Impacts on the Supply Chain

Contents

Abbreviations

The following is a list of abbreviations and associated definitions for terms appearing throughout this document:

Abbreviation	Definition
BET	Battery Electric Truck
CET	Catenary Electric Truck
EU	European Union
ERS	Electric Road System
FCET	(Hydrogen) Fuel Cell Electric Truck
Fuel Cell	A device that reacts stored hydrogen with oxygen from the air to provide electrical power
ICE	Internal Combustion Engine
HDV	Heavy Duty Vehicle – road vehicle over 3.5T, e.g. HGV, buses, coaches and 'vocational' vehicles such as gritters, refuse collection vehicles
HGV	Heavy Goods Vehicle
LCF	Low Carbon Fuels
OEM	Original Equipment Manufacturers
PEMD	Power Electronics, Motors and Drives
R&D	Research and Development
UK	United Kingdom
ULEV	Ultra Low Emission Vehicle
ZET	Zero Emission Truck

1 Introduction

1.1 Purpose of this paper

The purpose of this paper is to provide the Taskforce with an overview of key elements of the vehicle supply chain and issues over the vehicle lifetime that are critical to HGV decarbonisation.

The HGV supply chain and use landscape can be considered as a number of stages from manufacture to end of life as presented in Figure 1 for HDVs.

This paper focuses on HGVs and covers the impact of producing Battery Electric Trucks (BETs) and Hydrogen Fuel Cell Trucks (FCETs) on:

- the vehicle production process - the manufacture of parts, components, systems and fuels, vehicle manufacture and conversion; and
- vehicle maintenance and end of life.

Implications for Scottish firms and institutions are also drawn out.

The focus of the paper is on the impact of shifting to ZETs on the vehicle supply chain rather than on current supply chain issues relating to other external factors.

The impact on skills will be covered in a separate paper by Transport Scotland.

The Taskforce is asked to consider how can we maximise the involvement of Scottish suppliers and Scottish R&D in the design and development of any trials.

Where do OEMs see most potential for Scottish firms adding value?
How can operators make best use of local expertise?

1.2 Definitions and assumptions

Four main types of vehicle powertrain technologies are expected to contribute to the pathway to zero emission trucks – Battery Electric Trucks (BETs), Hydrogen Fuel Cell Trucks (FCETs), Catenary Electric Trucks (CETs) and Low Carbon Fuels (LCFs). The literature review did not reveal information on the impact of CETs and LCFs so these technologies are not covered in this paper. In the case of CETs, effects on the vehicle supply chain are expected to be similar to BETs. LCFs are likely to require minor modifications when compared to BETs and FCETs.

The supply chain for ZET production is defined as follows[1]:

- OEMs – manufacturing and integrating different components and systems into the final vehicle;
- Tier 1 suppliers – providing integrated systems such as powertrains, fuel cells, battery packs, etc.;
- Wider supply chain – comprising manufacturers and suppliers of components and systems, including mechanical, electronic, electrical, energy, thermal management, and software components and systems, as well as engineering firms.

[1] Based on definitions used in Optimat study.

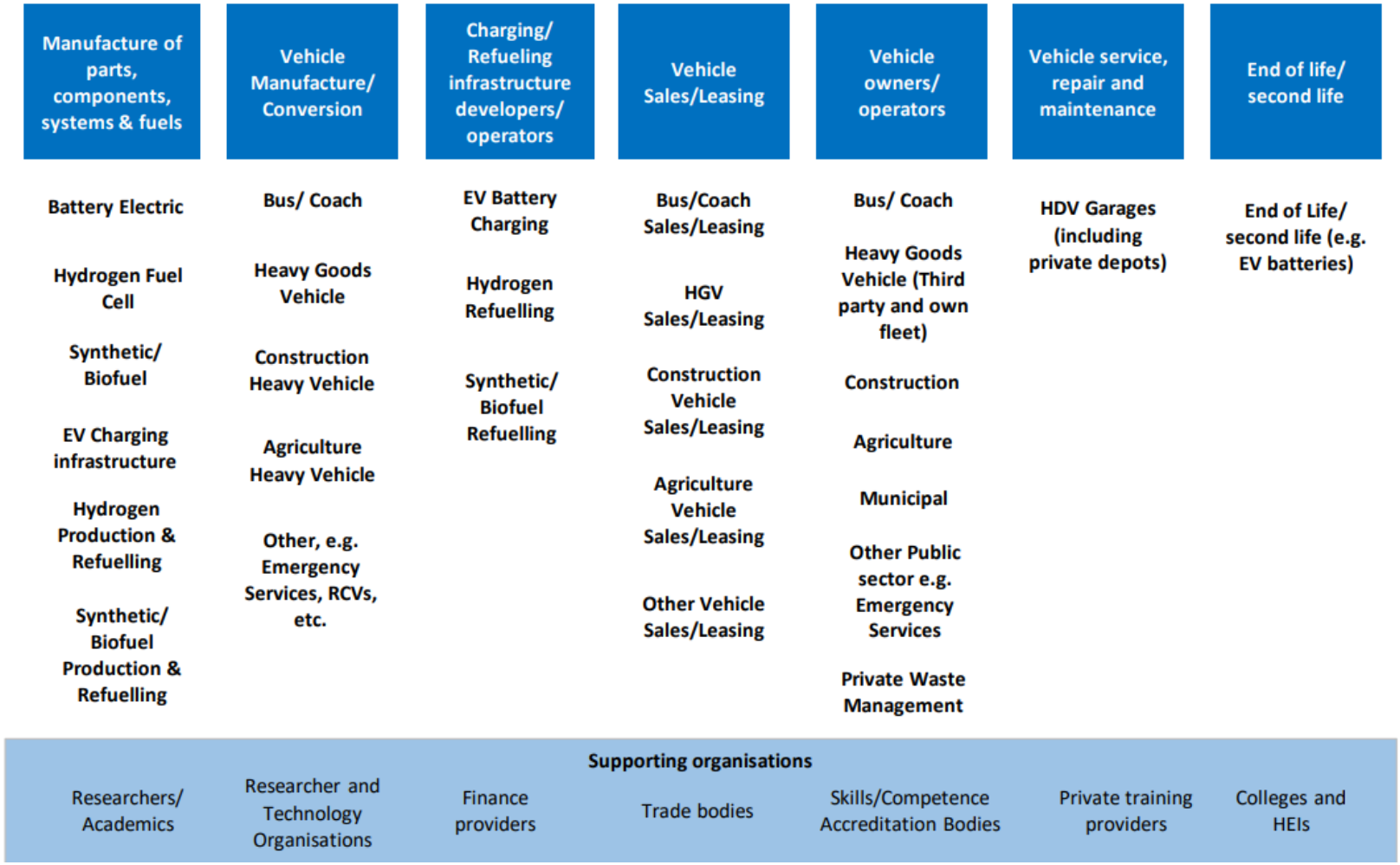

Figure 1 HDV supply chain and use landscape

(source: Optimat (2022))

1.3 Methodology

A mixed methods approach has been used to generate the evidence base for this paper. An initial review of published reports, new sources and organisational websites was supplemented by interviews with representatives from key manufacturers based in or supplying to the UK. Information from interview respondents has been anonymised unless also in the public domain.

2 Overview of existing supply chain landscape in Scotland

Almost all HGVs registered in Scotland are still powered by conventional (ICE) powertrains, with only 20 ULEV HGVs registered by the end of 2021, constituting less than 0.1% of the total. DAF[2] trucks accounted for over 30% of all HGVs registered in the UK 2020, followed by SCANIA (14.2%) and VOLVO Trucks (13.5%)[3].

There are currently no large established OEMs that manufacture HGVs in Scotland and one manufacturer of buses and coaches (Alexander Dennis). The four UK commercial vehicle manufacturers (Dennis Eagle, London Electric Vehicle Company (LEVC), Leyland Trucks and Vauxhall) exported almost 60% of their production, with almost all of this going to the EU[i]. Large OEMs have well established global supply chains for ICE trucks. Those producing vehicles in the UK may use Scottish suppliers for components, as is the case for DAF, for example.

A recent study identified nine OEMs active in the HDV sector in Scotland[ii]. These cover all powertrain technologies and include buses and coaches, HGVs, other on-road HDVs, such as RCVs, as well as off-road vehicles. A lack of significant tier 1 suppliers in Scotland also means that OEMs are sourcing major components and systems from suppliers outside Scotland and the UK, which have their own wider supply chains.

The study also found that only 20% of Scottish companies in the wider supply chain that were surveyed had business activities in the HDV sector, although 36% had plans to develop zero emission HDV business activities. However, only four companies had undertaken relevant R&D. Companies supplying into the wider automotive sector were mainly focused on the aftersales market (59%). Most of the supply chain companies have limited manufacturing capability. Volume manufacturing is normally outsourced to contract manufacturers outside Scotland.

Scotland has R&D centres in areas relevant to the ZET supply chain, including at the University of Strathclyde, Heriot Watt University and the Michelin Scotland Innovation Parc (MSIP) as well as supporting networks, such as Scottish Enterprise.[4]

3 Impact of zero emission HGVs on vehicle supply chain

The shift from production of trucks with ICE powertrains to BETs and FCETs has implications for the different stages of the vehicle production process. These are outlined in the following sections.

3.1 Vehicle manufacture, conversion and integration

ZETs are being produced by OEMs that already supply ICE HGVs operated in Scotland and by new entrants. The approaches adopted by these two types of producers may impact the supply chain differently.

[2] These are also branded as Leyland.

[3] Mott MacDonald calculations based on vehicle registration data from DfT

[4] See Background Paper 1 for more information.

Existing OEMs

Existing ICE truck OEMs are adapting their processes and business models for the production of ZETs:

- OEMs are basing their ZETs around their existing ICE chassis.
- Conventional powertrains have been a key source of competitive advantage and differentiation for OEMs[iii].While some OEMs are continuing to work with their existing powertrain suppliers on new technologies, or develop technology in-house, others have partnered with zero-emission powertrain suppliers[ivv]; for example IVECO have partnered with Nikola and DAF with VDL.
- OEMs are likely to co-locate ZET production with existing production capacity, although completely new facilities have been set-up. The IVECO/Nikola facility is located in Germany which is at the forefront of charging infrastructure trials and deployment[vi]. It was also noted in one interview that 'Rules of Origin'[5] for the UK following Brexit could lead to more production of vehicles or components in the UK to avoid tariffs.
- In interviews, OEMs indicated that they would continue to work with their wider existing supply chain and purchase from tier 1 suppliers. A need to shorten supply chains in the future and openness to new technology sources was also highlighted in one interview. OEMs active in the HDV sector in Scotland also indicated that existing supply chains could be trusted to provide parts on time and at volume, although these may not be optimal for ZETs[vii].
- Some OEMs reported looking at economies of scale in battery production and battery assembly may occur closer to vehicle production. Volvo has recently opened a factory in Belgium, for example[viii].

New vehicle integrators

New companies that are differentiating themselves in terms of their powertrain systems are entering the market for both BETs and FCETs.

A small number of firms design and develop their own vehicles, including chassis and cab as well as powertrains. This includes HVS in Scotland, Tevva (UK) and Volta Trucks (Sweden). These firms have or plan to have production facilities in the UK[ixx]; some taking advantage of existing automotive engineering capabilities in the Midlands.

A second group of firms integrate powertrain technology onto existing ICE vehicle chassis. This group includes Ballard Motive Solutions (BMS) in Scotland, as well as Electra (UK), SEA (US) as well as E-traction (Netherlands) and E-Trucks Europe (Netherlands). These firms may operate in different ways:

> While some firms have established relationships with OEMs to fit powertrains to their chassis, supplying into OEMs or obtaining chassis with suitable support from OEMs was acknowledged by interviewees as a key difficulty. OEMs have established supply chains and often wish to retain control of the process from a branding and warranty perspective.
>
> Other firms have developed powertrain systems that are compatible with a range of chassis and integrate these into vehicles in their own facilities. However,

[5] Check your goods meet the rules of origin - GOV.UK (www.gov.uk)

supplying powertrain kits to bodybuilders or fleet managers that have their own repowering facilities was seen as a potential route to market. One interviewee also indicated they were developing their own chassis.

Developing relationships with OEMs for particular use cases was seen as a way forward. BMS, for example is working with a Dennis Eagle chassis for RCVs[xi].

Overall, for new entrants:

Firms are at different levels of maturity, with BET providers generally more advanced than FCET providers. This may affect where they are located and how established their supply chains are. The need to scale production and control costs was cited in interviews as a driver for the supply chain selection. New suppliers being able to meet quality and price criteria was also raised by Scottish OEMs active in the HDV sector[xii].

Several firms report using Tier 1 suppliers for some powertrain components[xiii] but there may be scope for the wider supply chain, particularly for power electronics, where interviewees indicated there was scope for innovation.

UK based firms report using a mix of domestically and internationally sourced products[xiv]. One interviewee also reported that direct contacts or trade fairs were the main source of access to potential suppliers.

3.2 Capabilities and opportunities in the wider supply chain

The shift from production of ICE trucks to BETs and FCETs requires significant changes to the integrated systems provided by tier 1 suppliers and for components and systems in the wider supply chain, particularly in relation to energy systems (batteries, fuel cells, hydrogen storage), power electronics, thermal management systems and software systems.

A recent survey-based study on the wider supply chain capability for hydrogen fuel cell HDVs in the UK identified high power batteries, fuel cells, hydrogen storage, power electronics, motors and drives (PEMD), thermal management systems and control systems as critical components of the supply chain[xv].

The study found little current supply of UK components that met the requirements for heavy duty FCEVs but significant UK capability that could meet these requirements. Responses from the PEMD sector indicated that there may be production-ready solutions in other market segments that could be adapted for HDVs. A lack of production readiness, limited production capacity and a need for R&D were identified for other components.

The hydrogen fuel cell study also recommended at scale deployment as a way of increasing supply chain learning and integration and enabling substitution of imported components.

Over a third of surveyed firms in the wider supply chain for Scotland indicated an intention to explore business activities relevant to zero emission HDVs, although only 20% are currently active in the HDV sector[xvi]. Although academic excellence in energy systems and power electronics is available in Scotland, a need for a focal point for the supply chain was identified. Stakeholders felt that the supply chain

should focus on power electronics, sensor technologies, control systems (hard- and software based) and energy storage systems, in particular batteries.[xvii] Batteries are the biggest cost drivers in electric vehicles. Over 90 percent of battery production capacity is located outside Europe, mainly in Southeast Asia[xviii,6]. However, building relationships with OEM and tier 1 procurers to understand their needs was seen as important.

Access to trusted demonstration facilities where supply chain companies could test their technology in an operational context was considered a way of increasing the probability of market penetration[xix]. The Scottish Government announced in March 2021 the launch of a new heavy-duty vehicle platform testing and innovation facility, LOCATE, to be situated at Michelin Scotland Innovation Parc in Dundee.

The LOCATE initiative provides a 'first of a kind' platform level, route-to-market Power Train Test Bed (PTTB) for hydrogen fuel cell/ battery electric drive trains. LOCATE will form part of a Low Carbon Transport Programme being jointly developed between Scottish Enterprise and Transport Scotland.

The LOCATE test facility will provide an 'emulated' representation of real-world duty cycles for a variety of heavy-duty road/ niche vehicles. This replaces and brings forward what would traditionally have been on-road testing. LOCATE is unique in that it brings together PTTB capability with hydrogen and power network knowledge and skills gained from research and innovation through the University of St Andrews and University of Strathclyde.

UKRI has also announced funding to support the supply chain for electric transport, including investment in research on power electronics and PEMD as well as investment in regional industrialisation centres, including Strathclyde.[xx]

3.3 Maintenance and end of life

The largest HGVs are assumed to be on our roads between four and seven years. Smaller vehicles have longer average lifespans of between six and 14 years[xxi]. In the UK, vehicles often enter the rental market at the end of their first life. Currently, used European trucks find a second and third life in Eastern Europe, the Middle East, and Africa[xxii].

Findings from interviews and published evidence indicated that:

> ZETs have up to 80% less moving parts then ICE trucks. They will require less maintenance and less replacement of parts, although these parts are more expensive. Inspection frequency that is currently set up for ICE trucks may need to be reduced over time and change in nature. More diagnostic data will also be available compared to diesel trucks,
>
> Conventional powertrains contribute significantly to aftersales. OEMS will need to find new revenue streams to replace aftersales. These could include advanced connectivity features, with over-the-air updates[xxiii].
>
> OEMs and other actors, including from the energy sector[xxiv] are already thinking about 2nd life uses for batteries, including as storage devices in depots, to balance the electricity grid or for a range of additional uses. According to one

[6] The infrastructure to refine battery metals is also located in these countries and the raw materials are concentrated in a few places Briefing Note- Battery raw materials (bgs.ac.uk).

study, recycling could recover as much as 90% of critical battery materials[xxv]. Strategies for revitalising electronics, and software are also needed and remarketing chains could take account of local technology opportunities[xxvi].

Using the same chassis for diesel and zero emission trucks would mean that these could be refurbished and remanufactured and powertrain technology, which is likely to have advanced significantly by end of first life, replaced. However, although learning from experience with buses is useful, the ZET market is not mature enough to provide data on the relative lifetimes of chassis and powertrains. Furthermore, early experience indicates that repowering is complex and that there may be configuration issues in fitting zero emission powertrain systems to some existing ICE chassis.

Ownership models built around risk based pricing or truck as a service offers could support revenues[xxvii] and also alleviate concerns about residual asset values. For example, warranties for powertrains could be set to cover the first life and half the expected second life of the vehicle or could be based around limits on energy pass through. Models that currently offer full service and maintenance also reduce the risks to customers and reduce the need for upskilling.

4 Key findings for Scotland

A recent survey of Scottish companies found that, while main companies are unaware of the relevant supply capabilities in Scotland, growing demand for a more developed supply chain for zero emission HDVs represents an opportunity for Scotland to increase its market share in the future.

There is a strong desire for Scottish companies to diversify into the zero emission HDV sector as evidenced by the wider supply chain's intent to explore opportunities. The focus of these activities needs to be clear and should be undertaken in consultation with OEMs and tier 1 suppliers.

While a lack of awareness of activities between OEMs and supply chain firms[xxviii] mean it may be difficult for Scottish firms to become part of supply chains for OEMs in Scotland or elsewhere, at least one OEM in the UK currently uses Scottish suppliers and Rules of Origin for the UK may also encourage use of local suppliers. There may be more scope to develop relationships with new vehicle integrators that have production facilities in the Scotland or the UK than OEMs with more established supply chains or in-house capabilities.

Demonstration facilities for use by supply chain companies and at scale deployment of vehicles have been proposed as ways of developing domestic supply chain capability and increasing visibility.

High volume manufacturing capability may be important for supply chain firms as OEMs increase production. Scottish firms currently only have low to medium volume capabilities. Companies surveyed also highlighted the need for capital investment to fund manufacturing facilities.

Changes in ownership models may reduce the need for 3rd party maintenance of HGVs and aftersales in Scotland but reduce the risk to customers. There will also be an increased role for data diagnostics and connectivity.

The implications for second life and end of life uses of batteries and other vehicle components for Scotland are not yet clear. This could be an opportunity if new uses are found locally.

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SMMT

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