Heavy Trucks

HIGHLIGHTS

■ **TECHNOLOGY STATUS –** This brief covers powertrain technologies for trucks with a gross vehicle weight greater than 3.5 tonnes, in light of reducing greenhouse gas emissions in the transport sector. While the performance of trucks varies considerably in different countries and even across similar truck classes in the same country, average efficiency has steadily improved by 0.8 – 1% per year over the last 40 years [1]. However, in some countries where increasingly stringent air quality emission standards have been in force, like in the UK and other European countries, this has not necessarily been the case. Since 1990, efficiencies in the UK have not improved consistently. Rigid vehicles are now around 12.5% less efficient than in 1993 due to the impacts of vehicle adaptation to comply with the Euro emission standards (and also a shift to larger vehicles). In comparison articulated vehicles have improved by around 10% over the same period [1], Over the next ten years new trucks predicted to improve efficiency at around 0.5% per year [2]. Fuel use is still approximately 80% diesel, however modifications to various components of the combustion engine powertrain have proven effective in greenhouse gas reduction, and it is believed there are significant gains still to be made. Natural gas trucks, biofuels and - to a lesser extent - electric trucks, have begun commercial market uptake in some suitable applications, but their overall contribution remains negligible.

■ **PERFORMANCE AND COSTS –** In the medium to long term, current engines could improve their thermal efficiency by approximately 25% on today's average (21 – 32 l/100km for typical rigid and articulated vehicles respectively). Some of the technological improvements discussed below show how this can be done at relatively little cost. More information is needed on technology costs, but many of the improvements appear likely to be relatively cost-effective. Logistic systems to ensure better use of trucks, and shifts to larger trucks in some cases, can provide additional system efficiency gains, and may also be cost-effective [3]. For the larger emissions savings however, costs remain very high and are heavily influenced by the drive cycles of the vehicles. Dual fuel vehicles, which substitute natural gas for diesel, run at similar efficiencies to conventional vehicles but with lower emissions. Hybrids save between 7 - 20% on fuel use dependent on drive cycle, whilst full electric trucks - given urban delivery cycles - can achieve 70% savings. Recent studies have shown that the price premium for gas powered dual fuel and dedicated gas vehicles is around €27k, while hybrid and electric trucks cost around €50k and €100k more than conventional diesel trucks respectively.

■ **POTENTIAL AND BARRIERS –** Considerable fuel savings could be obtained from the current diesel engine fleet if all trucks were to achieve the fuel efficiency of today's newer models. The International Energy Agency (IEA) - in its BLUE Map scenario with a 50% global CO2 reduction by 2050 against 2005 levels – projects that on a global scale diesel use for road freight will be nearly halved by 2050, leaving hydrogen, electricity, gas and in particular biofuels to meet remaining demand. The technologies which use these alternative fuels will likely develop initially in their own niche applications where they are more economical. Deployment of biofuels will prosper in sustainable feedstock farming. Hydrogen and dual fuel natural gas engines will prevail initially in instances where trucks have repetitive drive cycles and can return to a central point to refuel. A recurring difficulty for hydrogen, dual fuel and electric trucks will be on-board energy storage, which requires large energy storage units and competes with payload; this damages the economics of the technologies when considered over their lifetime.

TECHNOLOGY STATUS - Heavy trucks are defined in this brief as vehicles with a gross vehicle weight, or GVW, greater than 3.5 tonnes. This definition spans the diverse makeup of heavy trucks particularly for vocational applications such as in construction (mobile cranes, cement trucks, tipper trucks) and municipal utility vehicles (e.g. refuse vehicles, road sweepers). However, the focus of this brief is on the largest energy consuming area, which is heavy trucks used in freight transport.

Trucks are composed of rigid and articulated vehicles. A rigid truck consists of a truck with the cab and body integrated on a single fixed chassis. An articulated truck consists of a tractor unit and semi-trailer (plus possible additional trailers) that carries the payload (or vocational auxiliary equipment). A 'road train' is the term used to describe a combination of a rigid (or articulated) truck and drawbar trailer.

Engine technologies across Europe, USA and Japan are very similar in terms of engine displacement, fuel injection equipment and after-treatment [4]. These three markets are also likely to make the most advances in engine technologies, as they are subject to the toughest emissions or fuel-related legislation on heavy trucks, particularly in Japan [1].

The following sections are defined by the major technologies currently deployed or available in the future for improving the efficiency and emissions performance of heavy trucks. Beneath each technology heading, the current state of the art technologies are described, or where a technology is close to market, its potential is discussed.

■ **Conventional gasoline / diesel ICE -** E-Tech-DS briefs T01 and T02, on advanced gasoline and diesel technologies respectively, cover the current status of

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