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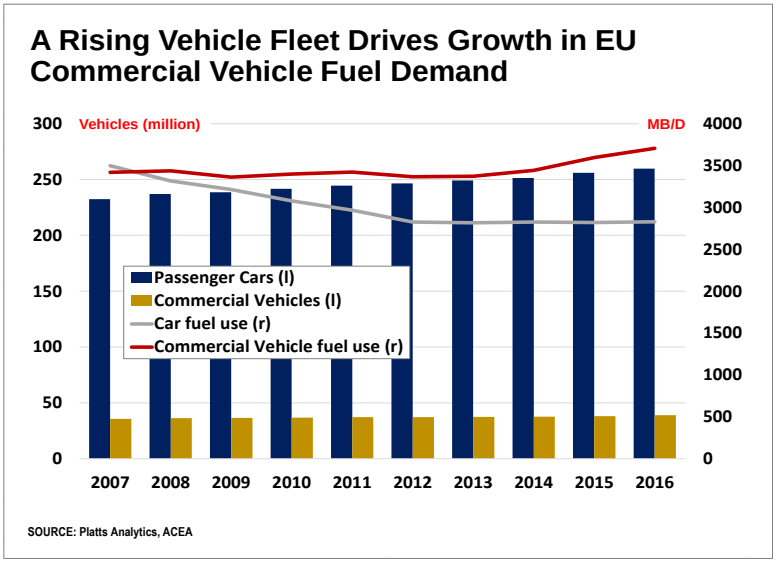
EU e-Bus Adoption: Limited Direct Diesel Impact with Valuable e-HDV Learning

On October 18, the European Parliament's (EP) Environment Committee backed a 35% cut in CO_2 emissions from new heavy-duty vehicles (HDVs) by 2030 - the first CO_2 standard for HDVs in the EU, which currently account for almost one quarter of the bloc's transport-related emissions. In addition to tougher climate targets than those proposed by the European Commission (EC) in May, the EP proposal contains a mandate that 50% and 75% of new urban bus sales must have zero tailpipe emissions by 2025 and 2030 respectively. If passed and ratified, this legislation will mark the beginning of a swift transition in the EU urban bus fleet. This paper analyses the EU bus fleet, evaluates the potential for fuel switching and the implications for traditional petroleum product demand. Based on an estimated EU public transport diesel fleet of 180,000 in 2017, about 80 mb/d of diesel demand is vulnerable to being supplanted by e-buses.

Historic EU Fleet: Light and Heavy-Duty

Rising average fuel efficiency across the European auto market, backed by regulation, is expected to drive light-duty vehicle (LDV) fuel demand declines out to 2030 even as the number of vehicles on the road rises. In our analysis New EU Car/Van Emissions Standards: Implications for Fleets and Fuels, we forecast that EU passenger light-duty vehicle (PLDV) gasoline and diesel demand (ex biofuels) will fall from 1.28 and 1.39 MMB/D respectively in 2016 to 1.14 and 0.97 MMB/D in 2030 (as can be seen in the graphic to the right). This decline will be partially offset, in our current forecasts, by fuel demand growth in the European HDV segment, where fuel efficiency has remained relatively stable over the last decade, even while commercial vehicle numbers (buses, trucks and vans) have risen by just over 1% a year.



However, oil demand growth in the European HDV sector will be challenged by a number of factors. Two salient drivers are a growing stringency of emissions standards and e-bus electrification.

- Legislative efforts by the EC were announced this May for CO2 emissions standards for new HDVs. These propose a mandatory 15% emissions reduction on 2019 levels by 2025 on large trucks, extending to other HDVs in 2022, and a 30% emissions reduction by 2030 for all HDVs. Improved fuel efficiency is the primary means of reducing carbon emissions, although alternative fuels and drivetrains do exist. Late Oct, the EP proposed more stringent targets of 20% and 35% reductions by 2025 and 2030 respectively.
- In 2017, new sales of e-buses with a GVW above 8 tons in Europe totalled 1,246, of which 85% were all electric. This was more than twice the 530 ordered the year prior.

One potential implication of these efforts is that Europe's HDV sector will undergo a process similar to that of the LDV sector; fuel demand will start to fall even as the number of vehicles continues to rise.

Modest beginnings

The rise in Chinese electric bus sales took the world by surprise. By end-2017, as cumulative sales of pure electric and plug-in hybrid buses surpassed 350,000, e-buses on Chinese roads were displacing as much fuel demand as the world's entire electric passenger car fleet. European cities are also moving to large-scale e-bus deployment. Some capitals have ambitious all-electric targets, generally in the 2025-2030 timeframe. Many second-tier cities have similar goals. E-buses are gaining favor in new bus purchases over former investment in biofuels, and are supplanting diesel-hybrid engines relatively quickly. E-buses accounted for 10% of new European bus sales in 2017, compared with just 1.3% for EVs in the passenger car market. However, there are far fewer urban transit buses in Europe than in China. E-bus purchases are largely replacing older diesels at end of life, but the short-term impact on oil demand is small. The significance of EU e-bus adoption is not the function of short-term fuel demand displacement, but the potential application of this experience to the wider HDV market; and not all of this experience may prove positive.

As in China, the initial focus in Europe is on urban transit buses. Europe is no stranger to electric urban transport; electric tram systems are common in major cities and have been in use for more than a century. In some cases, cities are integrating e-buses with existing infrastructure, using battery-enhanced trams to extend the range of the tram system, or overhead cables (catenary lines) to charge e-buses.

However, the existence of trams and other mass transit systems such as underground rail mean Europe's petroleum-fuelled urban bus fleet is relatively small. The European Automobile Manufacturers Association (ACEA) puts the total number of buses in the EU at about 890,000 (2017), which includes coaches and mini-buses. The EU's Declaration of intent on promoting large-scale deployment of clean, alternatively fuelled buses in Europe estimates the number of EU public transport buses at 200,000, citing Union Internationale des Transports Publics (UITP) figures, of which about 20,000 are alternatively-fueled, primarily by biodiesel and CNG, with over 2,000 e-buses in operation.

Transport for London (TfL), which runs a fleet of nearly 10,000 buses, cites average efficiency for its diesel buses at 53.3l/100km (4.4 US mpg), with performance of about 98% in terms of miles operated. Data on electric buses for 87 European cities suggests average mileage of 111 miles a day per bus. Based on an EU public transport diesel fleet of 180,000, this implies a figure of about 80 mb/d of diesel demand that could be supplanted by e-buses.

The EC Clean Bus Deployment Initiative is at this point concentrating on 1) public declarations of goals by cities and manufacturers, 2) creating deployment platform for organization and information exchange, and 3) creation of an expert group. It has a target of 30% of urban bus transport to be provided by clean buses by 2025.[1]

Clean buses are defined by the International Association of Public Transport as representing a mix of Euro VI standard conventional and hybrid engines, electric buses and alternatively fuelled buses. Many individual European city targets -- Paris, Madrid, Oslo and Athens -- are more ambitious, seeking to eliminate diesel engines by 2025, while others will stop new diesel bus purchases from this point or earlier.

Based on the 30% target, potential diesel demand displacement would be about 26.5 mb/d, if all 'clean' buses were non-diesel. In reality, some will be Euro VI standard conventional and hybrid engines. Equally, some cities may exceed the 30% target. This has to be set within the context of the overall commercial transport sector. In addition to the 890,000 total for buses, which includes coaches and minibuses, ACEA says there are 6.5 million trucks and 29 million light commercial vans circulating on EU roads.

Key drivers

Momentum behind urban e-bus adoption is stronger than for other sectors of the commercial vehicle fleet for a number of reasons:

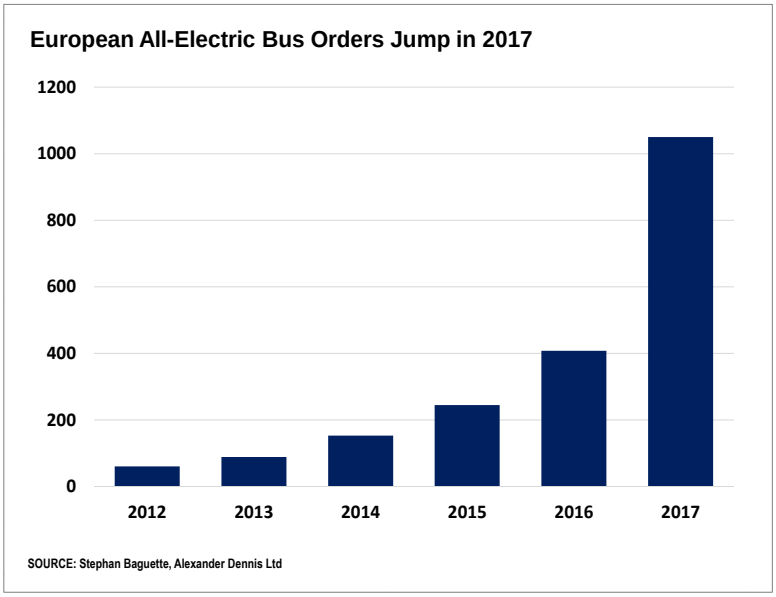
- European cities often fail to meet air quality standards. Polls indicate that there is strong public support for more stringent standards, and governments face a rising number of lawsuits over air quality from NGOs. The European Commission gave final warnings on air quality standards in 2017 to France, Germany, Italy, Spain and the UK, which may face infringement rulings in the European Court of Justice. Whether e-buses are genuinely zero emission depends on the electricity source, but the real adoption motivator is reduced road-side emissions.
- Mayoral and city government powers allow stronger fuel emissions regulation within cities than nationally. This is leading to a proliferation of low emissions zones in European cities and zero emissions targets.
- Most urban bus fleets in Europe are publicly or quasi-publicly owned. City government can therefore directly influence purchasing decisions.

[1] Declaration of Intent on Promoting Large-scale Deployment of Alt-fueled Buses in Europe

- State actors have access to low-cost financing, enabling them to take on the higher investment cost of EVs in pursuit of lower total lifetime costs.

These factors differentiate urban transit bus electrification from commercial goods deliveries. In addition, as bus routes are well defined, terminals and bus stops provide significant scope for opportunity charging. This extends daily range, which in turn improves the financial viability of electrification. The regular starts and stops of urban buses also allow for better operational economics vs. ICE engines that may often be idling or operating at lower efficiencies due to the need for frequent stops and acceleration.

Of the new European e-bus sales in 2017, about 60% opted for overhead charging, which is the system most amenable to opportunity charging, while the remainder were plug-in. Off-shift depot charging is currently the norm, but a shift to opportunity charging seems to be taking place. Pantographs – commonly used on trams -- create an electrical connection on top of the bus, facilitating recharging at terminals or bus stops without additional intervention by the driver.



Step-change in orders

All-electric bus orders in Europe have been steadily on the rise since 2012. Orders for pure electric buses by year can be seen in the graphic to the right. There are now 12 European e-bus manufacturers, indicating the growing supply chain. Based on 2017 sales and orders, China's BYD leads the field in conjunction with the UK's ADL, followed by Poland's Solaris, Dutch VDL and Sweden's Volvo. Germany's Siemens is the largest supplier of electrical systems, followed by BYD, Medcom and Volvo.

In March, 100 e-buses were deployed on the Amstelland-Meerlanden public transit route, serving the Netherlands' Schiphol airport, the eleventh busiest in the world. This route is expected to have 400 e-buses by 2021, making it 90% electric.

TfL in July ordered 68 new all-electric buses, including 21 of the city's iconic red double deckers. It aims to have 240 e-buses in operation by 2019 with all new double deckers to be hybrid or zero emission. All single deck buses are to be zero emission by 2020.

At the start of 2018, France's Ile-de-France Mobilites and RATP – both state organizations – ordered 250 e-buses under a two-year contract that could number 1,000 e-buses in total. First delivery is expected in 2020, with the aim of making the 4,700 bus fleet in Paris and surrounding region two-thirds electric and one third biogas by 2025. Like TfL, this decision followed e-buses trials in 2016. Unlike TfL, it appears to drop diesel hybrid buses as a long-term option.

Poland is funding an ambitious e-mobility public transport transition via its National Centre for Research and Development (NCRD), an executive agency of the Ministry of Science and Higher Education. The program could see more than 1,000 e-buses in operation. Poland's Medcom/Solaris is developing as a leading e-bus and system provider. Warsaw ordered 130 e-buses in 2017 for operation in 2021 with over 40% of the cost being financed by the EU. Katowice has ordered 300 e-buses, 30% of its fleet, for operation in 2023, 85% financed by the NCRD.

In addition to these high profile orders, the adoption of e-buses is becoming wider across European urban and suburban areas, supported by state finance. 13 European states already have e-bus fleets of 50 or more and e-buses are present in more than 80 European cities. In addition, 13 EU cities committed to procuring only zero-emissions buses post 2025 by joining the C40 Climate Leadership Group held in CA in Sept. 2018.

Wider implications

- Global bus market. The e-bus phenomenon is by no means restricted to China and Europe, and e-buses appear a relatively quick and cheap means of addressing the connected issues of urban mobility needs and air standards, compared with the costs and delivery timeframe of other types of urban mass transit systems. Europe is estimated to account for just 5% of new bus sales globally, with growth in hybrid and electric bus powertrains expected to be much higher in developing countries.

- Average HDV fuel economy. Although urban transit buses are a small part of the overall European HDV market, rapid electrification could start a rising trend in average HDV fuel efficiency, given its stability over the last decade. In combination with the likely spread of CO_2 emissions regulations, first at city level then nationally -- or as in the EU bloc-wide -- fuel demand from the HDV sector could gradually turn from growth area to neutral.

Learning curve. Lessons learnt from large-scale e-bus deployment will filter through to other stop-start route-based transport activities, for example refuse trucks, which are already a focus of electric power train manufacturers such as BYD. The experience may not be all positive: there is some evidence that heavier electric vehicles result in higher particulate emissions from more intensive tyre wear and road surface use. Moreover, the lithium-iron-phosphate battery technology that has dominated e-bus sales in China is not thought to be suitable for electric trucks. These will require further technological gains in alternative battery materials.

Nonetheless, the experience of mass e-bus deployment, particularly with regard to recharging systems, will provide valuable learning, which could spread outside of the municipal sector to light commercial deliveries, while opportunity and fast-charging, alongside battery range extensions, could see electrification make inroads into the motor coach segment over the next decade.

For the moment, we project that the impact on European diesel displacement of the uptake in electric buses to be relatively minor, rising to around 26 mb/d by 2025.

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