Impact of Electrification of Two-Wheeler Fleet on Well-to-Wheel Energy Efficiency and CO_2 Emissions in Indian Context

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Abstract

Well-to-Wheel analysis (WTW) (also known as fuel life cycle analysis) has been performed for two-wheeler vehicles to understand the impact of electrification on well-to-wheel energy consumption and CO_2 emissions in the Indian context. The WTW analysis results were compared for conventional gasoline and a battery-electric powertrain configuration. The well-to-tank (WTT) analysis was first performed for gasoline, diesel, CNG, and electricity (which form a closed-loop). The electricity pathway showed the highest WTT energy use, CO_2 emissions, and lowest WTT efficiency. The tank-to-wheel (TTW) analysis was performed for conventional gasoline and battery electric configurations by conducting simulations of the models over the World Motorcycle Test Cycle (WMTC). The battery-electric configuration showed lower TTW energy use (hence higher TTW efficiency) than the conventional gasoline configuration. As expected for the battery-electric configuration, the CO_2 emissions associated with the TTW phase were equal to zero. When WTT and TTW analysis results were combined, the battery-electric configuration offered higher WTW efficiency and lower WTW CO_2 emissions than the conventional gasoline-powered vehicle, even with the current electricity mix. This was because the advantage of the high TTW efficiency of the battery-electric powertrain outweighed the disadvantage of the low WTT efficiency associated with electricity generation. With the reduction in transmission and distribution losses, a reduction in the percentage share of electricity generated from coal-based power plants, and an increase in the percentage share of electricity generated from more efficient renewable energy sources, the battery-electric configuration is expected to further improve in terms of well-to-wheel efficiency and CO_2 emissions.

Keywords: Well-to-Tank energy efficiency, Tank-to-Wheel energy efficiency, Well-to-Wheel energy efficiency, CO_2 emissions