

Two- and three-wheeled vehicles and quadricycles

HIGHLIGHTS

■ **TECHNOLOGY STATUS** – Uptake of two-wheelers and three-wheelers is highest in Asian countries, where on average they account for almost three-quarters of the passenger vehicle fleet. Two-wheelers are particularly important as a transport mode for lower income groups, but are increasingly bought by wealthier urban workers who wish to avoid congestion and parking restrictions. The market is expected to grow due to their low running costs, rapid urbanization, lack of public transportation and the rising population. The Chinese two-wheeler market is the largest in the world, standing in 2010 at over 100 million, two-wheelers (running stock, mainly petrol engine) and another 100 million electric bicycles (“e-bikes”). The second-largest two-wheeler market in India was estimated at 56 million units (mainly petrol) in 2010. In OECD countries uptake is much lower; Europe is the largest market outside of Asia, with around 36 million units in circulation. The market for two-wheelers is split between high quality vehicles used in OECD countries and lower quality cheaper vehicles in developing countries. However, worldwide the most popular market segment is for small urban commuter vehicles with petrol engines <125cc. In China, this segment accounts for around 70-80% of two-wheelers purchases. A number of hybrid, LNG, CNG and fuel cell two-wheelers have also been developed, but they have no significant market penetration. Three-wheelers are less common worldwide than two-wheelers, but may provide an important transport service to people without access to a private vehicle or public transport. India has the largest market in the world, with annual sales of around 0.5 million. Quadricycles exist in niche markets, and most car manufacturers are expected to launch electric-powered “sub A” models in Europe by 2013 (the A segment includes the smallest passenger cars).

■ **PERFORMANCE AND COSTS** – Most two- and three-wheelers use internal combustion engine. Fuel efficiency improvement technologies used in passenger cars could theoretically also apply to two- and three-wheelers and quadricycles using internal combustion engines. However, uptake is likely to be limited due to space and cost constraints. Significant benefits can be achieved by improving fuel injection, particularly for the two-stroke engines common on smaller two-wheelers and on three-wheelers. Air-assisted direct fuel injection systems for two-stroke engines can reduce fuel consumption by 30-60% at a cost of \$40 for motorcycles and up to \$300 for three-wheelers. Four-stroke engines are 35-50% more fuel efficient than similarly sized two-stroke engines, but are larger, heavier and more complex. Electronic port fuel injection using sensors can reduce fuel consumption on four-stroke engines by 20% compared to mechanical carburetors (used on older models) and 5-10% compared to newer engines at a cost of \$85-\$170. Swirl control valves can reduce fuel consumption by 7% at a cost of \$32. In the largest world market (China), the purchase cost for two-wheelers with engines <125cc is typically less than \$380. In India, the entry level two-wheelers cost around \$360, but the most, popular size segment (i.e. 60% of the market) is motorcycles with engine size 75-125cc, with a cost of \$700-1,050. In Europe, the largest market segment (60%) is again the smaller engine sizes <125cc, but costs are much greater (\$1,310-3,930). Energy consumption is around 0.41-0.47MJ/km (1.3-1.5 litres/100km), but can be much higher for older or more powerful vehicles, and the majority run on petrol. Electric bicycles (“e-bikes”) are gaining popularity in several markets, although 95% are currently sold in China (20 million units per year). These cheap models use lead-acid batteries and cost \$200-320. The electricity requirement from “plug to wheel” is around 0.05-0.06MJ/km. The main three-wheelers market (i.e. India) consists largely of three-seated passenger vehicles (“auto rickshaws”). On-road prices are around \$1,270 and fuel consumption varies greatly from 0.8-1.75MJ/km depending on the age of the vehicle. Uptake of CNG and LPG versions with lower fuel consumption (around 0.86MJ/km) and retrofitting cost of is \$400-450 has been driven by attempts to reduce air pollution in cities. Electric three-wheelers are used in niche markets, but have not gained significant market share. Electric quadricycles with low energy consumption (0.18-0.45MJ/km) and cost below \$21,000 could emerge in the sub-A segment.

■ **POTENTIAL AND BARRIERS** – Uptake of motorized two- and three-wheelers is expected to increase in emerging economies. This growth could eventually give way to uptake of cars as countries become richer; however, increasing urbanization and high levels of congestion could counterbalance this effect. Other policies can inhibit the uptake of these vehicles – for example, some cities have banned two- and three-wheelers in order to reduce air pollution. The market for e-bikes is expected to grow rapidly, particularly in China. However, they cannot currently compete directly with gasoline two-wheelers (except in specific niche uses) due to their limited range, low speeds and long recharging times. Uptake of electric quadricycles is currently low, but is expected to increase (especially in Europe) due to exemption from congestion charges, improvements in battery technology, tighter CO₂ emission standards for passenger cars and the exemption from needing to obtain a license for these vehicles.