Public Transport

HIGHLIGHTS

TECHNOLOGY STATUS – This brief covers buses and coaches, trolleybuses, trams and light rail. Heavy intercity rail is coverd by ETSAP T11 (Rail Transport). Public transport is substantially more energy efficient than private vehicle use. Figures for OECD Europe show light duty vehicles (LDVs) typically consume 1.9MJ per passenger kilometre (p-km) compared to buses at 0.8MJ/p-km and rail at 0.3MJ/p-km [1]. The vast majority of buses and coaches are diesel powered. These have benefitted from general improvements in combustion engine efficiencies over recent years. In some countries there are significant numbers of natural gas powered buses operating. Hybrid-electric buses are in commercial production and in service in many cities across North America [2], China and Europe and there are also a few examples of small full-electric buses in service. Trials of hydrogen fuel cell buses have been conducted for a number of years but have yet to demonstrate overall energy savings. Electric trolleybuses - buses with overhead power lines - have low energy consumption (typically 0.2 - 0.6MJ/seat-km) and have a long history of use but form only a small percentage of the total bus fleet. Personal Rapid Transit systems (driverless electric vehicles which operate on a track or guideway) can also achieve low energy consumption (around 0.55MJ/seat-km) but are a relatively new concept and the first examples are just entering service. Light-rail, trams and metro systems are well established in many countries and offer significantly lower energy consumption than road-based public transport (0.18 - 0.28MJ/seat-km) due to the lower rolling resistance of steel wheels on rails, better aerodynamics and lack of congestion.

PERFORMANCE AND COSTS – Aside from general improvements in the efficiency of heavy duty diesel engines there are a number of technologies which can be applied to buses and coaches. Hybrid electric systems with stop/start operation offer 20 - 40% energy savings for typical bus usage patterns. The capital cost of hybrid buses is currently 40% higher than the cost of conventional diesel buses. However, as production volumes increase, the cost is expected to come down. The use of biomethane and bio-synthetic gas in converted engines can achieve at least a 60% reduction in CO_2 as well as local pollutants reductions. Retail prices are currently 20 - 25% higher but would be expected to reduce as production volumes increase. Battery electric buses offer up to 70% lower energy consumption in comparison to diesels, however current costs for comparable performance are prohibitive. As battery technology improves and costs come down their use is likely to increase. The primary opportunity for energy saving in light-rail, tram and metro systems comes from reducing weight. As with any transport powered by grid sourced electricity, the largest potential for carbon reduction comes from de-carbonising electricity generation.

POTENTIAL AND BARRIERS – To reduce overall transport energy use there is a need to encourage a shift from private vehicles to public transport. Public transport offers some of the best opportunities for the application of new more efficient and lower carbon technologies. The high vehicle utilisation rates and long service lifetimesmake payback periods much shorter than for private vehicles. Rail based systems offer the highest efficiencies but face barriers of high initial capital cost and the required land take in dense urban environments. For road based public transport, electric drivetrains appear to offer the greatest efficiency potential. For battery-electric vehicles, barriers are the high costs, modest battery lifetime and range limitations. For hydrogen fuel-cell vehicles, key barriers are high costs, lack of hydrogen storage and refuelling infrastructure and concerns over whole life-cycle energy requirements.

TECHNOLOGY STATUS

TECHNOLOGY STATUS – Public transport plays a central role in transport systems, particularly in countries in which private vehicle ownership is not widespread. Bus travel accounted for 6% of world transport sector final energy use in 2007 with rail (both light and heavy) accounting for a further 3% [1]. Public transport is generally significantly more energy efficient than private vehicle use, with bus and rail travel accounting for 18% of passenger-kilometres (p-km) in OECD Europe but only 5% of energy consumption [1].

Buses & Coaches – Buses are heavy duty vehicles primarily used for scheduled intra-urban, inter-urban and rural public transportation. Bus services are typically characterised by having shorter routes with high frequency stops, but in the developing world are frequently used for longer range transportation as well. In city use, average speeds can be as low as 7km/h but are more typically 10 - 17km/h. Depending on their design and intended purpose, buses typically seat anywhere between 20 and 150 passengers, although some designs can seat 300. From available data it appears that buses carry more passengers than urban rail systems in the vast majority of cities [3]. About 85% of bus sales are diesel-engine powered with the majority of the remainer being gasoline and a small number using compressed natural gas (CNG) [3]. In common with other heavy duty vehicles, such as goods vehicles, there is a range of energy saving technologies open to bus manufacturers. The most appropriate technologies to apply will depend on the drive cycle on which the vehicle operates. Buses are mostly found in an urban context and so operate on a predominantly low speed, transient (accelerating and decelerating) drive cycle and so benefit more from measures such as weight reduction and energy recovery technologies. They also tend to have centralised refuelling facilities so are an attractive contender for alternative fuels. Coaches, on the other hand, typically operate between urban centres on a predominantly high speed, steady

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