assume.

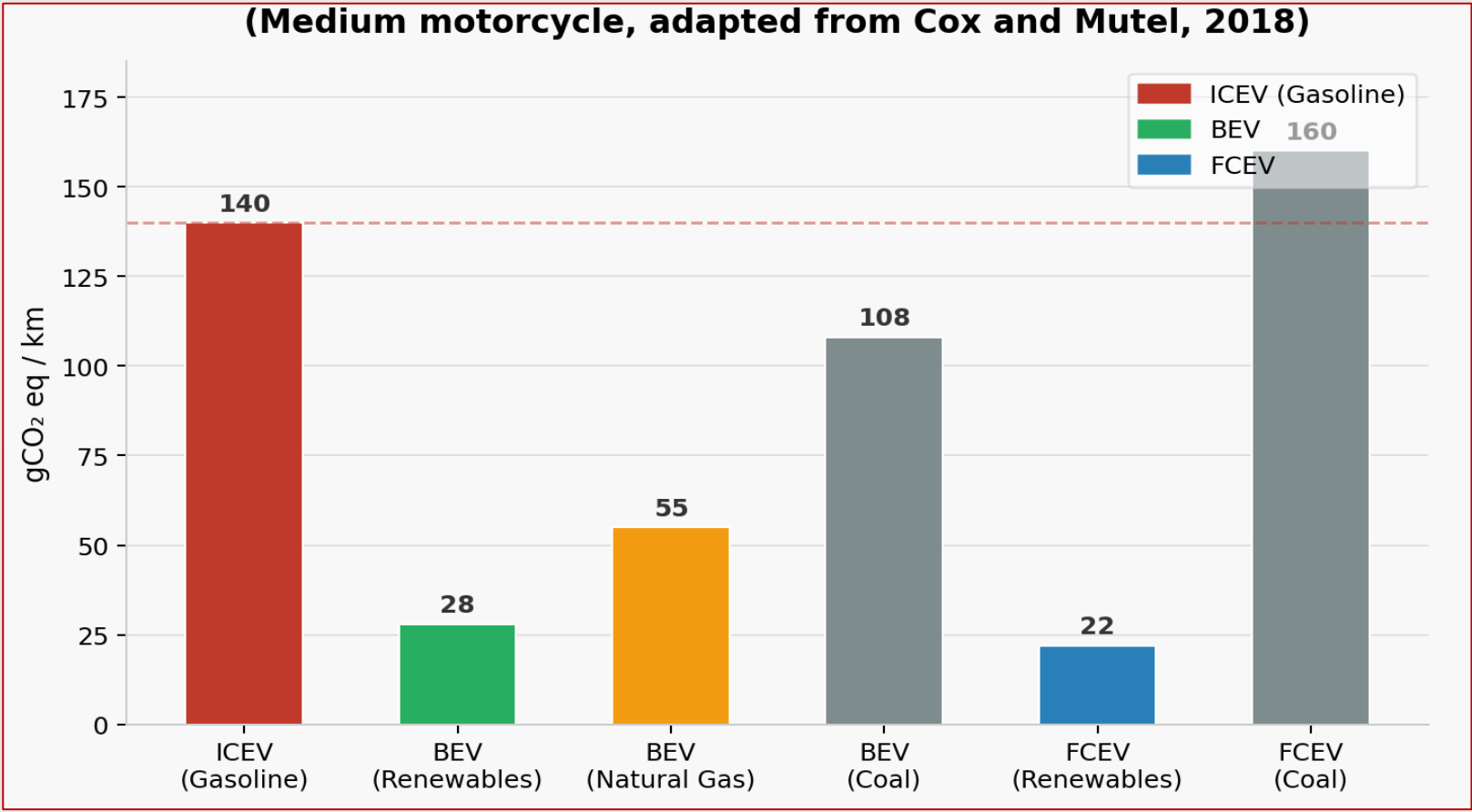


Figure 1: Lifecycle CO₂ by powertrain and energy source

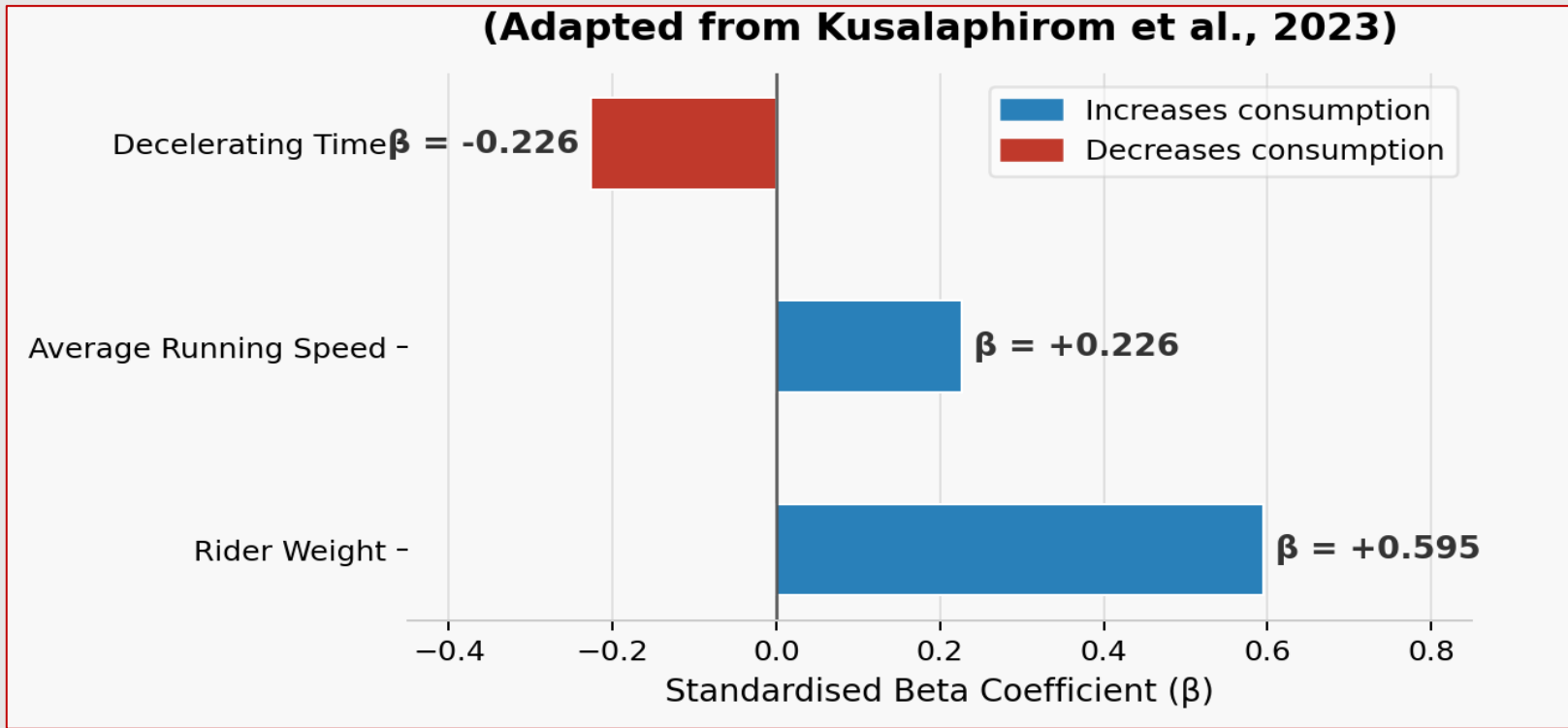


Figure 2: Regression factors for real world consumption

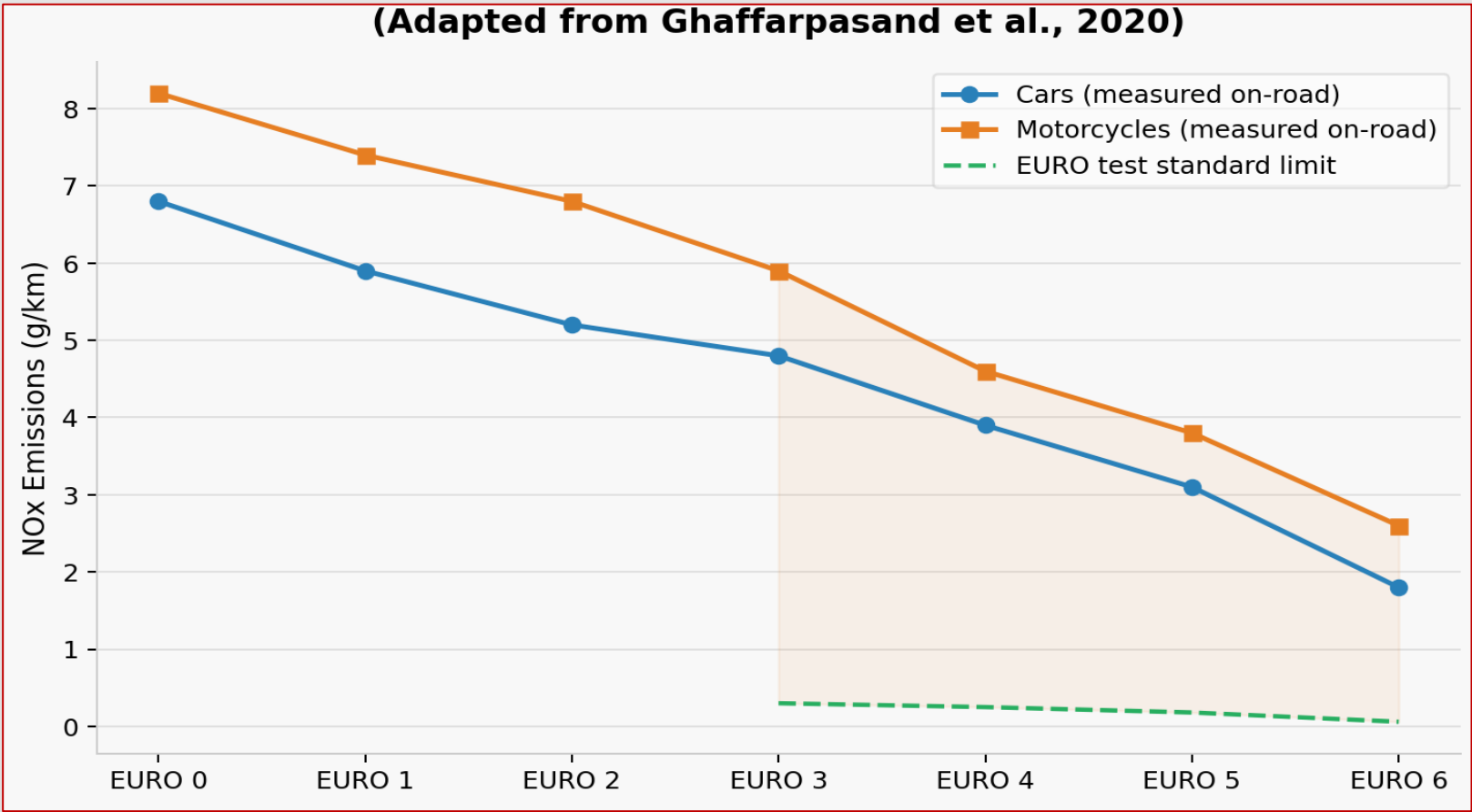


Figure 3: On-road NOx by EURO class

Real-world Consumption

From Kusalaphirom et al. (2023):

- Average consumption: 57.83 Wh/km, producing 25.74 gCO₂/km
- Rider weight was the strongest predictor, ahead of speed and deceleration
- Lightweighting has more impact on consumption than motor efficiency improvements.

(Figure 2)

Innovations and Applications

Key developments include advances in lithium-ion energy density, brushless permanent magnet motors, and regenerative braking. Real-world deployment across Southeast Asia shows measurable urban air quality benefits where grid intensity is low (Weinert et al., 2008; Kusalaphirom et al., 2023). Battery cost reduction remains the primary engineering target, with BEV total ownership cost projected to fall below ICEV within the current decade (Cox and Mutel, 2018).

Adoption Gap

In Indonesia, electric motorcycle sales reached just 31,827 units in 2023 against a total market of millions (Two et al., 2023). Only 36% of surveyed consumers agreed to adopt one (Murtiningrum et al., 2022). Eccarius and Lu (2020) identify purchase price and operating cost as the most consistent barriers across eleven Asian studies. Weinert et al. (2008) found policy support and technology improvement outweigh barriers to growth, but charging infrastructure remains the key unresolved obstacle.

Conclusion

Electric motorcycles offer genuine lifecycle emissions benefits across all grid types (Cox and Mutel, 2018), but real-world outcomes depend heavily on vehicle weight and grid intensity (Kusalaphirom et al., 2023). Conventional motorcycles remain under-regulated and underperform against standards (Ghaffarpasand et al., 2020). Adoption lags well behind potential, with cost and infrastructure as the primary barriers (Murtiningrum et al., 2022; Weinert et al., 2008; Eccarius and Lu, 2020; Two et al., 2023). The lectures left me with a clearer sense of timescale. I'd assumed electrification was a near-complete transition waiting on better batteries, however the evidence suggests the technology is ready, but the adoption curve will be shaped over decades by cost, infrastructure and policy.

References

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