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WAREHOUSING IN THE UK: OPERATIONS, PLANNING AND DECARBONISATION

Summary Report

Technical Report ENG-TR.034

May 2023

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– Summary Report**

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1. Introduction

This summary briefing report investigates the UK warehousing industry and the role it plays in supply chain management. It should be noted that this briefing report has been based on a review and use of existing publications and data, rather than through the carrying out of new primary research into the warehousing industry. Despite being an imperial rather than metric unit of measure, warehousing floorspace is most referred to in square feet (sq ft) rather than square metres (sq m) in this report as this is the unit typically used in the warehousing industry.

This report has been produced as part of the Centre for Sustainable Road Freight (SRF – EPSRC grant number EP/R035148/1). A slide set and a full report containing references to all the documents consulted in compiling this report are also available from the SRF website to accompany this report. Further details about the SRF project are available at: <http://www.csrf.ac.uk/>

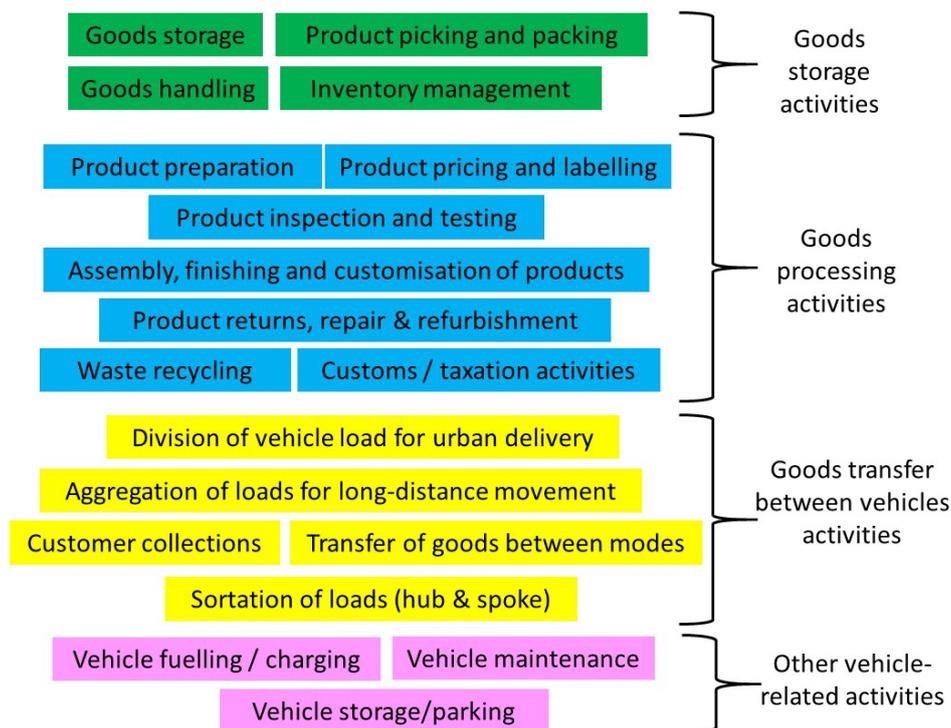
2. Activities and importance of warehousing

Despite the importance of warehouses and the functions they perform in supplying and selling goods and in international trade, traditionally relatively little attention has been paid to them in business and academic studies compared with other economic activities such as production, procurement, transport and marketing. This view began to change a little since the 1970s, with greater appreciation of the role of warehousing in logistics and supply chain management. Its importance in terms increasing supply chain productivity through avoiding lost sales and facilitating the continuation of other value-adding activities was recognised as well its costs if poorly managed.

Stock is held in warehouses for reasons including (Richards, 2014): uncertain and erratic demand patterns, distances between the manufacturer and end consumer, discounts obtained due to bulk buying, trade-off decisions made by businesses concerning transport and shipping costs that justify larger shipments, cover for disruptions to production processes, to provide the ability to increase production runs, to manage seasonal demand for specific products, to cope with peaks in demand at certain times of year (e.g. Christmas), to ensure spare parts are available, to part build products in anticipation of demand (i.e. work-in-progress storage), to hold onto products that are expected to increase in value over time, to store paper documents where a legal obligation to do so exists (such as contracts, accounts, invoices, patient records and legal documents). Despite efforts by businesses to reduce warehouse stockholding in recent decades it remains necessary to smooth the variations between supply of and demand for products (Rushton, Croucher and Baker, 2014).

The four basic activities that take place in a warehouse are: i) receiving goods, ii) transferring, putting away and storing goods, iii) order picking, and iv) shipping goods (Gu et al., 2007). Beyond its role as a staging and storage point for goods in their journey from producer to consumer (performing stockholding, order picking, packing and despatch activities), the warehouse also plays many other, often overlooked, roles in supporting the freight transport used to move these goods. **Figure 1** shows diagrammatically the activities that can take place at these logistics sites (referred to as 'warehouses' in this section). These include good storage activities, goods processing activities, goods transfer between vehicles and/or modes, and other vehicle related activities including (vehicle refuelling, maintenance and overnight parking).

Figure 1: Activities that may take place at warehouses (i.e. facilities where goods are stored and handled)



As well as the most common roles and activities of warehouses, they are also increasingly used for providing assembly activities for products (an extension of what traditionally took place in factories) and other value-adding activities such as a centre for handling returned products (especially in non-food online shopping supply chains).

Warehouses vary in terms of the type of goods they handle and store, some of which have very specific handling and storage requirements. Some warehouses are used for the storage of ambient goods, goods requiring temperature controlled storage (such as chilled and frozen), bonded goods for import or export that are held in specialist facilities by accredited operators to avoid the need for immediate payment of duties and taxes, hazardous goods that have legal requirements concerning their handling and storage procedures to prevent risks to staff and the wider society, and licensed products such as pharmaceuticals, goods requiring bulks storage such as liquids, powders, gases and agricultural crops, and goods that can be kept outdoors in open storage facilities. The goods handled and stored may be loose items, or contained in secondary or tertiary packaging to assist handling and storage space used (such as boxes, crates, pallets, containers or other type of unit load). The rate at which goods move through a warehouse, the quantities handled and the storage period will vary by product types, supply chain and purpose of warehouse.

Warehouses also vary in terms of their size, location, facilities, handling equipment used and degree of automation, and age of the building (with many larger warehouses being relatively new and located outside urban areas close to the motorway network but some smaller and medium sized ones, especially those in urban areas, being much older).

Warehouse design comprises five major decisions: i) determining the overall warehouse structure; ii) sizing and dimensioning the warehouse and its departments; iii) determining the detailed layout in each department in the warehouse; iv) selecting warehouse equipment; and v) selecting operational strategies. There are strong inter-relationships between these five decisions (Gu et al., 2010). These five decisions are closely related to the nature of use to which the warehouse will be put, the products it will handle, and goods throughput and storage service level

requirements of the supply chain service in which it operates. These decisions will be influenced by considerations about the efficiency requirements of the warehousing operation. Consideration of the costs of warehouse construction, inventory holding, replenishment and materials handling for the warehousing solutions available will also be important in this decision-making.

In addition to the indoor space at a warehouse required for receiving goods, storing goods, order picking, and shipping goods and the various tasks associated with goods handling and management, warehouses also require outdoor space for some of the activities shown in **Figure 1**, including the manoeuvring and parking of goods vehicles that ship goods to and from the warehouse. Depending on the type, size and location of warehouse these outdoor activities can also include activities such as vehicle fuelling/charging (and therefore on-site fuel storage, vehicle maintenance facilities, vehicle and trailer parking facilities, driver comfort and rest facilities, and outdoor storage.

The total size of the warehouse site therefore includes both the area occupied by the warehouse itself, as well as the land surrounding the warehouse on which vehicle movement, parking, other vehicle/driver activities and outdoors storage may take place. The 'plot ratio' of a warehouse is a metric used to measure the area of building on a warehouse plot of land. The plot ratio is expressed as a ratio of the gross floor area of the building to the total area of the site that surrounds it. Therefore, the higher the plot ratio, the greater the land area of the entire site that the warehouse building covers.

Many different terms are used to describe freight facilities where goods are stored and/or transferred between vehicles and modes (including warehouse, distribution centre, fulfilment centre, sortation centre, depot, store, logistics hub, cross-docking facility, Transshipment depot and consolidation centre). Many of these terms are used interchangeably by those referring to freight transport and logistics while some refer to specific functions.

Warehouses are either operated directly by a manufacturer, wholesaler, retailer or other user, or are operated on their behalf by a third party (such as a specialist goods handling and storage business, freight transport business or logistics operator).

Warehouses can be operated on a dedicated or shared user basis. A dedicated warehouse is operated for a single user (either operated by the user themselves or by a specialist third party on their behalf), whereas a shared user warehouse contract is typically operated by a specialist third party for more than one user. Shared user warehouses are mostly used by manufacturers, retailers or wholesalers with insufficient goods throughput to warrant a dedicated warehouse.

Growth in online shopping has led to a major new function for warehouses in the last twenty years. This sector is using both large warehouses close to motorways. In recent years, especially since the Covid-19 pandemic, this has also led to the opening of small fulfilment centres and delivery depots close to residential delivery catchment areas in urban areas (especially when same-day delivery is provided). A small number of micro delivery hubs in central urban locations are also being established at which parcels can be transferred to electric vehicles (vans, bikes and on-foot walkers with powered trolleys) for local delivery.

The rise in online meal platforms has led to a rapid growth in so-called 'dark kitchens' in urban areas, while instant grocery services established since the Covid-19 pandemic have led to the appearance of so-called 'dark stores' – fulfilment centres from which grocery orders are despatched typically on mopeds and bicycles. New operations such as these ecommerce food preparation and grocery retail services (which are often located in former industrial buildings), together with warehouse buildings that are increasingly being put to non-logistics uses including as data centres and filming locations, are expanding and challenging the definition of what is a warehouse.

Warehousing has been a rapidly expanding sector in the UK, with the number of registered warehousing and storage businesses with employees increasing by 52% between 2010 and 2021, and the turnover of these businesses increasing by 106%. By contrast, all registered businesses with employees in the UK increased by 19% and their total turnover by 38% (BEIS, 2021). UK government data indicates that in 2020 approximately 350,000 people were employed by warehousing and storage businesses (SIC code 5210), while a total of 630,000 employees described their occupation as relating to warehouse and stock control in 2021 (which includes those working for retailers, manufacturers wholesalers and freight transport and logistics operators) (ONS, 2022a).

An analysis of warehousing in England in 2018 indicates there were approximately 40,000 warehouses with a total floorspace of 1.7 billion square feet (sq ft). Therefore, the average warehouse floorspace was approximately 40,000 sq ft. Warehouses up to 100,000 sq ft accounted for 92% of these properties and 60% of this total floorspace, while warehouses over 100,000 sq ft accounted for 8% of these properties and 40% of this total floorspace (calculated from CoStar data in Turley, 2019).

Of those warehouses below 50,000 sq ft, approximately 25% are below 1,000 sq ft, 25% are between 1,000-2,500 sq ft, 20% are between 2,500-5,000 sq ft, 15% are between 5,000-10,000 sq ft and 15% are between 10,000-50,000 sq ft (calculated from data in BEIS, 2022). In total, warehouses were estimated to account for 12% of all non-domestic buildings and 34% of all non-domestic floorspace in England and Wales in 2022 (BEIS, 2022).

The most important types of occupiers of large warehouses in Britain in 2021 were freight transport and logistics businesses (19% of total floorspace in warehouses over 100,000 sq ft), high street, non-food retail (16%), food retail (12%), online retail (11%) and manufacturing (8%). Between 2015 and 2021 new warehousing floorspace in these large warehouses increased most for online retail (approximately 600% increase), followed by freight transport/logistics (approximately 40% increase), while it fell most for high street retail and manufacturing (UKWA and Savills, 2021). Approximately 35-40% of annual take-up of grade A warehousing space over 100,000 sq ft in 2021 was estimated to be due to online retail operations (CBRE, 2022; JLL, 2022b; Savills, 2022). In 2022, businesses providing logistics, warehousing and freight transport services accounted for 38% of the take-up of warehousing space, retailers (online and in-store) for 29% (13% by online only and 16% by physical and online retailers), other businesses (17%) and manufacturers (16%). The lower proportion of warehousing take-up accounted for by online retailers in 2022 reflected reduced online retail spending compared to 2021 together with substantially reduced warehousing take-up from some of the leading online retailers. (JLL, 2023).

The level of demand for warehousing in the last two years has left available space very limited. One estimate of the floorspace availability for sites in its dataset over 100,000 sq ft at the end of 2021 suggested 5.5% nationally (i.e. the vacancy rate), or only 1.1% if speculative sites under construction were excluded. This rose slightly to 6.4% and 2.5%, respectively, by the end of 2022 (JLL, 2022b, 2023). Another estimate showed a vacancy rate of 2.0% at the end of quarter 4 in 2022 for sites in its dataset (CBRE, 2023). A third estimate put the national vacancy rate at 2.9% at the end of 2021, the lowest ever national vacancy rate on record with exceptionally low rates of 1.7% in the East Midlands, 2.3% in the West Midlands and 2.0% in Yorkshire and the North East (Savills, 2022). This source estimated a national vacancy rate of 3.9% at the end of 2022 (see **Figure 2** - Savills, 2023).

Figure 2: Warehouse floorspace annual supply and vacancy rate for warehouses over 100,000 sq ft in Britain, 2009-2022



Source: produced from data in Savills, 2023.

Demand outstripping supply is having an upward pressure on warehouse rental rates, which rose by 61% between 2011 and 2021, more than double the rate of inflation (CoStar quoted in BPF and Savills, 2022). Increases in rental prices have been especially strong in recent years, rising 18% on average nationally year-on-year between 2020 and 2021 and a further 13% between 2021 and 2022 according to one source (JLL, 2023) and by 22% nationally between 2019 and 2021 and a further 14% between 2021 and 2022 (calculated from data in Savills, 2018, 2020, 2022, 2023). It is argued that at the UK national level, warehousing supply and demand are in balance and rents are more stable when vacancy rates are approximately 8% (BPF and Savills, 2022).

Shortages in the construction labour force as a result of Brexit, Covid-19 and some older workers choosing to exit the labour market together with the high price of construction materials due to supply problems and high energy prices, mean that new warehousing construction will struggle to keep up with demand in 2022, which is likely to result in rising warehouse rental rates and suppressed demand.

Since Brexit, the UK Government has also unveiled plans for Freeports (secure customs areas, typically at sea or air ports, with alternative tax duties, planning rules and customs rules to elsewhere in the country), Investment Zones (similar to Freeports but without customs areas), and so-called 'gigafactories' and other innovative manufacturing clusters to produce batteries and other products essential for success in a net zero greenhouse gas future. These will require additional warehouse capacity to be made available.

The UK Government has carried out a review of rateable values of non-domestic buildings based on 2021 data and began using these new values for calculating the costs of business rates payable for these buildings from 1st April 2023. Up until that point, business rates were based on 2015 rateable values. This review has led to business rates for warehouses and other industrial buildings increasingly sharply (Parker, 2023).

Warehouses are built and provided by the commercial property market, but their construction requires the provision of planning consent by local planning authorities. Property developers construct and rent warehouses to retailer, manufacturers, wholesalers and other users. Most warehouses are rented rather than owned by the occupier. Ownership of the warehouse and land is either retained by the property developer who earns a return on their investment from the annual rent paid by the occupier or the developer sells the warehouse or builds it on behalf of investors that include pension, life and investment funds, private equity and sovereign wealth funds who then receive the rental income. UK warehousing lease durations (along with other commercial

property leases) fell rapidly following the 2008 economic recession, then gradually rose again from 2011 due to strength in the sector but experienced further falls in 2018 onwards due to Brexit and in 2020 due to the Covid-19 pandemic. From 2002 to 2015 average rental lease durations for warehouses were shorter than for retail and office leases in the UK. However, due to the strength in the warehousing market, since 2016 average lease durations have been longer than in these other sectors. In 2019, the average duration of an industrial (warehousing and manufacturing) lease in the UK in 2019 was 6.7 years compared to (over the period 2002-2019) a high of 7.3 years in 2002 and a low of 4.6 years in 2011 (MSCI and BNP Paribas Real Estate, 2019). Warehouse leases are typically longer for larger business occupiers given the adaptations to the warehousing space they may make given the costs of such adaptations as well as the costs associated with relocation to another suitable site. Such adaptations can include the installation of expensive internal layouts, docks, automated handling equipment and upgrades to public utility provision such as the electricity or gas grid connection. The longest warehouse leases are usually not more than 25 years.

Warehousing lease arrangements often favour the owner (i.e. landlord) rather than occupier (i.e. tenant). The warehouse contracts that are entered into when an occupier decides to rent a warehouse typically require the occupier to keep the building in good repair and well decorated both during the lease and at the end of it. Depending on the terms of the contract, the occupier can be charged for compensation by the owner for the unlettable period after the lease ends while repair work is carried out by the owner. Some leases include the requirement for the occupier to pay a service charge to the owner. Some contracts permit the owner to use these service charges to get the occupier to pay for improvements to the building from which the occupier gets limited benefit due to the length of their lease. When entering a warehouse contract, occupiers need to take care not to take responsibility for repairs that were outstanding at the start of the lease. Rent reviews often take place during the period of the lease and typically assume that the occupier has carried out repairs and decoration even if this is not the case. Break clauses in leases are usually weighed in favour of the owner and can result in major costs for an occupier that has to terminate the warehouse contract if they do not follow the contract notice period and other requirements. As a result of the above, costly legal disputes over warehousing leasing contracts between owners and occupiers are relatively common.

Requirements for occupiers to obtain permission from the warehouse owner to make any changes to the building and its fixtures and fittings and the lack of the occupier's ownership of assets installed are major sources of inflexibility in the use of warehouse space and a key deterrent to the investment in technology and automation that can improve warehouse efficiency and their decarbonisation (such as upgrading energy infrastructure at buildings for electric vehicle recharging and installing solar panels on roof spaces). Third party freight transport and logistics operators typically have contract durations with their retailer and manufacturer customers that are shorter than their warehouse lease durations. They are therefore forced to try to predict their future needs and make decisions about the warehouse design and fixture and fittings they require at the outset of their leasing of the warehouses, with potential legal, financial and operational implications if these warehouse design, layout and equipment change over time.

3. Changes and developments in UK warehousing in recent decades

Warehousing has changed markedly in recent decades as a result of various changes in the UK economy and logistics practices. Important factors responsible for this change include: the rise of the service and relative decline of the manufacturing sector in the UK economy (resulting in a growing dependence on the importation of finished goods); the growth in the UK retailing sector and market concentration in the retailing market (resulting in the increasing dominance of major retailers operating their own warehouses); rises in interest rates during the early 1980s; the internal rationalisation of stockholding by large businesses leading to ever-larger but fewer warehouses primarily located on the strategic road network with a growing reliance on longer distance freight transport journeys (see **section 4**). This has been driven by the relative costs of stockholding and freight transport) and the growing deployment of materials handling equipment

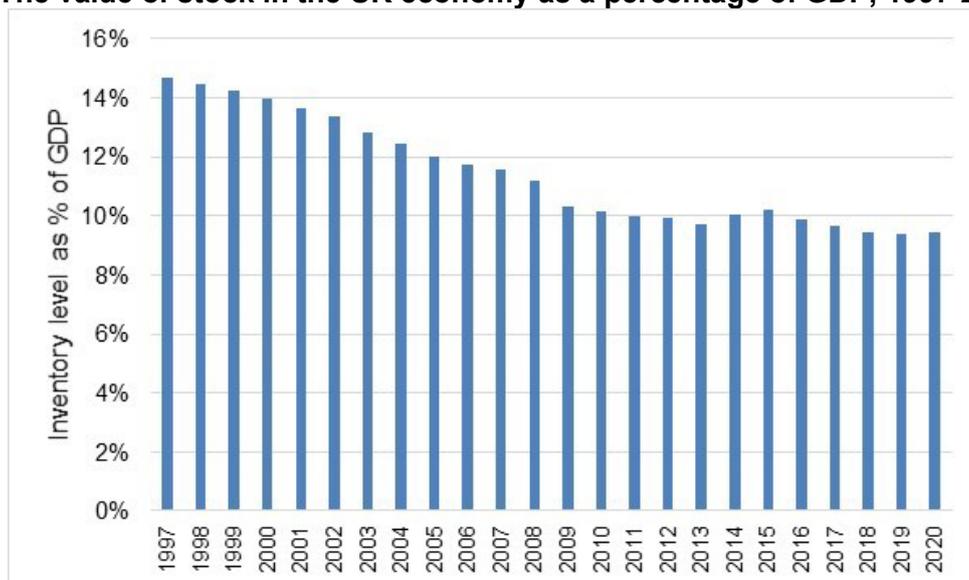
and automated stock control and picking systems. These factors have led to dramatic changes in the size and location of warehouses and the operations taking place within them, supported by an increasing degree of computer technology and automation and thereby a reduction in total workforce otherwise required.

Changes in logistics practices over this period resulted in the role of the warehouse shifting from being an inactive place/activity where goods were held in store with poor stock visibility along the supply chain to a dynamic supply chain node through which goods are channelled in accordance with demand. In conjunction with the increase in the dominance of large businesses and substantial increases in urban land values this has led to a reduction in stockholding levels in shops and offices in order to convert stockholding space into sales areas and other value-added activities and reduce total space requirements in these facilities. This has been achieved by placing greater reliance on frequent deliveries from warehouses to these urban sites by goods vehicles.

Over recent decades the average size of warehouse has increased markedly, with an ever-growing proportion of warehouses with more than 100,000 sq ft of floorspace. To give a sense of scale, this area is equivalent to approximately 1.5 full-size football pitches. The average eaves height of warehouses has also been increasing (approximately fifty years ago warehouse eaves heights were often 5 metres whereas now the average eaves height of large warehouses is approximately 14 metres). For example, the Amazon warehouse at Tilbury which opened in 2017 has a floor area of 0.5 million sq ft and an eaves height of 22 metres, with four internal storage levels providing a total floorspace of 2 million sq ft.

This growth in average warehouse size has been combined with a greater centralisation of these large warehouses especially in the middle of the country (particularly the East and West Midlands) located in close proximity to the motorway network which receive goods arriving into the UK via ports and which rapidly transfer these goods onwards to retail and business locations across the country where they are sold and used. This inbound and outbound warehouse transport primarily takes place using articulated HGVs. The amount of time that goods are stored in warehouses has diminished over recent decades as logistics management has become more efficient and demand focused, with the warehouse increasingly becoming a transshipment point used to organise and co-ordinate the supply chain rather than primarily a place of inactive stockholding (see **Figure 3**).

Figure 3: The value of stock in the UK economy as a percentage of GDP, 1997-2020

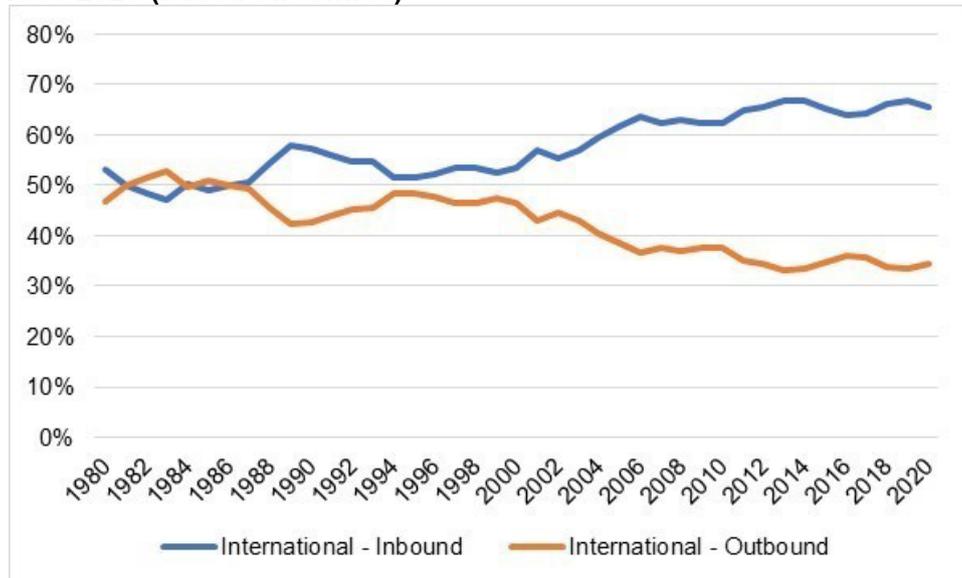


Note: includes stocks of raw materials, work-in-progress materials, and finished goods and based on current prices.

Source: calculated using data in ONS, 2021, 2022b.

Despite the increasing speed with which goods move through their supply chains and the warehouses in those chains, the total quantity of warehousing has increased nationally at a considerable rate over recent decades, primarily as a result of the growth in retailing in the UK together with the relative decline in UK manufacturing and the consequent rise in importation of consumer and capital goods. Maritime transport handled 93% of all international freight lifted to and from the UK in 2020 – **Figure 4** shows the growing disparity between inbound and outbound goods at UK major seaports.

Figure 4: Proportion of inbound and outbound international freight to and from UK major seaports, 1980-2020 (based on tonnes)



Source: calculated from data in Department for Transport, 2021a.

Warehousing uptake in the UK in 2020 and 2021 was the strongest on record and warehouse vacancy rates reached an all-time low (Savills, 2022). Supply chain difficulties experienced as a result of Covid-19, Brexit and the war in Ukraine have led to businesses wanting to hold increasing stock levels. In addition, the rapid growth in online shopping in the last five years, exacerbated by the onset of the Covid-19 pandemic in 2020, has further fuelled the demand for warehousing as the focus of retailing and the provision of retail goods moves increasingly away from physical shops to fulfilment centres. This recent surge in online shopping has also reversed the previous decline in warehousing in urban areas as retailers acquire sites from which to fulfil same- and next-day deliveries.

4. Impact of developments in warehousing on freight transport

The growth in the total amount of warehousing in the UK, together with the trend towards ever-larger centrally located warehouses in close proximity to the motorway network means that most goods flows to and from large warehouses take place using articulated heavy goods vehicles (HGVs). Only approximately 6% of warehousing floorspace in large warehouses over 100,00 sq ft in England is rail-connected (GL Hearn et al., 2022).

The reliance placed on domestic road freight transport has been growing over recent decades due to the developments in logistics operations and supply chain management discussed in **section 3** together with the UK's growing dependence on the importation of capital and consumer goods and the growing economic importance of retailing. At the same time, the rising cost of urban land has led to diminishing storage space in many shops and offices requiring more frequent deliveries by HGVs and LGVs (light goods vehicles) to provide them with the goods they require (see **Figure 4** which summarises key factors influencing these trends).

Figure 4: Summary of issues driving change in warehousing and stockholding strategies and their impact on road freight activity in recent decades in UK

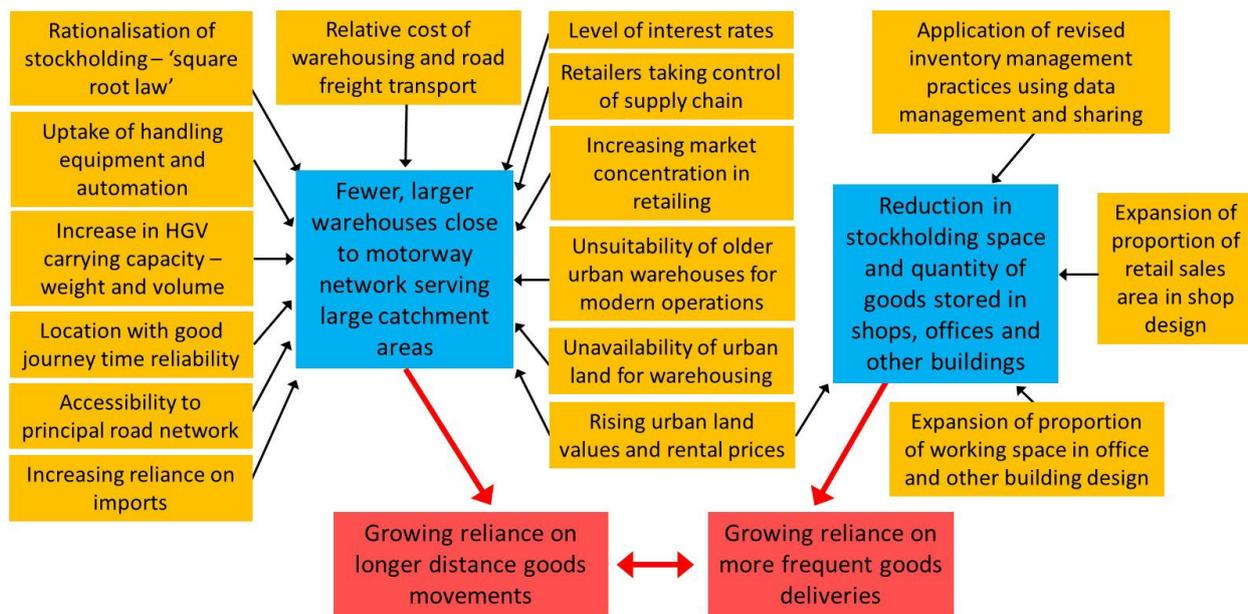
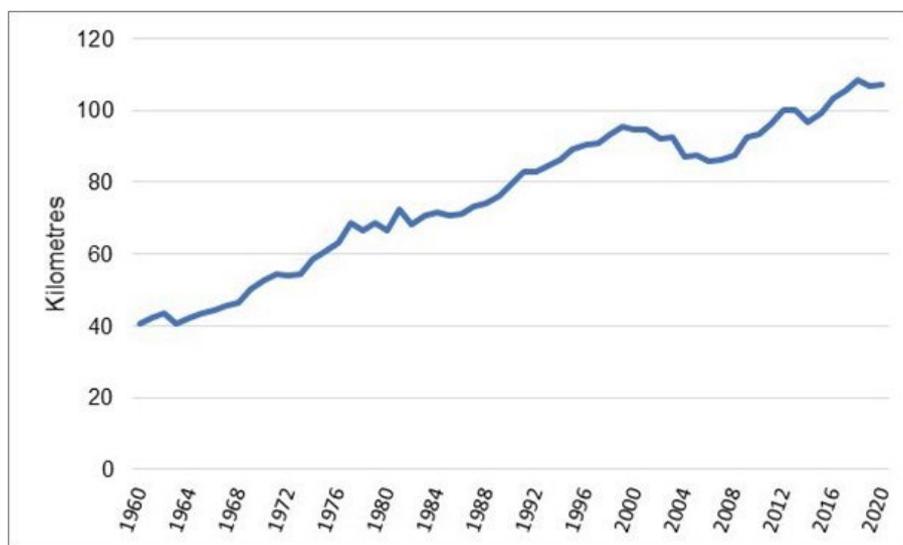


Figure 5 reflects the growing reliance on longer distance freight transport journeys to and from warehouses (and other facilities) in Britain since 1960. This has been driven by the relative costs of stockholding and freight transport) and the growing deployment of materials handling equipment and automated stock control and picking systems. The average length of haul will have to reach a limit at some point given that the geographical size of Britain is fixed, but this has not yet been reached.

Figure 5: Average length of haul for road freight transported by HGVs in Britain, 1960-2020



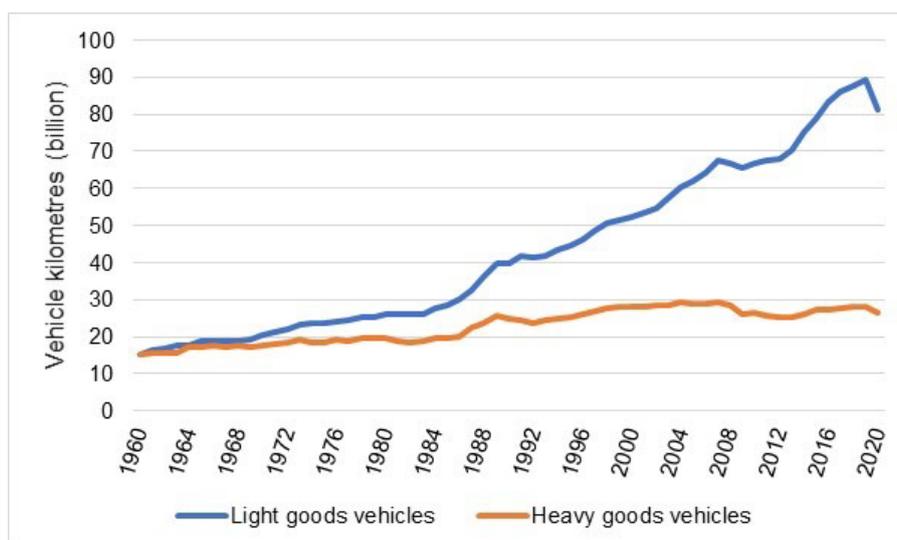
Note: Does not include freight lifted by non-UK registered HGVs.
 Source: calculated from data in Department for Transport, 2021b.

The shift towards fewer but larger warehouses (and hence average journey distances) and the growth in total warehousing floorspace together with the reduction in stockholding space and stock levels in other commercial buildings and the consequent increase in frequency of deliveries to shops, offices and residential homes has resulted in the total distance travelled by heavy and light goods vehicles (HGVs and LGVs) increasing over time (see **Figure 6** – it should be noted that LGVs are used to provide services as well as to distribute goods). This is despite the fact that the

maximum payload weight and volume of HGVs has increased over time due to technological and regulatory change.

Articulated HGVs accounted for 76% of all non-bulk tonnes lifted and 85% of all non-bulk tonne-kilometres performed by HGVs in Britain in 2020 (analysed from data in Department for Transport, 2021c). The importance of articulated HGVs in road freight transport in Britain has been increasing over time from for 42% of all tonnes lifted and 69% of all tonne-kilometres performed by HGVs in Britain in 1990, to 66% of all tonnes lifted and 82% of all tonne-kilometres performed in 2020 (analysed from data in Department for Transport, 2021d).

Figure 6: Vehicle kms travelled by LGVs and HGVs in Britain, 1960-2020



Source: Department for Transport, 2021b.

Articulated HGVs are predominantly used for transporting goods imported into the UK from sea ports and air ports and from manufacturing plants in the UK to national and regional warehouses. By contrast smaller HGVs and LGVs are often used for delivering goods from regional and local warehouses and depots to shops, offices and private residences (with articulated HGVs often only used to make deliveries to the largest retail and commercial outlets with off-street parking space). This is reflected in 2020 traffic data about the types of road used by goods vehicles. Articulated HGVs travelled approximately 60% of their total mileage on motorways and 24% on trunk A-motorways and trunk A-roads. LGVs travelled only 20% and 13% of their total mileage on motorways and trunk A-roads, respectively, with much of their travel taking place on roads in built-up areas (calculated from data in Department for Transport, 2021b, 2021e).

5. Planning for future warehousing requirements

The future demand for warehousing in the UK is somewhat uncertain. Some commentators expect warehousing demand to continue to increase in the coming years as UK businesses require greater 'near-shoring' (also referred to as 'on-shoring' and 're-shoring') of the production and/or stockholding of goods that they currently import from distant, international locations to mitigate against continued or future supply chain disruptions at ports and borders. However, implementing such a change to supply chains takes considerable time to implement, so it is too soon to be able to say with any certainty whether many businesses are implementing such a strategy.

It should be noted that a near-shoring production strategy can also lead to greater risks from national disruption and that in nearby countries to raw material inputs and labour markets, as well as transport infrastructure, so does not necessarily improve supply chain resilience. Locating stockholding closer to customer markets would be likely to lead to substantial investment costs in new warehousing facilities, possibly in locations with higher land values and rental prices. It would

also be likely to result in higher logistics operating costs due to the benefits that centralising stockholding and placing more reliance on freight transport provides. Clearly greater thought needs to be given by businesses to supply chain resilience to prevent disruption to long distance goods transport.

Economic factors emerging in 2023, including the cost of living crisis and a looming recession, may damp down demand for goods and hence warehousing space, and may adversely affect the growth of instant delivery online retailers that emerged during the pandemic providing groceries and meals and taking out urban premises to store, pick and despatch these goods. Meanwhile, inflationary pressures that are driving up energy, labour and transport costs are liable to also result in rising warehouse rental prices making them unaffordable for some occupiers.

Warehousing supply and demand are dealt with by the market, with occupiers deciding how much space they require and developers and investors providing that space, with the market determining its rental value. However, the UK Government plays an important role in terms of national planning law and guidance concerning the granting of planning consent for warehouse development, while local planning authorities make decisions on individual warehouse applications.

Warehousing has traditionally been viewed by public sector economic development officers and town planners as generating low employment density, low paid, unskilled work. Whilst the pay of manual warehouse workers has not improved considerably in recent years, and the work of many doing so has become increasingly precarious with the introduction of zero hours contracts, the increasing deployment of automation in large scale warehouses is providing higher skilled better paid work for those involved in its implementation and maintenance. In addition, the land uses typically viewed as superior to warehousing by public officials, such as offices, retailing outlets and manufacturing sites, are far less in demand as a result of changes in working practices (with many more people working from home since the pandemic leading to a reduction in office demand) in retailing provision (with the growth in online retailing over the last twenty years resulting in a gradual but progressive decline in the demand for retail space) and in the continued relative decline in UK manufacturing. In addition, warehousing developments been viewed less preferentially than housing schemes in local authorities' efforts to meet the dwelling needs of a growing population.

It is therefore an appropriate time for a reconsideration of the importance and status of warehousing by public sector economic development officers and town planners given the decline in other types of work and their demand for buildings, and the need to create jobs for a workforce that will expand in future. Reconsideration of the importance of warehousing should go beyond national Government guidance concerning the decision-making process for warehouse development at a local level and should instead involve a coherent national strategy for warehousing that takes account of its importance in modern, efficient, decarbonised supply chains and the provision of space for it and which could be enshrined in the National Policy Planning Framework. The publication of the Department for Transport's 'Future of Freight Plan' in June 2022 marks an important start in this process, with the UK Government acknowledging the importance that it identifies, "a National Freight Network (NFN) across road, rail, maritime, aviation, inland waterway and warehouse infrastructure", pledging that "our long term aim will be to remove the barriers which prevent the seamless flow of freight" (Department for Transport, 2022a). Within this plan the government has also noted that it "is working with industry to explore ways to protect and expand the warehousing land capacity" (Department for Transport, 2022a). In order to achieve change, this work by the UK Government will clearly need to go far beyond 'exploring ways' but the statement is an acknowledgement of the importance of this issue.

This Plan also recognises that current local planning system is not working adequately for warehousing and other logistics development proposals, with proposals often dealt with too slowly, thereby "reducing the level of certainty for applicants, investors and communities. This increases the uncertainty of delivering development associated with freight and logistics, actively discouraging promoters from bringing forward schemes and can lead to sub-optimal outcomes."

The government argues that “all of these considerations can be better met through better collaboration between industry and local authorities supported by an agile and responsive planning system” (Department for Transport, 2022a). Obtaining planning permission for warehouse can be slow and expensive for property developers. Since 2020, the Government made several statements about simplifying the planning system in general and specifically in relation to Freeports and Investment Zones. If such changes are enacted this could make the development of warehouses where they are required easier than at present. However, similar statements were made in relation to Enterprise Zones which were introduced in 2011 with few such planning simplifications being achieved. So, concerted Government action will be required to achieve these stated goals.

At a regional and local level, efforts to ensure the provision of suitable quantities and types of land for warehousing in appropriate locations as well as to safeguard such land for future demand should be reflected in Local Plans. These can be supported by Local Industrial Strategies that highlight the role and economic importance of warehousing. Industry has an important role to play in achieving this by communicating to national, regional and local governmental bodies its warehousing needs and working with these public policymakers to help ensure that outcomes of such efforts are suitable, realistic and reflected in Local Plans. Town planners will also have to be realistic about the plot ratios that are required at warehouse to facilitate all the outdoor activities and facilities that are necessary. Any efforts by planners to insist of higher plot ratios to adversely affect the functioning of the warehouse and the cost of warehouse operations and the negative impacts of its operations on neighbouring sites. Some planners and politicians have shown enthusiasm for the intensification of industrial sites either through co-location or the development of multi-level facilities. In the case of warehousing, the former is liable to be impractical when the co-located developments are residential dwellings given the noise and operating hours associated with warehouses, while the latter is liable to lead to less efficient and more expensive warehouse operations.

6. Other issues facing warehouses and the freight transport operations that serve them

Analysis of data from the UK Government’s Labour Force Survey shows that in 2021 (quarter 2) 12.2% of those working in elementary storage occupations were non-white, compared with 2.1% of managers and directors in storage and warehousing. Women represented 23.5% of workers in elementary storage occupations and 19.0% of managers and directors in storage and warehousing (Logistics UK, 2021). This data indicates the under-representation of non-white and women workers in better paid and managerial roles in the warehousing industry.

Research has shown that the use of agency workers was much greater in the warehousing sector than in the UK economy as a whole in 2017 (with 10% of warehouse workers sourced via an agency compared with only 2% of all UK workers). Women were almost twice as likely as men to be agency warehouse workers. Warehouse workers born outside the UK were twice as likely as UK-born workers to be agency workers in 2017 (14% of non-UK born workers compared with 7% of UK-born workers). Agency workers can get paid much less than directly employed staff doing the same work (Kik et al., 2019).

Median hourly pay rates (excluding overtime) in the UK in 2021 for all employees working in warehousing and storage occupations were £10.39 for workers in elementary storage occupations (up 3.9% annually), £11.25 per hour for stock control clerks and assistants (up 4.4% annually) and £14.31 for managers and directors in storage and warehousing (up 3.3% annually) (ONS, 2022c). This compares with a median hourly wage for all employees in the UK of £14.05, reflecting the relatively poorly paid nature of much warehouse work despite the annual increase due to recent worker shortages in warehouses. These recent shortages in the UK warehousing workforce, as well as in HGV drivers, are having impacts on supply chains in the UK. These workers shortages are primarily due to EU workers leaving the UK due to Brexit and the impacts of Covid-19 pandemic on the population and the National Health Service. Approximately 0.5 million workers have left the labour market in the last two years, many due to long-term sickness. Large

warehousing sites have become increasingly clustered in certain locations in the UK especially the Midlands and often not being served by good public transport services. This can increase competition between neighbouring warehousing sites for potential workers.

The UK government appointed Director of Labour Market Enforcement ruled in 2019 that in the warehouse sector, “Vulnerable workers are being exploited, in some cases indicative of modern slavery. Many more workers in the sector are not receiving National Minimum Wage” (Director of Labour Market Enforcement, 2019, p.15). Research has shown that elementary warehouse workers tend to be allocated tasks as required by the business, with little scope for worker decision-making or discretion. Low task discretion is associated with a negative impact on wellbeing and motivation compared to high task discretion (Kik et al., 2019).

A survey of 160 logistics workers in the UK in February 2022 asked respondents about nine aspects of their jobs to understand how important these were to them and how satisfied they were with them. The participants included those in warehousing and driving roles in both non-managerial and managerial roles. The three most highly rated aspects of the respondents’ jobs were ‘my job security’, ‘my pay’ and ‘amount of work’. Net satisfaction scores were considerably lower than net importance scores for all nine job aspects. Of the most three important aspects, net satisfaction scores were lowest for ‘my pay’, and ‘the amount of work’. The difference between net importance and satisfaction scores for these three aspects was considerable (28-52%) (Frontier Economics, 2022).

The warehousing and storage sector tends to receive relatively little media attention in the UK. However, the news attention it does receive is typically negative, including coverage of low pay, use of agency workers, zero hours contracts poor working conditions and overzealous performance management and penalisation in a small number of businesses. Recent high profile media cases that showed the industry in a poor light include the practices at the Sports Direct warehouse in Shirebrook, Derbyshire investigated in 2015-16. Eighty percent of its 5,000 workers were found to be on zero-hours contracts, with workers subject to extensive, time-consuming on-site body searches at the end of every shift without compensatory pay and many frequently given warnings about their work rate (Goodley and Ashby, 2015; House of Commons Business, Innovation and Skills Committee, 2016). Further negative media coverage of warehousing work included the online clothing retailer Boohoo’s working conditions and unauthorised pay deductions at its Burnley warehouse in 2017 and a subsequent newspaper article in 2020 about its wider supply chain practices in Leicester that led to an independent review of its business practices (Levitt, 2020).

Action films often provide the only occasion on which the general public get to see inside warehouses. However, the warehouse is typically portrayed as a place of crime and violence in which fights, shootouts and torture are conducted (with films including ‘The League of Gentlemen’ (1960), ‘Reservoir Dogs’ (1992), ‘Hard Boiled, (1992), ‘Layer Cake’ (2004)’, ‘Kick Ass’ (2010) and ‘Baby Driver’ (2017). In 2021, the BBC screened a television drama entitled ‘Life and Death in the Warehouse’ which depicted the poor treatment of workers in a fictional online retail warehouse, but which was based on a year of research including speaking to those who worked in the industry. Positive representations of the warehousing sector in the arts are far scarcer.

The warehousing and logistics industry (comprising developers, investors, occupiers, freight transport and logistics operators and relevant trade associations and professional bodies) needs to better communicate to the general public and potential workforce the growing diversity of roles and opportunities being created by the growth in adoption of automation and robotics in warehouses, including computing, engineering and management roles with attractive rates of pay. It also needs to take a joint stance against the practices of those among its ranks that behave in an unethical manner towards their workforce (in terms of pay and working conditions), ensure that gender and ethnic diversity is achieved in all forms and levels of warehouse work and take steps to project a positive image of the importance of warehousing operations and job opportunities. At the same time, Government needs to ensure that the pay and working conditions of elementary

warehouse workers are monitored and changes made to existing labour law in respect of zero hours contracts. The industry needs to also make greater efforts to provide washing, toileting and rest facilities to those vehicle drivers visiting the site to make collections and deliveries.

Automation is already affecting the level of employment in larger warehouses that have adopted it. In the longer term, the total size of the warehousing workforce is likely to fall per sq ft as ever-greater levels of sophisticated technology is introduced across sites of all sizes. This reduction in employment will especially affect manual roles in warehouses. However, humans performing manual roles are likely to continue to co-exist alongside this technology given the substantial costs of making a warehouse fully autonomous and of doing so to the extent that such technology is capable of meeting all the seasonal peaks in demand. It is likely to remain more cost-effective to cope with peak periods in warehousing operations by using additional human labour rather than having expensive technology that is under-utilised.

Greater attention should be paid by local planning authorities to vehicle trip generation estimates submitted as part of planning applications for new warehousing developments. Research suggests that the current methodology used to produce these traffic flows underestimates its actual volume, thereby imposing negative traffic and associated social and environmental impacts on residents and others in close proximity to such sites. This current methodology is based on assumptions that are outdated for warehouses operating in modern, demand-responsive supply chains, with goods being conveyed at all times of day and night.

Goods vehicle queuing problems on motorways and other roads in Kent as drivers attempt to reach Dover ports and the Channel Tunnel have become more frequent since Brexit. This may, in the longer term, lead to less reliance on roll-on roll-off (RoRo) goods vehicle traffic using these routes between Britain and mainland Europe for the import and export of goods. Such RoRo traffic may be redirected via other ports, together with a shift away from the use of accompanied vehicles towards unaccompanied trailers (to save driver time and costs) as well as greater use of lift-on lift-off (LoLo) container flows to other major ports beyond Kent. Any such changes in decisions about routings for and methods of transporting goods between mainland Europe and Britain would also be expected to influence warehousing location decisions.

7. Decarbonising warehouses

At present, the UK Government strategy for decarbonising warehouses is rather unclear and BEIS (the department responsible) has had relatively little to say about this since 2015, when the Government scrapped its predecessor's target that non-domestic buildings should be net zero by 2019. Any changes to national planning law (including the National Planning Policy Framework) that are necessary as part of this come under the remit of the Department for Levelling Up, Housing and Communities (DLUHC). Meanwhile, the Department for Transport is responsible for the decarbonisation of goods vehicles and other freight transport modes and has published plans concerning this, but these do not address their refuelling at warehouses and other distribution centres. The Department for International Trade is responsible for the importation of goods to the UK. Therefore, far closer working and co-ordination between BEIS, DLUHC, and the Departments for Transport and International Trade will be necessary to achieve supply chain decarbonisation that takes account of warehouses and associated logistics buildings together with the provision of the goods they receive (internationally and domestically) and the freight transport activity that provides these to them. In addition, closer co-ordination between different Government Departments with responsibility for various aspects of logistics and supply chain decarbonisation is not apparent.

As the Climate Change Committee has noted, the target for net zero GHG emissions "can only be achieved if government, regional agencies and local authorities work seamlessly together" (Climate Change Committee, 2020). It noted that local authorities have powers or influence over a third of emissions in local areas. This includes responsibility for local planning law concerning consent for new warehousing and the conditions imposed on it. Therefore, national government

must work far more closely with local government and other regional governmental bodies and executive agencies if the decarbonisation of warehousing and freight transport is to be achieved in a timely, cost-effective and efficient manner.

Government data shows that electricity and gas consumption per unit area of warehouse is lower than for many other non-domestic buildings. However, due to warehouses accounting for 34% of total non-domestic floorspace in 2020, they were responsible for 12% of total electricity use and 6% of total gas use in non-domestic buildings in England and Wales in 2020 (and 8% of total energy use in non-domestic buildings) (BEIS, 2022). The total quantity of energy consumed operationally in warehouses fell far less between 2012-2020 than for many other types of non-domestic building (see **Table 1** - BEIS, 2022). This is likely explained by the growing quantity of warehousing floorspace over the period and the growing use of automated machinery.

Table 1: Change in total electricity and gas consumption in non-domestic buildings by building use in England and Wales, 2012-2020

Building use	Electricity	Gas	Total
Community*	-34%	-27%	-30%
Education	-18%	-3%	-7%
Emergency services	-13%	-10%	-11%
Factories	-13%	10%	-1%
Health	-12%	11%	5%
Hospitality	-33%	-28%	-30%
Offices	-24%	-7%	-19%
Shops	-27%	-4%	-19%
Warehouses	-2%	-7%	-3%
Other	17%	20%	18%
Total	-14%	2%	-7%

Note: * - Buildings used for community, arts and leisure purposes.

Source: calculated from data in BEIS, 2022a.

It is estimated that the operational energy used by warehouses in the UK accounted for approximately 16% of the GHG emissions (CO₂e) from the UK supply chain in 2020 (based on domestic freight transport activity and operational warehousing energy use). If both domestic and international freight transport activity are taken into account, then warehousing energy use in the UK accounted for 11% of the GHG emissions (CO₂e) from the UK supply chain in 2019 (calculated using data in BEIS, 2022a, 2022b).

Assessment of energy use and GHG emissions related to buildings often only takes account of their operational life ('use phase') of the building. Even then, such assessments often omit energy use and GHG emissions associated with maintenance and refurbishment during the building's life. Proper consideration must take account of energy use and GHG emissions at all phases and in all activities of the life of a building. This includes the manufacturing, construction, use and end of life phases.

Some 'sustainable' warehouses have been constructed in recent years, indicating the steps that can be taken by developers and the construction industry to contribute to the UK's net zero GHG target. Energy supply and provision at warehouses can be improved by using renewable energy sources. Such approaches can include using flat roofs of large buildings for solar photovoltaic (PV) panels. It is estimated that the largest 20% of warehouses in the UK have sufficient roof space to double the UK's solar generation capacity from 14 to 28 GW (Delta Energy & Environment, 2022). Other available renewable energy generation approaches to energy supply include wind turbines, borehole thermal energy storage, electric air source heat pumps, water source heat pumps, electricity recharging points and hydrogen fuel cells for on-site handling equipment (BPF and Savills, 2022).

According to UK Government plans, new LGVs purchased after 2030 will have to be zero GHG tailpipe emissions, while for HGVs this will apply for vehicles up to 26 tonnes gross weight from 2035, and for heavier vehicles from 2040. Zero GHG tailpipe emission HGVs may be powered by hydrogen, electric batteries, and/or an Electric Road System (ERS). Whilst an ERS provides energy directly to the vehicle during its connection with it, HGVs powered by batteries or hydrogen will require recharging/refuelling.

Zero GHG tailpipe emission LGVs servicing warehouses and distribution centres are likely to be battery powered; such vehicles already exist and are in use in small numbers in the UK LGV fleet. At the end of 2021, 0.7% of the total LGV fleet in the UK was battery-electric (calculated from data in Department for Transport, 2022b). Warehouse and depot infrastructure required to facilitate goods vehicle recharging /refuelling can be expensive and can take considerable time to carry out.

Barriers to installing vehicle recharging infrastructure, solar panels and other renewable energy technology at warehouses include: the relatively low energy consumption at some warehouses, that most warehouses occupiers lease rather than own the building and may have short remaining lease durations, the risk of stranded assets if the occupier leaves the warehouse, obtaining permission from landlords who may be reluctant to grant approval, the design knowledge and expertise required, and the potentially high cost and long timescale of obtaining necessary grid connection upgrades from Distribution Network Operators (DNOs).

Some developers are also beginning to focus on including warehouse design features and amenities which are intended to improve worker wellbeing, primarily in order to improve attraction and retention rates amongst the workforce. This can include greater attention to air flow, light, temperature, sound, water use, space for movement and exercise, and other features that can enhance mental and physical wellbeing. Prologis has focused on outdoor space for workers and the local community for walking, running, cycling and resting. Its DC5 warehouse in Tilburg in the Netherlands and the GLP developed Altitude building, in Magna Park, Milton Keynes both completed in 2018, were Europe's first warehouses to meet the WELL Building Standard (GLP, 2020; JLL, 2020; Prologis, 2019).

8. Conclusions and recommendations

8.1 Changes and developments in UK warehousing

Warehousing has changed markedly in the last fifty years as a result of various changes in the UK economy and logistics practices. Important factors responsible for this change include: the rise of the service and relative decline of the manufacturing sector in the UK economy (resulting in a growing dependence on the importation of finished goods); the growth in the UK retailing sector and market concentration in the retailing market (resulting in the increasing dominance of major retailers operating their own warehouses); rises in interest rates during the early 1980s; the internal rationalisation of stockholding by large businesses leading to ever-larger but fewer warehouses primarily located on the strategic road network with a reliance on longer distance freight transport journeys (which has been driven by the relative costs of stockholding and freight transport); and the growing deployment of materials handling equipment and automated stock control and picking systems. These factors have led to dramatic changes in the size and location of warehouses and the operations taking place within them, supported by an increasing degree of computer technology and automation and thereby a reduction in total workforce otherwise required.

Changes in logistics practices over this period resulted in the role of the warehouse shifting from being a relatively inactive place where goods were held in store with poor stock visibility along the supply chain to a dynamic supply chain node through which goods are channelled in accordance with demand. In conjunction with the increase in the dominance of large businesses and substantial increases in urban land values this has led to a reduction in stockholding levels in

shops and offices in order to convert stockholding space into sales areas and other value-added activities and reduce total space requirements in these facilities. This has been achieved by placing greater reliance on frequent deliveries from warehouses to these urban sites by goods vehicles.

Over recent decades the average size of warehouse has increased markedly, with an ever-growing proportion of warehouses with more than 100,000 sq ft of floorspace as well as increasing eaves heights. This has been combined with a greater centralisation of these large warehouses especially in the middle of the country (particularly the East and West Midlands) located in close proximity to the motorway network which receive goods arriving in the UK via ports and which rapidly transfer these goods onwards to locations across the country to retail and business locations where they are sold and used. This inbound and outbound warehouse transport primarily takes place using articulated HGVs. The amount of time that goods are stored in warehouses has diminished over recent decades as logistics management has become more efficient and demand focused, with the warehouse increasingly becoming a transshipment point used to organise and co-ordinate the supply chain rather than primarily a place of inactive stockholding.

Despite the increasing speed with which goods move through their supply chains and the warehouses in those chains, the total quantity of warehousing has increased nationally at a considerable rate over recent decades, primarily as a result of the growth in retailing in the UK together with the relative decline in UK manufacturing and the consequent rise in importation of consumer and capital goods. Warehousing uptake in the UK in 2020 and 2021 was the strongest on record and warehouse vacancy rates reached an all-time low. Supply chain difficulties experienced as a result of Covid-19, Brexit and the war in Ukraine have led to businesses wanting to hold increasing stock levels. In addition, the rapid growth in online shopping in the last five years, exacerbated by the onset of the Covid-19 pandemic in 2020, has further fuelled the demand for warehousing as the focus of retailing and the provision of retail goods moves increasingly away from physical shops to fulfilment centres. This recent surge in online shopping has also reversed the previous decline in warehousing in urban areas as retailers acquire sites from which to fulfil same- and next-day deliveries.

8.2 Planning for future warehousing requirements

The future demand for warehousing in the UK is somewhat uncertain. Some commentators expect warehousing demand to continue to increase in the coming years as UK businesses require greater 're-shoring' (also referred to as 'on-shoring' and 'near-shoring') of goods that they currently import from distant, international locations to mitigate against continued or future supply chain disruptions at ports and borders. However, implementing such a change to supply chains takes considerable time to implement, so it is too soon to be able to say with any certainty whether many businesses are implementing such a strategy. Such a near-shoring production strategy can also lead to greater risks from national disruption and that in nearby countries to raw material inputs and labour markets, as well as transport infrastructure, so does not necessarily improve supply chain resilience. Clearly greater thought needs to be given by businesses to supply chain resilience to prevent disruption to long distance goods transport.

Another approach being discussed by some commentators to achieve greater supply chain resilience involves businesses implementing less centralised stockholding with warehousing sites located closer to the sales markets served. Similar to near-shoring of production this involves relocating stockholding closer to customers. However, the impacts of such a strategy on avoiding supply chain disruption is unclear especially if production continues to take place in very distant locations, as this leaves much potential for goods flows to still be affected in their movements between the point of production and stockholding. It would also be likely to lead to substantial investment costs in new warehousing facilities, possibly in locations with higher land values and rental prices. It would also be likely to result in higher logistics operating costs due to the benefits that centralising stockholding and placing more reliance on freight transport provides.

Economic factors that began to emerge in 2022, including the cost of living crisis and a looming recession, may damp down demand for goods and hence warehousing space, and are adversely affecting the growth of online retailers, especially those providing instant deliveries that emerged during the pandemic providing groceries and meals and taking out urban premises to store, pick and despatch these goods. Meanwhile, inflationary pressures that are driving up energy, labour and transport costs are liable to also result in rising warehouse rental prices making them unaffordable for some occupiers.

Warehousing supply and demand are dealt with by the market, with occupiers deciding how much space they require and developers and investors providing that space, with the market determining its rental value. However, the UK Government plays an important role in terms of national planning law and guidance concerning the granting of planning consent for warehouse development, while local planning authorities make decisions on individual warehouse applications.

Warehousing has traditionally been viewed by public sector economic development officers and town planners as generating low employment density, low paid, unskilled work. Whilst the pay of manual warehouse workers has not improved considerably in recent years, and the work of many doing so has become increasingly precarious with the introduction of zero hours contracts, the increasing deployment of automation in large scale warehouses is providing higher skilled better paid work for those involved in its implementation and maintenance. In addition, the land uses typically viewed as superior to warehousing by public officials, such as offices, retailing outlets and manufacturing sites, are far less in demand as a result of changes in working practices (with many more people working from home since the pandemic leading to a reduction in office demand) in retailing provision (with the growth in online retailing over the last twenty years resulting in a gradual but progressive decline in the demand for retail space) and in the continued relative decline in UK manufacturing. In addition, warehousing developments been viewed less preferentially than housing schemes in local authorities' efforts to meet the dwelling needs of a growing population.

It is therefore an appropriate time for a reconsideration of the importance and status of warehousing by public sector economic development officers and town planners given the decline in other types of work and their demand for buildings, and the need to create jobs for a workforce that will expand in future. Reconsideration of the importance of warehousing should go beyond national Government guidance concerning the decision-making process for warehouse development at a local level and should instead involve a coherent national strategy for warehousing that takes account of its importance in modern, efficient, decarbonised supply chains and the provision of space for it and which could be enshrined in the National Policy Planning Framework. The publication of the Department for Transport's 'Future of Freight Plan' in June 2022 marks an important start in this process, with the UK Government acknowledging the importance that it identifies, "a National Freight Network (NFN) across road, rail, maritime, aviation, inland waterway and warehouse infrastructure", pledging that "our long term aim will be to remove the barriers which prevent the seamless flow of freight" (Department for Transport, 2022a). Within this plan the government has also noted that it "is working with industry to explore ways to protect and expand the warehousing land capacity" (Department for Transport, 2022a). In order to achieve change, this work by the UK Government will clearly need to go far beyond 'exploring ways' but the statement is an acknowledgement of the importance of this issue.

This Plan also recognises that current local planning system is not working adequately for warehousing and other logistics development proposals, with proposals often dealt with too slowly, thereby "reducing the level of certainty for applicants, investors and communities. This increases the uncertainty of delivering development associated with freight and logistics, actively discouraging promoters from bringing forward schemes and can lead to sub-optimal outcomes." The government argues that "all of these considerations can be better met through better collaboration between industry and local authorities supported by an agile and responsive planning system" (Department for Transport, 2022a).

At a regional and local level, efforts to ensure the provision of suitable quantities and types of land for warehousing in appropriate locations as well as to safeguard such land for future demand should be reflected in Local Plans. These can be supported by Local Industrial Strategies that highlight the role and importance of warehousing. Industry has an important role to play in achieving this by communicating to national, regional and local governmental bodies its warehousing needs and working with these public policymakers to help ensure that outcomes of such efforts are suitable and realistic. Town planners will also have to be realistic about the plot ratios that are required at warehouse to facilitate all the outdoor activities and facilities that are necessary. Any efforts by planners to insist of higher plot ratios to adversely affect the functioning of the warehouse and the cost of warehouse operations and the negative impacts of its operations on neighbouring sites. Some planners and politicians have shown enthusiasm for the intensification of industrial sites either through co-location or the development of multi-level facilities. In the case of warehousing, the former is liable to be impractical when the co-located developments are residential dwellings given the noise and operating hours associated with warehouses, while the latter is liable to lead to less efficient and more expensive warehouse operations (see Allen and Piecyk, 2023d for further discussion of these issues).

Greater attention should also be paid by local planning authorities to vehicle trip generation estimates submitted as part of planning applications for new warehousing developments. Research suggests that the current methodology used to produce these traffic flows underestimates its actual volume, thereby imposing negative traffic and associated social and environmental impacts on residents and others in close proximity to such sites. This current methodology is based on assumptions that are outdated for warehouses operating in modern, demand-responsive supply chains, with goods being conveyed at all times of day and night.

The warehousing and logistics industry (comprising developers, investors, occupiers, freight transport and logistics operators and relevant trade associations and professional bodies) needs to better communicate the economic and other benefits warehousing has to offer the general public and local communities as well as to take a joint stance against the practices of those among its ranks that behave in an unethical manner towards their workforce (in terms of pay and working conditions). It needs to communicate to the general public and potential workforce the growing diversity of roles that are being created by the growth in adoption of automation and robotics in warehouses, including computing, engineering and management roles with attractive rates of pay. At the same time, Government needs to ensure that the pay and working conditions of elementary warehouse workers are monitored and changes made to existing labour law in respect of zero hours contracts. The industry needs to also make greater efforts to provide washing, toileting and rest facilities to those vehicle drivers visiting warehousing sites to make collections and deliveries.

Automation is already affecting the level of employment in larger warehouses that have adopted it. In the longer term, the total size of the warehousing workforce per sq ft is likely to fall as ever-greater levels of sophisticated technology is introduced across sites of all sizes. This reduction in employment will especially affect manual roles in warehouses. However, humans performing manual roles are likely to continue to co-exist alongside this technology given the substantial costs of making a warehouse fully autonomous and of doing so to the extent that such technology is capable of meeting all the seasonal peaks in demand. It is likely to remain more cost-effective to cope with peak periods in warehousing operations by using additional human labour rather than having expensive technology that is under-utilised. Questions remain about which tasks should be left to humans to achieve optimum joint performance with machines, how to ensure that humans have a good working environment when collaborating with automated machines, and how to remove the tasks most associated with human worker injury, discomfort and boredom. In addition, little research has been carried out into the environmental impacts of the various automated technologies being developed for and used in warehouses.

Goods vehicle queuing problems on motorways and other roads in Kent as drivers attempt to reach Dover ports and the Channel Tunnel have become more frequent since Brexit. This may, in the longer term, lead to less reliance on roll-on roll-off (RoRo) goods vehicle traffic using these

routes between Britain and mainland Europe for the import and export of goods. Such RoRo traffic may be redirected via other ports, together with a shift away from the use of accompanied vehicles towards unaccompanied trailers (to save driver time and costs) as well as greater use of lift-on lift-off (LoLo) container flows to other major ports beyond Kent. Any such changes in decisions about routings for and methods of transporting goods between mainland Europe and Britain would also be expected to influence warehousing location decisions.

Warehouse contracts between owners and occupiers need to become fairer and more flexible. Such changes would allow occupiers to make alterations to buildings and their fixtures and fittings they require for operational efficiency (such as installing mezzanine floors, technology and automation), how they use the building and with which other businesses they share the space without this being prevented or delayed by owners. This contract flexibility also needs to address the ownership of such capital investments which currently often reside with the owner, thereby potentially deterring occupier investment in making their warehouses best suited to their needs. The fairness and flexibility of the contract also has implications for the carrying out of energy efficiency improvements and the installation of equipment required to decarbonise warehouses (such as upgrading energy infrastructure at buildings for electric vehicle recharging and installing solar panels of roof space). It would also prevent the absurdity that can occur of occupiers having to remove infrastructure at the end of their lease that would have been of use to subsequent occupiers and which has to be reinstalled by them, and the environmental impacts of such situations. The parties in the warehousing industry (owners, occupiers, property agents and consultants and insurers) need to work together to bring about such changes to lease flexibility that facilitates operational efficiency and decarbonisation.

8.3 Decarbonising warehousing and the supply chain

The total quantity of electricity and gas consumed operationally in warehouses fell far less between 2012-2020 than for many other types of non-domestic building. This is likely to have been due to the growth in total warehousing floorspace and the increasing use of automation, computing and other technology on their energy requirements.

Analysis indicates that in 2020, the operational energy used by warehouses accounted for approximately 16% of the GHG emissions (CO₂e) from the UK supply chain, with 84% accounted for by freight transport operations (based on domestic freight transport activity and operational warehousing energy used in the UK in 2020 – this data only includes warehouse energy use in England and Wales). If both domestic and international freight transport activity are taken into account, then warehousing energy use in the UK accounted for 11% of the GHG emissions (CO₂e) from the UK supply chain in 2020 (calculated using data in BEIS, 2022a, 2022b, 2022c).

Assessments of energy use and GHG emissions related to buildings often only take account of their operational life ('use phase') of the building. Even then, such assessments often omit energy use and GHG emissions associated with maintenance and refurbishment during the building's life. Proper consideration must take account of energy use and GHG emissions at all phases and in all activities in the life of a building including warehouses. This includes the manufacturing, construction, use and end of life phases. A few 'sustainable' warehouses have been constructed in recent years, indicating the steps that can be taken by developers and the construction industry to contribute to the UK's net zero GHG target.

The current UK Government and devolved administrations have been slow to bring forward new legislation concerning energy efficiency and GHG emissions of new and existing warehouses. An increase in the rate of Government action in building standards and energy efficiency requirements for non-domestic buildings is required if the warehousing industry is to meet net zero GHG emissions by 2050 given the lifespan of warehousing and the legal and operational difficulties associated with retrofitting existing buildings and installing infrastructure to decarbonise them. Many warehouses being built now will still be in operation in 2050 so urgent action is required to address these issues. Far greater consideration of the refuelling of zero emission goods vehicles

is also required by developers and local and national Government. The UK Government has been far slower to set targets and actions for reducing warehouses GHG emissions than for transport vehicles. Policymakers need to acknowledge the related nature of logistics activities and therefore set GHG emission reduction targets for both.

At present, the UK Government strategy for decarbonising warehouses is rather unclear and BEIS (the department responsible until recently) has had relatively little to say about this since 2015, when the Government scrapped its predecessor's target that non-domestic buildings (including warehouses) should be net zero by 2019. Any changes to national planning law (including the National Planning Policy Framework) that are necessary as part of this come under the remit of the Department for Levelling Up, Housing and Communities (DLUHC). Meanwhile, the Department for Transport is responsible for the decarbonisation of goods vehicles and other freight transport modes and has published plans concerning this, but these do not address their refuelling at warehouses and other distribution centres. The Department for International Trade is responsible for the importation of goods to the UK. Therefore, far closer working and co-ordination between BEIS, DLUHC, and the Departments for Transport and International Trade will be necessary to achieve supply chain decarbonisation that takes account of warehouses and associated logistics buildings and the freight transport activity that handles goods to & from them (domestically and internationally).

As the Climate Change Committee has stated, the target for net zero GHG emissions “can only be achieved if government, regional agencies and local authorities work seamlessly together” (Climate Change Committee, 2020). It noted that local authorities have powers or influence over a third of emissions in local areas. This includes responsibility for local planning law concerning consent for new warehousing and the conditions imposed on it. Therefore, national government must work far more closely with local government and other regional governmental bodies and executive agencies if the decarbonisation of warehousing and freight transport is to be achieved in a timely, cost-effective and efficient manner.

The Department for Transport also needs to work with DLUHC and BEIS to ensure that Government infrastructure investment in railways and ports helps to facilitate freight modal shift to non-road modes by improving these transport links between ports, warehouses and centres of demand. This would help stimulate greater private sector warehousing provision and demand at strategic rail freight terminals and in UK ports that can make use of alternative freight transport modes. These modal shift efforts should also include streamlining the time taken for planning decisions for such rail and port developments which currently hinder their provision and results in excessive costs for developers, thereby discouraging them. Consideration should also be given to including requirements in national and local planning policy that new large warehouses need to be co-located with and incorporate rail and water facilities. The provision of financial or other incentives for property developers to include rail and water facilities in their applications for large new warehouses to encourage modal shift should also be considered.

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