Energy Efficiency of Autonomous Car Powertrain

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Abstract

This paper investigates the energy efficiency and emissions benefits possible with connected and autonomous vehicles (CAVs). Such benefits could be instrumental in decarbonising the transport sector. The impact of CAV technology on operation, usage and specification of vehicles for optimised energy efficiency is considered. Energy consumption reductions of 55% – 66% are identified for a fully autonomous road transport system versus the present. 46% is possible for a CAV on today's roads. Smoothing effects and reduced stoppage in the drive cycle achieve a 31% reduction in travel time if speed limits are not reduced. CAV powertrain optimised for different scenarios requires just 10 kW – 40 kW maximum power whilst the vehicle mass is reduced by up to 40% relative to current cars. Urban-optimised powertrain, with only 10 kW – 15 kW maximum power, allows energy consumption reductions of over 71%. UK energy consumption by cars could be 30% – 45% of current levels with a fully autonomous road transport system, depending on an energy efficiency versus travel time trade off. This could be reduced to just 26% if ride-sharing in urban areas achieves a doubling in average occupancy and travel times remain at today's levels.

A comparison of IC engine and battery-electric powertrains optimised for a fully autonomous road transport system indicates the benefits of electric powertrain, with a primary energy requirement per unit distance of ⅓ of the equivalent IC engine CAV. Greenhouse gas emissions per unit distance for the battery-electric CAV are 55% of an IC engine CAV with current UK electricity emissions intensity, reducing to 13% at 2030 emissions target levels. Reduced drive cycle energy requirements (44% of current levels) allow greater range and improved economics of electric vehicles whilst reduced power variance allows smaller batteries for hybrids, similarly helping their case.