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ABOUT THE AUTHOR

**David Fowler** is a freelance business and

echnology journalist. He was editor of

*Transport Times* magazine from 2007 to 2017 and now contributes to a range of

echnology- and transport-related titles

one of the most difficult issues to solve.

road transport must get to zero carbon.

One fundamental point is clear, however:

Certainly, cars and vans will be there within

the next decade following the Government

announcement that the ban on sales of new

petrol and diesel models will be brought for-

ward to 2030, with plug-in hybrids banned

Greg Archer, UK director of campaign

group Transport & Environment, says:

"The reality is that if we're going to achieve

the overall target of zero emissions (for the

whole economy), vehicles - cars, vans, buses

and trucks - must become zero, because

other sectors such as aviation, shipping and

For most vehicles, the clearest route to decarbonisation is a switch to electric, a

process that will need to run in parallel with

Brian Robinson, LowCVP commercial

vehicles emissions consultant, says: "Our

general view is that electrification in one

form or another - fuel cells, battery electric,

or electric road systems - is clearly the long-

term answer for any road vehicle. What we

mean by long-term varies according to the

For many years, limitations of battery

technology meant electric vehicles (EVs)

could not match the range or payload of

their fossil fuel equivalents. Now, following

battery advances, industry watchers expect

a dramatic surge in the number of battery-

powered light commercial vehicles on UK

roads - typically used for parcel delivery vans,

for last mile deliveries and by traders - over

And there is an emerging consensus that

the next 12-to-18 months.

combination of use and type of vehicle."

agriculture are much more difficult."

the decarbonisation of electricity.

from 2035

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ecarbonisation of heavy road vehi-

cles, including trucks of all sizes,

buses and coaches, refuse trucks

and the like, has long been seen as

next few years. For heavier and long-distance trucks, the picture remains mixed, with a number of competing fuels and technologies, and there is likely to be a need for governments to set a direction and for international consensus. Along the route to full decarbonisation, many other drivetrain options or fuels will

have a role, from internal combustion/battery hybrids and plug-in hybrids to zero-emission fuels such as biodiesel and biomethane. EVs are only zero-carbon if the electricity used to charge their batteries or extract hydrogen to power fuel cells is also decarbonised. So, "electricity generation must become 100% renewable", Archer says, adding: "It's on a good trajectory now to achieve decarbonisation by 2050.

Contracts for Difference scheme. "The pace of change is astonishing," Archer says. "It's down to the fact that renewables are now the cheapest form of electricity. We've reached the tipping point." For light vans (up to 3.5-tonnes), trials have

of availability.

Archer adds: "For cars there are quite strong CO<sub>2</sub> targets that manufacturers have to meet. For vans, the targets are much less ambitious, but they're just as viable."

The uptake of electric vans is likely to be transformed in the near future, with large orders in the pipeline for organisations such as British Gas and UPS. "Urban delivery trucks – up to 16-tonnes – can also be electrified, using batteries," continues Archer. "The price of batteries is falling quickly. Most of these trucks don't do vast mileages and can complete a daily cycle."

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# **FUELS FOR** INDUSTRY HEAVYWEIGHTS

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Electricity is often the first solution that comes to mind when considering how to reduce air pollution generated by road transport. But it is not practical in every instance, reports David Fowler

28 ISSUE 8 • NOVEMBER 2020

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electrification of the lower end of the heavy goods vehicle range - delivery trucks of up to 18-tonnes – will be a viable prospect in the

There has been "phenomenal uptake" of renewable generation over the past few years, following policies such as the Government's

shown battery electric vehicles (BEVs) can be viable, but take-up has been limited by lack

#### **BIG ORDERS FOR ELECTRIC VANS**

They then return to a depot for recharging

The same is true for buses, which also run

over a fixed route and can recharge at the depot or at the end of the route. Before the coronavirus pandemic, buses were moving faster than any market segment to battery electric, he adds, reaching 9% of the market.

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LowCVP's Robinson adds: "Urban bus duty cycles are basically similar to urban delivery heavy goods vehicles (HGVs), but the fixed nature of their routes and stopping points makes them well suited to opportunity charging en route, particularly at the ends of routes while the driver has a break."

Opportunity charging is more likely to be needed because buses have additional drains on their power, such as for heating and ventilation

"You don't need to increase the battery size to cover the extra ancillary loads, but you do need a bit more infrastructure than just at the depot for charging," says Robinson.

For the regional delivery sector, with trucks typically carrying 16-24 tons for around 100 miles between depots, Archer says they, too, could be electrified with battery power, but would require battery charging infrastructure at the places they call on daily.

To be efficient they would have to be fast charged, so some investment in infrastructure would be needed. "It's challenging: some upgrading to the local distribution grid would be needed, but it's not insurmountable," Robinson says.

He does not see hydrogen as a viable option for this segment because, overall, the efficiency of using electricity to make hydrogen using electrolysis rather than using it directly to charge batteries is much lower - about 30% at the wheel compared with around 75%.

"You will need an enormous amount of renewables," he says. "We need to use renewables sparingly and efficiently. We are at the same time trying to decarbonise the arid.'

For long haul there are three credible options. First, electric trucks with very large batteries, exemplified by the Tesla Semi. The weight of the batteries will have an impact on payloads, and they will need to be fastcharged at intervals.

Although trucks have to stop regularly



### **INSIGHT: ALTERNATIVE FUELS**

▶ (for 45 minutes after every 4.5 hours of driving under European tachograph rules), 

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this would represent a big demand on the grid, needing high voltage electricity. The second option is electric road systems or e-highways, using an overhead catenary wire or possibly inductive charg-

ing on the inside lanes of motorways to top  $\sim$ up trucks as they go. The wires would not have to be continuous because trucks would still have batteries for operating away from motorways and in city centres.

The third option, favoured by many, is hydrogen, to be used in fuel cells to generate electricity to drive an electric motor.

"The problem remains about making the hydrogen," says Archer. To power all trucks in the UK over 16-tonnes using hydrogen would equate to electricity demand of 86TWh (26% of annual UK generation in 2019), compared with 40.2TWh using electricity directly (to charge batteries or in e-highways).

Robinson believes the key decision for long haul is between catenaries and hydrogen. He adds: "As an engineer I'd go for the one that's a lot more efficient" – that is, e-highways. "It's a very fundamentally energy efficient way of doing it," he says.

And building the catenaries should not be as problematic as electrifying rail has been. For roads, the power requirement is lower, and because the system does not need to be continuous, difficult and expensive sections can be missed out. Moreover, the difficulties with rail electrification have been mainly political and structural rather than technical.

#### LET THE MARKET DECIDE

The final decision might be a case of letting the market decide, he suggests, adding that trials are likely to be needed to inform a decision: "I'm not sure we're at the point to decide which is the right answer."

Another possible option under consideration is synthetic diesel, made from CO2 either from the atmosphere or captured from industrial processes such as cement works and combined with hydrogen. However, this is less efficient than using hydrogen in a fuel cell and the overall efficiency is only around 13% at the wheel, so even larger quantities of electricity would be needed. Archer believes that if there is a role for such synthetic fuel it is likely to be mainly for aviation



#### European Hvdrogen Backbone Source: https://

gasforclimate 2050.eu/

Total cost

of ownership

(TCO) trajectory

of trucks up to

2050

LowCVP's Robinson argues that in the transition period there will be an important role for biomethane and hydrotreated vegetable oil. HVO is a high quality diesel, manufactured by companies such as Neste Oil, Eni and Total, and is formed by reacting waste vegetable oil with hydrogen.

Biomethane from anaerobic digestion

of waste is another possible zero emission

fuel. "It's a good fuel, but, if made from waste,

there's a limit to how much you can make,"

he says.

The resulting product is a hydrocarbon which can be used as a direct replacement for diesel, unlike traditional biodiesel, which is made by a different process and can only be blended with fossil diesel to a maximum concentration of 7%

Some have questioned the sustainability of the feedstocks used in HVO, which include palm oil. Neste claims that "sustainablyproduced, 100% certified and 100% traceable palm oil is part of Neste's extensive portfolio of renewable raw materials"

It adds: "We expect conventional vegetable oils demand to be replaced entirely by waste and residues by 2025. In recent years, palm oil has accounted for approximately 20% of our annual renewable raw material inputs." In the case of biomethane it can be argued, Robinson adds, that if methane is captured that would otherwise have been released into the atmosphere, the process is carbonnegative, because methane is more powerful greenhouse gas than carbon dioxide.

The drawback is that all these fuels are used in combustion engines and, therefore, still release pollutant emissions from the tailpipe (even though this is at a low level for Euro VI engines).

Archer summarises Transport & Environment's view: "Which of the options

# The role of hydrogen

Hydrogen Europe represents 185 industry members and 25 national hydrogen association and promotes the use of hydrogen in the EU.

Sabrine Skiker, EU policy manager for land transport at the organisation, says: "There is common agreement by stakeholders and the European Commission that hydrogen will play a crucial role in long haul, where battery will not do the trick."

But it also has a role in urban delivery, for buses and other sectors. Battery EVs are starting to be used in city centres where a 60-mile daily range is sufficient. "Out of the city centre, for inter-city and suburban buses, hydrogen starts to play a key role," she says.

The use of hydrogen fuel cells allows the range to be extended up to 250 miles as well as more flexible operations where routes are not fixed, with refuelling taking only 10-12 minutes.

An example is Cologne, where in the city centre operator KVB uses battery buses, while in the suburbs RVK is using 35 Van Hool A 330 FC fuel cell buses (to be increased to 50).

Portuguese manufacturer Caetano recently launched a fuel cell bus, the H2.City Gold. It is available in 10-metre and 12-metre versions and is powered by the same fuel cell stack as the Toyota Mirai passenger car.

The same logic applies to urban delivery. Groupe

will emerge for the long-haul trucking sector is still not clear. It will require international agreement to ensure we have compatible infrastructure across the EU and UK, and don't end up with different systems in different countries. Our view is that we need to be doing some trials to evaluate internationally."

In the meantime he argues attention should be on urban and regional deliveries. His 'to do' list includes:

- Regulate the truck manufacturing industry, as in the car industry, to require it to be selling an increasing number of zeroemission urban and regional delivery trucks every year.
- Provide powerful incentives to make electric trucks cheaper to use than diesel, to help businesses make the transition (with distance-based charging for diesel trucks). Provide assistance for installing the

TCO for trucks USD/ton per km LCV for urban MDT for regio 0.22 0.22 0.20 0.20 3,18 0.18 0.16 0.16 0.14 0.12 0.12 0.10 0.10 0.08 0.0 0.05 0.06 0.04 0.04 0.02

worrying," Skiker says.



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Vauxhall Vivaro next year. Renault has launched fuel cell range-extended versions of the Kangoo hydrogen version of its Crafter van.

"They are using this option because of operational flexibility and payload, and to make sure you can drive using the air-conditioning in summer without

Hydrogen Europe's view is that the advent of mobility as a service (MaaS) and automation means vehicles will be used more intensively, and, in the case of automated vehicles, the need for constant connectivity and the use of artificial intelligence in guidance systems will require a lot of energy, bringing hydrogen into the picture.

Skiker stresses that Hydrogen Europe sees fuel cell and battery technology as complementary. "We don't see this as a battle," she says. "We see huge developments in batteries, but there will be applications where battery won't be sufficient."

Fuel cells are now considered technically mature, but work is needed to bring the costs down. However, in January, the Hydrogen Council predicted cost parity between fuel cell and diesel for heavy-duty trucks would be reached by 2030.

The European Commission's hydrogen strategy sets ambitious targets of installing 6GW

HDT for long-haul

0.22

0.20

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0.14

0.12

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PSA has announced it will launch hydrogen of renewable hydrogen electrolysers by 2024 versions of the Peugeot Expert, Citroën Jumpy and and 40GW by 2030, equating to 1Mt renewable hydrogen by 2024 and 10Mt by 2030.

Skiker says production of hydrogen will go handand Master, and Volkswagen is developing a in-hand with increases in renewable generation renewables are intermittent and hydrogen will be used as a seasonal energy storage medium. "Hydrogen is an enabler," she says.

> Regarding infrastructure, it could be transported in liquid form, but is also likely to be produced on site by locating electrolysing plants next to renewable generation.

> There is also a proposal, by 11 European gas infrastructure companies from nine countries, to refurbish the existing natural gas pipe network (since natural gas will be phased out) as a 'Hydrogen Backbone' across Europe.

> With the European Alternative Fuel Infrastructure Directive coming up for revision in 2021, Skiker says: "We need to make certain we have enough incentives for member states to invest in hydrogen."

It has made 10 recommendations, such as including hydrogen in the list of mandatory fuels, exploring synergies between the TEN-T (Trans-European Transport Network) and the TEN-E (Trans-European Networks for Energy), and creating a regulatory framework to encourage the expansion of a hydrogen refuelling station network across Europe.

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Cost build-up

60% Just and Infrastructur

20% Non-











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## The view of trade associations

In its Vision for Decarbonising Road Freight document, the Road out what it believes is needed to bring about fundamental change, including "clear rules" to support investment.

It sets out a hierarchy of eliminate - minimise - offset. This means eliminating carbon emissions from freight movements where possible; where this is not practical, minimising carbon emissions, and offsetting any

> charging infrastructure needed at depots for delivery vehicles (currently the full cost

• Set a date by which full electric vehicle

"There's a massive amount we can do

today on the shift towards zero emissions for

urban and regional deliveries," he says. "It's

clear that battery electric will be the solution.

The focus for the next 15 years is to get large

numbers (of trucks) out on the road. We can make really rapid progress. But, if we want to

decarbonise transport fully by 2050 and stop

selling diesel trucks by the mid-2030s, we

How far is this translating into practical

Truck maker Daf has around a dozen fully

need to move very quickly."

action?

**REAL WORLD EXPERIENCE** 

has to be borne by the customer).

delivery will be required in cities.

been eliminated. It calls on the environment include working Government to work with industry Haulage Association (RHA) sets to "commit as soon as possible to creating a freight transport decarbonisation road map"

> give hauliers and their customers confidence to invest in zerocarbon measures by removing the concern that the regulatory framework could "retrospectively undermine that investment"

Logistics UK, formerly the Freight Transport Association, remaining emissions that have not says its priorities for the

with the Government to provide a definition of an ultra-low emission truck, to encourage the development of ultra-low This is essential, the RHA says, to technologies, and to provide a central standard for local authorities looking to go beyond the clean air zone standards. It also calls for a definition of

ultra-low smission fuels, support for alternative fuels, support for larger capacity vehicles, and investment in rail and water freight to encourage model shift.

the cost

premium for

HVO compared

with fossil

diesel

electric versions of its CF truck undertaking field trials with customers in real operations to accumulate experience. It is commercially available for sale in some markets in continental Europe, but at low levels of production.

"We see this continuing to grow at a relatively low level," says Daf Trucks marketing manager Phil Moon, adding that quite a high level of product development is continuing. Recently, changing to a new battery supplier doubled the range to around 125 miles while cutting the weight by 700kg.

A big spike in demand is expected by 2025, Moon adds, because the mayors of a number of capital cities are planning to introduce zero emission zones by then, while European legislation on carbon reduction targets for manufacturers will influence vehicle design.

Though the ability to cover the daily duty cycle of an urban delivery vehicle based in or on the periphery of an urban area is now feasible, for longer distance and heavier vehicles he believes either internal combustion/ electric hybrids or plug-in hybrids will have a role, operating in zero emission mode (with geofencing) in urban areas and using the internal combustion engine for the longer distance, higher speed out of town parts of the journey.

As part of Paccar, Daf is working on a project to produce fuel-cell powered Kenworth trucks in the US, using a Toyota fuel cell and with Shell providing the hydrogen.

But Moon believes government investment will be needed to create the hydrogen supply infrastructure. E-highways require even more infrastructure, he argues, and are a long way from fruition.

Meanwhile, Daf is looking at renewable alternatives to diesel and is particularly keen on HVO over gas alternatives, because it can be used in a standard diesel engine whereas gas fuels need a spark-injection engine.

However, HVO comes with a 10% cost premium over fossil diesel and is supplied > mainly by bulk delivery. Nevertheless, Hovis plans to extend HVO to its whole fleet. It is also used by a number of councils.

"We would like to see more interest in HVO from the Government and for incentives to be provided such as duty reduction," Moon says. There is frustration that arguably less

advantageous gaseous fuels benefit from duty reductions. An opportunity to change this in last year's duty review was missed.

On the question of hydrogen versus e-highways, he hopes the Government's decarbonisation plan, expected soon or early next year, will provide more clarity. Adopting new technologies is a challenge for fleet managers who work on five-year replacement cycles and want to avoid ending up with a mixed fleet. Manufacturers, too, need a steer over future direction so they can respond.

DHL's Supply Chain business runs 35,000 heavy freight vehicles, from articulated trucks including branded fleets for supermarket customers travelling mainly on motorways between distribution centres, to smaller trucks delivering to customers such as Boots, Marks & Spencer and convenience stores on the high street.

Parent company Deutsche Post says DHL's strategy to 2025 sets a target that 70% of its first- and last-mile operations are operated



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"Urban deliveries is where we see in the short-term the solution is more likely to be based around electrification," says lan Clough, managing director for transport for DHL Supply Chain in the UK and Ireland. "It's a much better fit with our business – the distance the vehicles have to travel allows us to consider EVs."

The biggest challenge to the

transition to EVs is now

infrastructure. Range

anxiety has been and gone

JON LAWES, HITACHI CAPITAL VEHICLE

SOLUTIONS 31

By Christmas, it hopes to have an all-electric 16-tonne rigid Volvo FL 4x2 truck on the road, one of only 50 produced for Europe and the only one in the UK.

It is expected to have a range of 50-60 miles and will be charged overnight at the depot. It will operate in London as part of the regular delivery fleet and will allow the company to evaluate operational details such as what driver training needs will be, how to manage charging and so on.

For large articulated trucks, Clough says: "Our approach is to move into gas. We would like to move to bio-LNG, but the availability is severely limited. We aim to have around 5,000 gas vehicles on the fleet by 2025 and we'll continue to progress down that route."

The company would like to see Government incentives to support the transition and give confidence to invest over a 10-year time horizon.

Hitachi Capital Vehicle Solutions leases all types of vehicles to a range of customers. Jon Lawes, managing director, says he expected during the on-going Covid-19 crisis that "the electrification agenda would go on to the back burner, but it's accelerated", perhaps, he thinks, because of people experiencing cleaner, quieter city centres during the pandemic.

He expects cars and light vans to make the transition to electric quickly. The company has ordered 1,000 e-Vivaro vans for British Gas, due to come into service by mid-2021,

HCVS is a participant in the Ofgem-backed Optimise Prime trial to study the impact of EVs on power networks. Billed as the world's largest commercial EV trial, it is using telematics to collect comprehensive data on charging activity of up to 3,000 vehicles under different regimes: charging at home (with Centrica); depot charging (with Royal Mail); and opportunity charging (with Uber). Its aim is to come to "a comprehensive understanding of the impact that electrification of commercial vehicles will have on distribution networks" and "explore opportunities to minimise this impact". Meanwhile, HCVS recently launched Intelligent Fleet Decarbonisation, which employs two software packages and offers

companies a turnkey solution to switching to net zero. It provides support for customers in building a business case for fleet electrification, taking into account vehicle sourcing and financing options, the size and age of the existing fleet, and the suitability of the depot

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the largest EV order for a commercial fleet in the UK. It also has a pure electric refuse truck on order for another customer. Refuse trucks are low speed, low mileage vehicles and on one level would appear an obvious candidate for electrification, but also have other significant power demands such as for waste compaction and lifting bins.

Lawes says: "It's amazing because of the amount of moving parts in refuse trucks. If they can be electrified, it's getting there."

There is still a considerable price premium, but Lawes says HCVS is keen to work with customers to encourage the adoption of new technology.

The total cost of ownership (TCO) model, he says, now works in favour of electric cars and light vans.

"Last mile will go EV very quickly," he says. "Small vans are there, such as the Nissan ENV, the Vivaro and their Peugeot and Citroën equivalents.'

He adds: "In 12-18 months, large panel vans will become a lot more affordable, the model will work."

For the electric truck market, the TCO model for does not stack up yet, but "the economics will get there"

#### **OPTIMISE PRIME**

for conversion including requirements for grid infrastructure.

"The biggest challenge to the transition to EVs is now infrastructure," says Lawes. "Range anxiety has been and gone."

Luke Wake, international director of automotive engineering and advanced technology at UPS, says: "Over the past two-to-three years, battery technology has advanced to the point where the cost model for EVs for the last mile makes it our preferred use case."

He says UPS is "agnostic" about technology but it needs to be viable at scale. "We fit it into our operations rather than change operations to fit the technology, which is less efficient and more difficult to scale.

UPS has collaborated over the past three years with UK manufacturer Arrival and is buying 10,000 electric vans designed to its specification for Europe and North America.

For more rural applications, but still light or medium duty, the company sees rangeextended EVs as most appropriate for covering the additional stem mileage from the depot, but capable of operating in zero emission mode in city centres.

Natural gas is seen as a transitional fuel, with air quality benefits.

Lawes argues that, with gas, it is easier to change from fossil fuels to renewables than with diesel. UPS currently favours this approach for long-haul – what happens in the future will depend on how far battery technology develops. However, it has ordered 125 battery electric Tesla Semis for the US. Hydrogen fuel cells are also a potential solution, dependent on developments.

UPS recently led the Smart Electric Urban Logistics project with UK Power Networks and the Cross River Partnership, with funding from the Office for Low Emission Vehicles. Its Kentish Town depot in north London needed to boost EV charging capacity. The depot had previously had an expensive grid upgrade to increase capacity, but hit a limit at 657.5-tonne vehicles.

The trial showed that, by using a smart grid algorithm to spread demand, coupled with on-site energy storage batteries, all 170 vehicles could be charged overnight. UPS will now study how demand can be optimised over a wider area of the grid. 🛐

