LowCVP
Low Carbon Vehicle Partnership

Powered Light Vehicles:

Opportunities for Low Carbon 'L-Category' Vehicles in the UK

The Low Carbon Vehicle Partnership was established in 2003 to accelerate the shift to lower carbon vehicles and fuels and create opportunities for UK businesses. It is a public-private partnership with approximately 200-member organisations from diverse backgrounds including automotive and fuel supply chains, vehicle users, academics and environmental groups. The LowCVP with its members play a key role in helping influence government strategy to deliver its low carbon road transport mandate.

With growing interest in the field, LowCVP formed a consortium of stakeholders, bringing together a range of interested parties over the years to impartially assess the potential opportunities and actions required for L-Category "Powered Light Vehicles" (PLVs) to penetrate the UK transport market.

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This executive summary report is an abridged version of the assessments conducted by the individual consortium members over the last few years, which are all available to download from the LowCVP website: **www.LowCVP.org.uk/PLV**

These reports are not intended as an end in themselves, but instead to act as a spur to action. To build upon the UK's capability in ultra-light automotive engineering and to provide the right conditions which support the market for Powered Light Vehicle uptake.

Renault Twizy

Powered Light Vehicles:
Opportunities for Low Carbon 'L-Category' Vehicles in the UK

The PLV Consortium (PLVC) was formed to assess the potential for the larger three and four-wheeled 'L-Category' classified vehicles, which are referred to as Powered Light Vehicles (PLV) in this report, as a future transport solution in the UK. In the view of the members of the consortium, Powered Light Vehicles offer important potential environmental and economic growth opportunities for the UK. For these to be realised, however, several regulatory aspects need to be addressed, along with a need for PLVs to be incorporated into the existing policy framework. It was also identified that there is no existing network to enable stakeholders to engage in discussions around PLVs and through which progress in this area could be driven.

The use of PLVs is widespread in several large markets around the world. Typically, these consist of 3 or 4-wheeled vehicles used for personal mobility and "last-mile" goods delivery. Globally, there is likely to be growth in demand for this category of vehicle as the demand for mobility and goods in space-constrained urban environments increases and – particularly in developed markets – as a result of environmental drivers.

The main conclusion of the Consortium was that PLVs - with either an electric or highly efficient internal combustion engine powertrain - create an opportunity to provide an important reduction in polluting emissions and energy consumption, both during the manufacture and operation of these vehicles in the UK. Furthermore, PLVs offer potential growth opportunities for the UK, building on the existing engineering capabilities of the automotive sector and, in particular, the motorcycle, motorsports and niche vehicle sectors, which are well-positioned to exploit opportunities for this category of vehicle.

The PLVC assessment also identifies a number of challenges to the manufacture and use of PLVs in the UK. These relate to the delineation of regulations relating to sit-on and sit-in vehicles, and the incorporation of PLVs into existing UK and EU policy frameworks.
This executive report summarises the key findings of the PLVC assessment, along with some recommended short-term and long-term actions that the consortium has identified as being key to unlocking the market for PLVs in the UK.

The full series of reports written by consortium members are available for further background information and can be downloaded from the LowCVP website: www.LowCVP.org.uk/PLV

Toyota i-Road

What are Powered Light Vehicles?

Powered Light Vehicles (PLVs) is a term used in this report to refer to a subset of 'L-Category' vehicles. L-Category vehicles are a group described in EU Regulation 168/2013, which range from powered two-wheelers (PTWs) such as motorbikes and mopeds, to heavy quadricycles.

Figure 1: L-category vehicles classifications

The primary focus of this assessment was around the larger, enclosed vehicles at the heavier end of the L-Category spectrum; the three and four-wheeled vehicles (L5e-L7e), which are referred to as Powered Light Vehicles in this report. The PLVC focused on this range of L-Category vehicles because it was felt that powered two-wheelers, such as motorbikes and mopeds, have already established markets in the UK.

How are Powered Light Vehicles currently used?

The range of applications for PLVs in the global automotive market is particularly wide due to the diversity of the sub-categories. This has led to the production of vehicles that are suitable for a range of different activities. However, there are principally three application themes:
- Personal mobility
- Leisure
- Light commercial use.

In the UK, there is a well-established motorcycle and moped market with personal mobility and leisure the primary uses. However, there is growing interest in light commercial use of PLVs for 'last mile' delivery in response to congestion and on-line shopping demands.

There are a range of applications for PLVs internationally. In developing economies such as India and China there are huge markets for PLVs, driven primarily by economic factors in which these vehicles are used for commercial and personal mobility. In other developed economies that are similar to the UK, there are a range of applications for PLVs, some historical and some driven by regulation. Italy and Spain have long established markets for three-wheeled light commercial vehicles, such as the Piaggio Ape. The French market for quadricycle cars is driven by regulatory factors of which a key element is the fact that some do not require a driving licence to use. In Japan, the Kei car market driven by congestion and parking space limitations.

Why should the UK's Road Transport ambition include Powered Light Vehicles?

There has been a consistent push to reduce vehicle emissions in the UK through legislation and fiscal incentives. This has been focused primarily on light duty vehicles but is being extended to heavy duty commercial vehicles (M and N Categories). However, little consideration has been given to L-Category vehicles and in particular to three and four wheeled PLVs. The PLVC believes that there could be significant market opportunities as consumers become increasingly aware of the need for sustainable transport solutions, and as their buying behaviours and usage patterns in terms of the rise of 'mobility services' develop.

There are clearly trade-offs to consider when changing from a conventional passenger car (M-Category) to a PLV e.g. reduction in maximum number of occupants; top speed limitations; operational range - which is typically less than 200 miles - and a restriction on auxiliary features due to the weight constraints. However, the reduced weight of PLVs is a crucial factor which helps to deliver greater energy efficiency and lower emissions compared with conventional vehicles (Figure 2).

Figure 2: Energy efficiency of lightweight vehicles

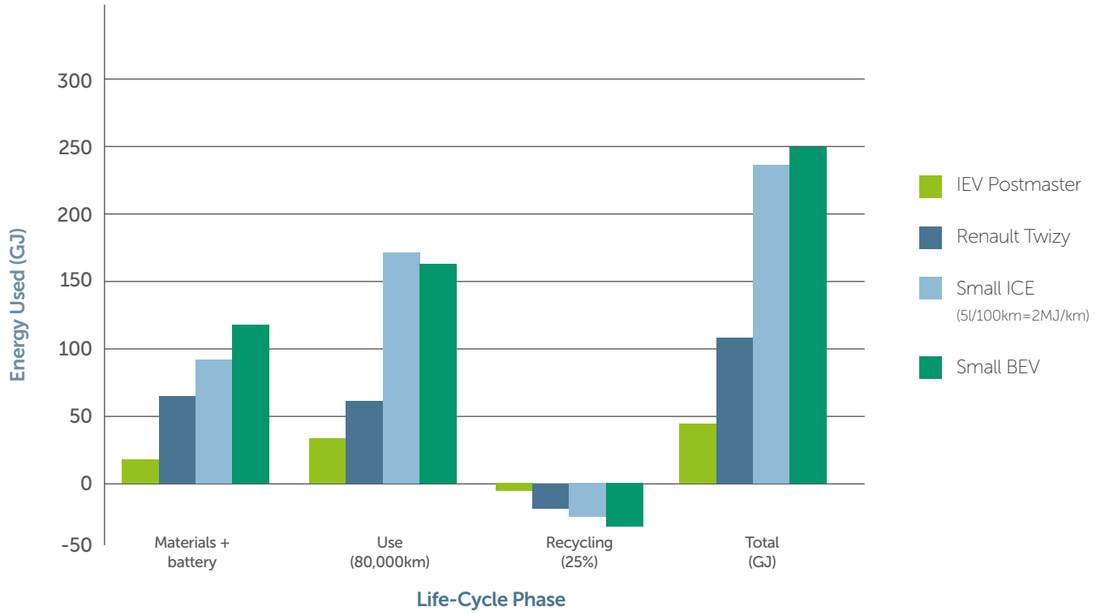
Approx. Energy Consumption in kWh/100km

N.B Aggregated figures. Exact comparison requires harmonised test cycle procedure

Twike

The whole-life carbon footprint of PLVs compared to conventional passenger cars is expected to be significantly lower owing to their smaller size and weight. The PLVC study has estimated the total life-cycle energy consumption of PLVs to be, typically around 50% lower than conventional passenger cars (Figure 3).

Figure 3: Energy used over the lifetime of a vehicle in Gigajoules (GJ)



With zero tailpipe emissions, the electrification of the PLVs will further improve air quality in urban areas and enable vehicular access to potentially restrictive urban Clean Air Zones[1] that are currently being considered across UK cities.

In addition to the carbon footprint and air quality benefits, PLVs could provide a growth opportunity for the UK. However, there are currently no UK manufacturers of PLVs and Europe's largest manufacturers are based in France and Italy, with the majority powered by internal combustion engines. At the time of writing, there is currently limited international competition from manufacturers producing PLVs with a zero-emission powertrain, so there may be potential opportunities for the development of battery electric and other alternative powertrains.

The UK has existing engineering capabilities and a strong automotive sector. The motorcycle, motorsport and 'niche vehicle' sectors, are well suited to exploit opportunities to supply existing and potential markets for PLVs. This presents an opportunity for the UK's automotive – and, particularly, niche vehicle - manufacturing sectors, potentially creating job opportunities and products all along the supply chain for domestic use and export to other markets around the world.

The PLVC believes the development of a market for PLVs in the UK would have environmental and growth benefits, very much in line with the UK's overarching Industrial and Clean Growth Strategies.

[1] Clean Air Zones (a.k.a Low Emission Zones in Scotland, and Ultra Low Emission Zone in London) are areas in which local authorities have brought measures in, such as vehicle access restrictions, to improve the local air quality, usually in terms of nitrogen oxides (NOx) and particulate matter (PMx) emissions.

Increasing the use of PLVs - what challenges face the UK?

To grow the Powered Light Vehicle market in the UK, the PLVC has identified several opportunities and issues that need to be considered.

From a regulatory perspective, the regulatory framework for "sit-in" L-Category PLVs needs to be improved and made distinct from "sit-on" L-Category vehicles such as scooters and motorcycles for which an established market already exists. This needs to include a clear and appropriate legal framework covering crash test procedures, suitable drive cycle and type approval processes for this market sector to become established. An appropriate regulatory framework is vital to provide clarity not only for manufacturers but also confidence for consumers.

In addition, ultra-low emission PLVs should be incentivised in line with other vehicles types. The OLEV Plug-In Vehicle Grant eligibility criteria, currently covers electric cars (M1) and vans (N1) and some motorbikes and mopeds but excludes compact efficient alternative Powered Light Vehicles such as the Renault Twizy, SAM EV03, Goupil G5 and MEGA D-Truck. Nor are PLVs included in fleet average CO_2 emission regulations. They could be incorporated into the existing framework to encourage carbon reductions in both the UK and European levels.

From a consumer acceptance perspective, the successful uptake of PLVs in the UK will be dependent on product design and the business models for use, which require considerable thought and ingenuity. The integration of product design with the functional requirements and styling will be critical for market acceptance along with fresh business approaches. Innovative new business models which maximise the utilisation of PLVs through vehicle share schemes while providing a range of other connected services could provide new value-added mobility services.

The challenge for the UK is to develop a compelling, innovative product and novel business case that gains initial traction in the market to demonstrate the use case and monetisation model for Powered Light Vehicles. Pilot schemes, such as local community car clubs, that can be used to develop market traction will be beneficial.

Aixam Mega D

Key Areas Investigated by the Powered Light Vehicle Consortium

The PLVC has considered the commercial, technical and regulatory issues surrounding PLVs as part of a future sustainable transport solution for the UK and has highlighted five important areas for action to unlock this market segment.

1. Market Demand

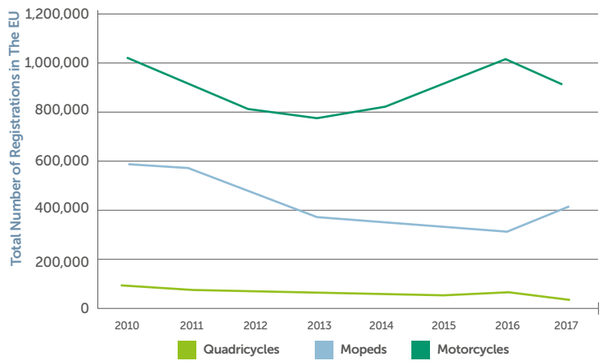
The Consortium study has identified that more and better data is needed for the UK to assess the current and possible size of the PLV market and therefore the potential economic benefit. Though there is some tangible evidence of a growing demand for PLVs, it is currently difficult to separate powered two-wheeled vehicle sales from the rest of the L-Category market. Further work is required to assess the potential UK market for PLVs, although an indication of its size can be drawn from other market segments and other countries.

Data on L-Category registrations is collected by the EU and published by the ACEM (The Motorcycle Industry in Europe) but is not complete for all EU member states and registrations and vehicle fleet data are not directly comparable. The ACEM reported that in 2015 there were 33.2 million motorcycles and mopeds (excluding quadricycles) in the European (EU+EFTA) vehicle fleet.

Generally, between 2010 and 2018, there has been a trend growth in the motorcycles and quadricycle market share at the expense of mopeds in European L-Category markets. New registrations of L-Category vehicles in the EU in 2018 were reported to be just over 1 million vehicles, with ICE & battery electric quadricycles making up 5% of all L-Category registrations; a continued growth trend in the market share of quadricycles.

In 2018 there were 50,342 electric-powered L-Category vehicles registered in the EU, which represents 3.8% of total L-Category registrations, up from 0.7% in 2011, (the first year in which data was collected.)[2]

Figure 4: Monthly EU Registrations of Electric Mopeds, Motorcycles and Quadricycles



European Union Registrations of L-Category Vehicles (ICE & Electric)

However, by the end of 2018 there were only 610 ultra-low emission quadricycles registered in the UK, and 412 plug-in grant-eligible motorcycles and mopeds[3]. These registered volumes suggest the UK is still at the innovator stage, according to the standard Roger's adoption curve or diffusion process. Innovators are key communicators in encouraging diffusion of technology and market growth. However, product improvements are likely to be required to drive increased take-up, through cleaner and safer vehicle options with connected services.

The market is more mature in France, Italy and Spain where quadricycle registrations in 2018 were 16,167 (4% electric), 6,705 (10%) and 4,331 (5%)[4] respectively. In Italy and Spain there is an established commercial PLV market for deliveries and the agricultural sector. While the PLV market in France is driven by an established market supplying the elderly population, young drivers and urban users who require no driving licence.

The USA doesn't have a vehicle class that is directly comparable to PLVs; their light vehicles are known as "Low Speed Vehicles" (LSV). Successful trials have seen regulations changed to suit the user, where golf-cart type vehicles are permitted to drive on (local) public roads at up to 25mph for example.

In Japan, a culture of small vehicles has evolved around the Kei car. Kei cars are a class of vehicle in Japan that bear many resemblances to the European heavy quadricycle (L7e), with the most significant difference being their weight (approx. 100kg heavier). Manufacturers and owners of Kei cars have received several tax breaks from the Japanese government in the past based on the overall geometric footprint of the vehicle.

In India, standards are similar to Europe's L-Category, however the government has recently introduced a new quadricycle category under regulation GSR 99(E). Although the new Quadricycle category description was issued in 2014, it has been contested in the Indian High Court to include crash requirements. The current expectation is a phased approach with relaxed crash requirements starting in 2018, followed by European passenger car equivalent crash safety in 2020. This is a significant change for the Indian ultrahigh volume market, that may become a standard that other markets adopt in the future.

Globally, the demand for electrified PLVs is projected to grow, with the electric motorcycle & scooter market size valued at over USD 15.5 billion in 2017 and projected to have a 5% compound annual growth rate from 2018 to 2024.[5]

It is clear that the UK PLV market is underdeveloped but has the potential to grow significantly, given the proper regulatory framework, market support and the incorporation of these vehicles into carbon reduction targets.

[2] ACEM Motorcycle Industry in Europe Market Data 2018 - https://www.acem.eu/market-data-2018
[3] Department for Transport Statistics: VEH0130
[4] ACEM Motorcycle Industry in Europe Market Data 2018 - https://www.acem.eu/market-data-2018
[5] Electric Motorcycles and Scooters Market - Industry Size Report 2024, Global Market Insights, May 2018

Increasing the use of PLVs - what challenges face the UK?

Potential Market Size

The PLVC developed a set of scenarios to help assess the potential size of the PLV markets and the environmental benefits which could follow from developing this market in the UK. These scenarios are not forecasts and further work is needed to develop the understanding of the potential PLV market size. The scenario reported here provides a maximum market potential and would be dependent on the introduction of an appropriate regulatory framework, PLVs being incorporated into incentive mechanisms and there being consumer acceptance.

The potential market size for PLVs in the UK will differ from the personal mobility and freight markets. In order to quantify the demand for Powered Light Vehicles, the PLVC conducted some basic desktop modelling that focused on potential substituted demand from the lighter end of the M1 and N1 category vehicle markets, rather than additional demand.

For the UK passenger car fleet, the "Mini" segment of M1 cars currently accounts for around 28% of the total car fleet. By 2030, with favourable incentives, Powered Light Vehicles could account for up to 14% of total personal transport vehicles, a fleet of as many as 5.4m vehicles; half that of the "Mini" car fleet.
As for the UK light commercial vehicle fleet, N1 vehicles under two tonnes currently account for almost 10% of the light commercial vehicle (vans up to 3.5t) fleet. By 2030, if a fleet of PLV commercial vehicles accounted for 20% of total light commercial vehicle fleet (N1 category), it could comprise approximately one million vehicles.

There is clearly a need for further work to assess the market potential for PLVs in the UK. A key issue is access to data to assess the current and potential future market size. However, there is evidence that the Powered Light Vehicle market in the UK is under developed and that there is considerable potential for growth in the UK based on increased use of Powered Light Vehicles for personal mobility and for commercial use.

2. Vehicle Supply

There are over 40 companies making vehicles in the UK at some of the most productive plants in the world. Indeed, according to Eurostat data, the UK's automotive components sector is one of the stronger performers in Europe in terms of Gross Value Added per employee, marginally ahead of Germany and 50% stronger than the European average. The automotive supply chain in the UK includes a wide range of companies, from small specialists to large multinationals.

A study by the Automotive Council (2014) mapped the UK's Tier-1 landscape and identified what capabilities it offers. Among the 44 respondents who defined the category of products they made, 41 included powertrain components in their portfolio, followed by chassis, interior and exterior parts. Only four respondents supplied electrical or electronic products. More details are shown in Table 1.

Table 1: Categories of products made by tier-1 suppliers in the UK

Component Category	No.*	%
Powertrain	41	30%
Chassis	28	20%
Interior	27	20%
Exterior	23	17%
Electronics	3	2%
Electrical	1	1%
Other	15	11%
TOTAL NUMBER OF PRODUCTS	138	100%

Overall, the report concluded that upstream supply chain companies have a significant appetite for re-shoring purchasing, with 15% of respondents recording that they would ideally like to repatriate 100% of their purchases back into the UK. In addition, a number of independent reports have identified the need to stimulate the automotive supply chain – and, in particular, the electric vehicle supply chain, as a key driver of the UK economy.

The UK also has significant manufacturing and engineering capabilities in the low volume, extreme performance of the motorsports, motorcycle and niche vehicle sectors, which have unique capabilities applicable to the PLV sector.

A review of the UK motorsport industry, commissioned by the Motorsport Industry Association (MIA) and supported by the Government in 2012 identified that the UK motorsport sector comprising of 4,500 companies had an annual turnover of £9bn, employing approximately 41,000 people with average R&D spend worth approximately 25% of turnover.

The UK also has a strong motorcycle manufacturing sector which is used to developing products to tighter budgets and margins than other parts of the automotive industry. The motorcycle manufacturing sector includes the manufacture of motorcycles, components and fuel/oils. The manufacture of motorcycles is the most significant activity and has increased significantly and consistently over time in recent years. The Motor Cycle Industry Association (MCIA) in 2015[6] reported that UK motorcycle-related manufacturing had a total turnover of almost £6 billion, which contributes more than £1 billion in taxes to the UK economy, and that the sector also provided direct employment for more than 58,500 people.

The PLVC concluded that the UK has existing engineering capabilities, a strong automotive sector and that the motorcycle, motorsport and niche vehicle sectors in particular, are well suited to exploit opportunities relating to this category of vehicles.
It should be noted that growth of the PLV market could be a partial substitute for larger passenger cars. Whilst the volume of sales switching from UK- based brands is likely to be very small given that UK production tends to be focused on higher value vehicle production, there may be some transfer of demand, although imported brands are likely to be more susceptible.
More importantly, the PLV market represents a potential export opportunity for the UK to the rest of the world.

3. Economic and Environmental Benefits

Economy

A report entitled "An Economic Assessment of Low Carbon Vehicles" (Ricardo-AEA, 2013), while focusing on cars and vans, presents an estimate of the economic impact of low carbon vehicles, producing figures both for the net GDP impact and for the jobs created all along the supply chain. The study concludes that a shift to low carbon cars and vans increases overall spending on new vehicle technology; a sector in which Europe and the UK excel, and therefore generates positive direct employment impacts. Innovative vehicle technology will play a key role in Powered Light Vehicles, and therefore the same positive mechanisms of job creation can be expected to apply in the case of PLVs.

The UK has significant capabilities in creating lightweight vehicles; from the low-volume, extreme performance of the motorsports sector, to a dedicated motorcycle industry which is distinctly different to the UK automotive industry in its lower volumes, smaller development budgets and faster product development processes. These industries are also supported by a dedicated supply chain, specifically tailored to the demands of smaller vehicle types.

Powered Light Vehicle design and manufacturing is therefore expected to help further develop these industries, potentially creating more sustainable job opportunities that will need to adapt to focus on new priorities and products all along the supply chain and offer opportunities for export.

The UK has an established framework to provide access to funding and support to businesses aspiring to address the sustainable transport issues. National initiatives, including the Research Councils, Innovate UK, the Advanced Propulsion Centre and Local Enterprise Partnerships offer support and funding to promising concepts and offer a route to market. There are also a range of tailored initiatives, such as the Niche Vehicle Network which supports enterprises seeking to establish a low volume approach in their business planning, providing support for supply chain and manufacturing issues.

The scale of economic benefit will very much depend on deploying an appropriate regulatory framework, incorporating Powered Light Vehicles into incentive mechanisms and on the degree of consumer acceptance. However, the scenario with the highest market potential used by the PLVC would be capable of supporting a Powered Light Vehicle manufacturing base of a similar order of magnitude as the motorcycle industry in the UK by 2030. However, further research will be necessary to quantify the economic benefits in more detail to ensure they can most effectively be secured.

Environment

The UK has a long-standing commitment to decarbonising the economy with targets set in the Climate Change Act 2008 and the Energy Act 2013, along with the Road to Zero and Industrial strategies which map out priorities and policies relevant to reducing carbon emissions from transport and seeking low carbon growth. Powered Light Vehicles, with low mass and a small road footprint have the ability to offer energy efficient driving and help reduce congestion and, as such, are a good fit with the UK's carbon reduction and other objectives.

In addition, there is grave concern in the UK's congested cities about how to tackle poor air quality while ensuring mobility is affordable and available to all. Long-term exposure to nitrogen oxides and particulate matter is estimated to cause the equivalent of 9,400 deaths per year and costs the economy in the region of £2 billion p.a. in London alone[7]. It is also found that people living in deprived areas are disproportionately affected by air pollution. Cheaper and cleaner personalised transport, in conjunction with improved public transport, would have the greatest impact on the health and wellbeing of people in these communities. The urgency to tackle this problem has been reinforced in recent years by the High Court's rulings during 2017 and 2018 that further action by the UK Government and others is needed to improve air quality.

As part of the study into Powered Light Vehicles, Queens' University Belfast modelled the impact of a shift away from "Mini" segment M1 cars to smaller, lighter-weight PLVs. The research modelled what the effect on emissions replacing a proportion of passenger cars with PLVs could have and showed how this might reduce the levels of NOx and GHG emissions, from the use of ICE, hybrid and battery electric PLVs. This study was later extended to look at the impact on emissions of replacing a proportion of light

[6] MCIA - Economic Benefits of the UK Motor Cycle Industry 2014
[7] https://www.london.gov.uk/press-releases/mayoral/london-quantifies-health-effects-of-no2
https://www.london.gov.uk/press-releases/mayoral/every-londoner-is-exposed-to-dangerous-toxic-air

Increasing the use of PLVs - what challenges face the UK?

In the car /personal mobility market the displacement of half of the Mini segment car fleet with 2.9m PLV cars would result in a reduction of 4.7m tonnes of CO_2 and 1.3ktonnes of NOx by 2030. In the light commercial vehicle market the displacement of 1.5m light commercial vehicles with PLV commercial vehicles would result in a reduction of 779ktonnes of GHGs and 1.3ktonnes of NOx.

This represents the maximum reduction in emissions based on the assumption that all Powered Light Vehicles will be electrically powered through a UK electricity grid with an increased renewable generation mix. However, there are also significant potential emission reductions even if Powered Light Vehicles use a mixture of ICE, hybrid and battery electric power trains.

The ability to accurately understand the difference in emissions between PLVs, passenger cars and commercial vehicles would help manufacturers, legislators and fleet operators understand the opportunity provided by PLVs to reduce cradle-to-grave emissions.

An important conclusion of the study, therefore, is that a significant adoption of Powered Light Vehicles in the UK would reduce energy consumption, nitrogen-oxide emissions and carbon emissions, particularly if the PLVs were all fully electrified.

It should be noted that the composition of the UK electricity grid, which is becoming progressively decarbonised, has a significant bearing on the 'in-use phase' emissions of all forms of electric vehicles. It is therefore important that appropriate low carbon technologies and power generation sources are implemented if the UK is to continue to progress and reach its greenhouse gas emission reduction targets.

Introducing more PLVs to the UK market would be in line with the Government's commitment to develop low carbon, sustainable urban transport solutions as highlighted in the Road to Zero strategy. With the appropriate use of regulation, industry incentives, consumer incentives and campaigning, Powered Light Vehicles also present an opportunity to complement other 'green' urban initiatives such as Clean Air/Zero Emissions Zones.

However, measuring the impact of substituting conventional passenger and urban delivery vehicles with PLVs, is not a trivial task. Even at a vehicle level, analysing the emissions test cycles and, thus, data comparisons between PLVs, passenger cars and commercial vehicles are complex. At a city level, this is further complicated by other changing factors that may not be readily measurable. Therefore, an approach and set of standards to support a more holistic impact analysis of PLVs introduction on a city, would help accelerate the potential introduction of these vehicles in the UK.

4. Safety considerations

Current safety Regulation 168/2013 which would apply to Powered Light Vehicles does not demand passive crash safety, as required for passenger cars. Some PLV manufacturers voluntarily develop their vehicles to comply with existing passenger car crash standards for various reasons; brand differentiation to attract customers who would otherwise not buy their vehicle etc. Incorporating additional structures to achieve passive safety requirements clearly adds weight, cost and reduces the operational efficiency and environmental performance of a vehicle. However, an appropriate balance needs to be found between safety considerations and other benefits.

The safety of occupants and other road users is, though, critical to any vehicle offering. PLVs offer an option between highly specified 'sit-in' passenger vehicles and fully exposed 'sit-on' PTWs.
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Passive Safety

The technologies associated with minimising injury to vehicle occupants when a collision occurs, is known as passive safety. These include structural energy absorption, seat belts and airbags.

The development of passive safety systems in PLVs globally is quite limited, as current standards do not call for this requirement. In the absence of PLV crash protection regulations, some PLV manufacturers opt to incorporate safety features to provide what they interpret to be adequate safety for urban use and for coherence with their passenger car brand. As an example, Renault incorporated costly crash safety features in their Twizy vehicle.

Introducing crash safety regulations for PLVs is generally expected to improve their public acceptance. Clearly, they will introduce additional cost and weight to PLVs, requiring both novel technical solutions and new business models for the vehicles to be commercially viable.

In addition to PLV safety regulations, a consumer index such as an NCAP rating system specifically for PLVs would also help consumers in their buying or shared use decisions.

Active Safety

The technologies associated with the anticipation and avoidance of collisions are known as active safety systems. This includes lane departure warning, blind-spot warning, forward collision warning and automated braking. The development of active safety systems for the L-Category Powered Light Vehicle market is rapidly growing, with the use of Vehicle-to-Vehicle or Vehicle-to-Infrastructure (V2X) technologies which monitor, warn and take action based on real-time knowledge of other road users and the infrastructure.

The mandatory introduction of active safety systems combined with appropriate requirements for passive safety is expected to minimise the overall crash safety risk to PLV occupants given the vehicle weight and size.

Two types of active safety systems may prove beneficial for PLVs and should be investigated further:
- Forward Collision Warning.
- Autonomous Emergency Braking (AEB).

Studies into generic accident scenarios which could benefit from active safety systems estimate that an AEB system could dramatically improve road safety in Europe:
- Within 3 years: annually save 60 lives and 760 serious casualties.
- Over 10 years: annually save 1,220 lives and 136,000 serious casualties.

Improved safety regulations are required for enclosed "sit-in" L-Category Powered Light Vehicles relating to safety standards, crash test procedures and in the development of active safety systems. This could include: the mandatory use of seatbelts; new regulations regarding safety cell performance; steering column movement and interior head protection; the enhancement of existing functional safety regulations relating to the impact test for pedestrians and funded research for AEB systems specifically for Powered Light Vehicles.

5. Buying/Sharing Decision

Powered Light Vehicles could be part of a fleet of shared vehicles, fleets of commercial cargo vehicles or directly owned by individuals. In each case, whether the vehicles are owned or leased for short or extended periods, there are a few key factors that are expected to influence the decision to use PLVs. These factors include:
- Total Cost of Ownership (TCO)
- Integrated functional design and styling
- Occupant safety
- Convenience (e.g. protection from the weather)
- Environmental benefit

The PLVC conclude that further work is needed to develop data and a deeper understanding of these factors and that innovative technical/commercial solutions will be required. This must take into consideration the technical design requirements associated with safety, functionality, environmental benefit and styling to achieve a compelling alternative to current vehicles used in urban environments.

Beyond the creative engineering, design and business models required to create a compelling case to use PLVs in place of existing vehicles, further work is expected to be necessary for PLVs to be a success. This includes pilot schemes to demonstrate their benefits to consumers and businesses, as well as incentive schemes to accelerate their uptake and to incentivise industry to develop compelling solutions.

One example of a successful pilot programme was undertaken in the USA to understand how light electric vehicles could be used in towns. Consumers were able to trial the vehicles, enabling manufacturers to collect information on consumer preferences. The work helped to drive the evolution of light electric vehicle regulation and the development of new products in the US.

An example of an effective 'green' marketing campaign in the UK is the 'Go Ultra Low' campaign, which has brought together policy makers and manufacturers to promote Ultra Low Emission Vehicles (ULEVs). The 'Best practice principles for environmental claims in automotive marketing to consumers' report produced by the LowCVP, SMMT and ISBA provides guidance for marketing activity on a consistent and acceptable basis.[8]

Aixam Vision

[8] https://www.smmt.co.uk/wp-content/uploads/sites/2/Best-Practice-Principles.pdf

Recommendations

The PLVC conclude that there is potential for the UK to develop a PLV market driven by the need to improve urban air quality, reduce urban congestion and energy consumption. Furthermore, this will create new job opportunities in existing relevant UK businesses.

Key recommendations from the PLVC to facilitate market development of Powered Light Vehicles in the UK:

- **Raise awareness among key stakeholder** - fleet buyers, consumers and policy makers - awareness of the environmental and societal benefits as well as the economic potential offered by L-Category Powered Light Vehicles. Achieve clarity (for consumers) between M1 cars and existing enclosed L-category vehicles, especially with respect to different levels of safety standards and ancillary comforts.

- **Undertake whole life-cycle assessment of Powered Light Vehicles,** so that consumers and legislators have quantitative data regarding the impact of replacing M or N-category cars and vans with Powered Light Vehicles.

- **Make representations at EU level to include Powered Light Vehicles in fleet averages,** to encourage the manufacture and purchase of these vehicles as a replacement for conventional cars.

- **Implement technical R&D projects needed to optimise innovative** new vehicle systems/components for this weight class of vehicle (existing car supply chain components are often too heavy).

- **Conduct end-user research to build on the insights from early adopters** and better understand their needs/desires – e.g. vehicle specifications and retail price targets (including TCO considerations) required to achieve mass adoption.

- **Re-assess the OLEV Plug-In Vehicle Grant eligibility criteria,** which currently covers cars (M1) and vans (N1) and some motorbikes and mopeds, but excludes compact efficient alternatives (e.g. Renault Twizy, SAM EV03; Goupil G4).

The consortium also recognised some key points for further discussion and research, including:

- **DfT along with the Vehicle Certification Agency (VCA) to consult stakeholders on creating a National Small Series Type Approval (NSSTA) for Powered Light Vehicles,** as provided for by EU Regulation 168/2013, to assist small UK companies in entering the market. (Currently only M, N and O category vehicles are supported by NSSTA in the UK).

- **Improve regulatory delineation between open "sit-on" and enclosed "sit-in" L-Category Powered Light Vehicles.** The former (scooters, motorcycles, quadbikes) are already an established market, whereas the latter have neither a clear identity for consumers (e.g. safety standards) nor the best legal framework (e.g. suitable drive cycle / crash test procedures) to flourish.

- **Seatbelt use should be mandatory for "sit in" Powered Light Vehicles** and seatbelt anchor to pass UNECE14.

- **New regulations are needed for:**
  - a minimum safety cell performance: frontal and side impact crash tests performance (appropriate for the class), rollover test, seat with whiplash protection.
  - Steering control movement after impact UNECE 12.
  - Interior head protection to UNECE 21 (1986).

- **Impact test for pedestrians** (enhancement of existing functional safety regulations). Accident research performed on L-Category Powered Light Vehicles to review and amend the initial test proposed for the frontal, lateral and roll-over load cases.

- **Funded research is performed to ensure that future vehicles of all sizes** are able to detect Powered Light Vehicles in their AEB sensing algorithms. Along with funded research in the development of AEB, city, inter-city and pedestrian safety and funded research into the implementation of an integrated safety test protocol of L-Category Powered Light Vehicles.

Appendix

This summary report is an abridged version of the assessments conducted by the individual consortium members over the last few years, which are all available to download from the LowCVP website: www.LowCVP.org.uk/PLV

These reports are not intended as an end in themselves, but instead to act as a spur to action. To build upon the UK's capability in ultra-light automotive engineering and to provide the right conditions which support the market for Powered Light Vehicle uptake.

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