



# The financial and economic impact of warehouse fires

**An evidence-based assessment of the direct and indirect economic impacts in England and Wales of fires in warehouse buildings without automatic fire sprinkler systems (AFSS)**

**Report for the Business Sprinkler Alliance**  
January 2014

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**Authorship and acknowledgements**

This report has been produced by Cebr, an independent economics and business research consultancy established in 1992. The study was led by Oliver Hogan, Director and Head of Microeconomics and Shehan Mohamed, Senior Economist with analytical and research support from Cebr Senior Economist Colin Edwards, Economist Danae Kyriakopoulou, with senior advice, guidance and insights from Graham Brough, our CEO. The views expressed herein are those of the authors only and are based upon independent research by them.

This study has been commissioned by the Business Sprinkler Alliance and has utilised a combination of data provided by environmental and planning consultants, BRE Global, the Fire Protection Association and those available in the public domain through the ONS, DECC, Nomis and a range of other sources.

The report does not necessarily reflect the views of the Business Sprinkler Alliance.

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## EXECUTIVE SUMMARY

This report by Centre for Economics and Business Research (Cebr) quantifies the financial and economic value of the damage and disruption caused by fires in commercial warehouse premises located in England & Wales which are not fitted with automatic fire sprinkler systems (AFSS).

Current legislation on fire safety primarily seeks to guard against loss of life and the spread of fire to surrounding premises, with little provision for the protection of the premises itself or its physical contents, which can include valuable inventory and capital assets like machinery and equipment. Such a provision would provide better incentives for the parties to commercial warehouses (developers, owners, occupiers etc.) to invest in active fire protection measures such as AFSS. This would, in turn, serve the primary objectives anyway.

But such incentives can be clouded by the arrangements governing ownership and control of commercial premises – particularly in warehousing. The information asymmetries between the different parties to the premises has resulted in uncertainty surrounding the benefits that can be expected to be reaped from investment in AFSS. This has produced a market failure whereby the technology is underprovided. This report seeks to shed light on these uncertainties by assessing the financial losses to business as a result of warehouse fires and how this translates into losses to the economy of England and Wales.

**Between 2009 and 2012, there was an annual average of 588 fires in commercial warehouses** that did not have automatic fire sprinkler systems installed as a preventative measure. These 588 fires are estimated to have the following annual impacts on business, the economy, employment and the exchequer:

- A total **direct financial loss to business of £230.2 million** per year
- An aggregate **direct economic loss of £62.8 million to GVA**,<sup>1</sup> and a more significant **loss of £127 million when the ‘ripples’ through the economy are accounted for by lost indirect and induced multiplier impacts**
- An **employment loss of 996 jobs per year**, of which 612 jobs are lost indirectly
- A **tax loss of £31.7 million to the Exchequer** from reduced business rates, employers’ NICs, income tax, corporation tax etc.

Table 1 below presents the financial losses to those businesses directly affected by warehouse fires by category of damage and disruption, as well as the direct loss to the ongoing economic performance that flows from these financial losses. **To the estimate of £56.8 million is added £6 million in lost earnings of the employees of warehouses affected by fire.** This is what produces the aforementioned £62.8 million direct loss of GVA.<sup>2</sup>

1 GVA or gross value added is a measure of the value from production in the national accounts and can be thought of as the value of industrial output less intermediate consumption. That is, the value of what is produced less the value of the intermediate goods and services used as inputs to produce it. GVA is also commonly known as income from production and is distributed in three directions – to employees, to shareholders/financiers and to government. GVA is linked as a measurement to GDP – both being a measure of economic output. That relationship is (GVA + Taxes on products - Subsidies on products = GDP). Because taxes and subsidies on individual product categories are only available at the whole economy level (rather than at the sectoral or regional level), GVA tends to be used for measuring things like gross regional domestic product and other measures of economic output of entities that are smaller than the whole economy, such as the warehousing industry.

2 The loss to GDP would be slightly larger, assuming that the warehousing industry pays more indirect taxes, like VAT, than it receives in subsidies on its services. However, as noted in the previous footnote, it is not possible to calculate these accurately.

**Table 1: Direct financial and economic losses by loss category, 2012, millions of pounds**

Loss Category	Financial Loss	Economic Loss (loss in GVA)
Building	81.3	-
Contents	3.3	-
Machinery	18.7	-
Stock	39.7	-
Business Interruption	38.8	21.7
Loss of rent	6.2	-
Other	7.1	-
Business failure	23.8	23.8
Loss of growth	3.6	3.6
Local business disruption	7.7	7.7
<b>Total</b>	<b>230.2</b>	<b>56.8</b>

Source: Fire Protection Association, BRE Global, Cebr Analysis

Table 2 summarises these direct economic impacts on GVA, taxes and employment split by warehouse size. This shows a **direct loss of 384 jobs and £8.2 million in direct tax losses**.

**Table 2: Total direct annual loss in GVA, tax and employment due to warehouse fires, 2012**

£ millions	Small (< 2,000 m <sup>2</sup> )	Medium (2,000 m <sup>2</sup> to 10,000 m <sup>2</sup> )	Large (>10,000 m <sup>2</sup> )	Total
<b>Total direct loss in GVA (£m)</b>	11.4	33.7	17.8	62.8
<b>Total direct tax loss to the Exchequer (£m)</b>	2.0	4.2	2.1	8.2
<b>Total direct employment losses</b>	155	164	64	384

Source: Fire Protection Association, BRE Global, Cebr Analysis

Applying estimates of the multipliers for the warehousing industry (based on Cebr's input-output models) to the direct economic impacts from above provides our estimates of the lost multiplier impacts on GVA, employment and tax takings. These are presented in Table 3 below.

**Table 3: Total annual multiplier losses in GVA, tax and employment due to warehouse fires, 2012**

	Small (< 2,000 m <sup>2</sup> )	Medium (2,000 m <sup>2</sup> to 10,000 m <sup>2</sup> )	Large (>10,000 m <sup>2</sup> )	Total
<b>Total indirect &amp; induced multiplier economic costs (£m)</b>	28.2	65.8	33.1	<b>127.1</b>
<b>Total indirect tax loss to the Exchequer (£m)</b>	5.3	12.0	6.0	<b>23.4</b>
<b>Total indirect employment losses</b>	248	261	103	<b>612</b>

Source: Fire Protection Association, BRE Global, Cebr Analysis

Our findings show that a total of **£127.1 million per year is lost indirectly due to warehouse fires and a total indirect jobs loss of 612 employees is also realised**. Through these multiplier impacts, the **further loss to the Exchequer is £23.4 million per year as a result of warehouse fires**.

Table 4 combines the estimates of the direct, indirect and induced impacts on the economy from above to produce our estimates of aggregate economic impacts.

**Table 4: Total annual loss in GVA, tax and employment due to warehouse fires, 2012**

	Small (< 2,000 m <sup>2</sup> )	Medium (2,000 m <sup>2</sup> to 10,000 sqm)	Large (>10,000 m <sup>2</sup> )	Total
<b>Direct economic costs (£m)</b>	11.4	33.7	17.8	<b>62.8</b>
<b>Indirect economic costs (£m)</b>	28.2	65.8	33.1	<b>127.1</b>
<b>Total economic costs (£m)</b>	39.5	99.5	50.9	<b>189.9</b>
<b>Total loss in employment</b>	404	425	167	<b>996</b>
<b>Total tax loss to the Exchequer (£m)</b>	7.4	16.2	8.1	<b>31.7</b>

Source: Fire Protection Association, BRE Global, Cebr Analysis

**Our findings show that warehouse fires cost the national economy £190 million in GVA annually and result in approximately 996 job losses every year. The aggregate tax loss to the Exchequer is estimated at £31.7 million.**

Delving deeper into local-level impacts reveals that impacts at this level have the potential to be more severe and permanent, particularly if a warehouse business that has suffered fire fails completely or reopens in a different location. Our analysis of a number of case studies is, in the absence of better information, undertaken through the lens of the national modelling framework. The estimates are purely assumptions-based, therefore, and purely illustrative in order to demonstrate how local areas are negatively impacted by fire can suffer disproportionately relative to the national picture.

At the national level, the impacts can be expected to look much less severe because there are positive impacts on other local economies that benefit from businesses that have suffered fire re-locating to their area. While such gains mitigate the local losses when considered from the point of view of the England & Wales economy as a whole, the fact is that the local losses can be severe and permanent if nothing takes the place of the business that was once there.

Cebr's estimates of the losses to the economy as a result of warehouse fires also takes account of the disruption to businesses operating in close proximity to the warehouse that suffered a fire. Our review of 12 case studies reveals that, on average, around 21 businesses are affected through road closures and air and water contamination. Warehouse fires tend to be most disruptive when they occur in industrial parks because they result in road closures within the park itself and in the wider surrounding road network that leads to the park.

Fires in warehouses also impact the environment and, in doing so, impose additional economic costs. Firstly, fires generate carbon emissions, both from CO<sub>2</sub> released during the fire itself and from CO<sub>2</sub> generated during the replacement and rebuild phase following the fire. Thousands of litres of water are used to control fires, resulting in additional costs. The total quantifiable environmental costs associated with warehouse fires are summarised in Table 5 below.<sup>3</sup> These are calculated using £56 per tonne as the appropriate monetary value of the CO<sub>2</sub> emissions - the 'non-traded' value of carbon in 2012 as outlined by the Department of Energy and Climate Change - and based on a total number of fires of 588 per year in total.

**Table 5: Annual environmental costs (£ millions)**

	Small	Medium	Large	Total
<b>CO<sub>2</sub> released during fire</b>	0.6	0.8	0.5	1.9
<b>CO<sub>2</sub> embodied in replacement</b>	1.6	2.2	1.3	5.0
<b>CO<sub>2</sub> embodied in rebuild</b>	0.3	0.3	0.2	0.7
<b>Cost of water used in firefighting</b>	2.5	0.4	0.2	3.1
<b>Total</b>	<b>5.0</b>	<b>3.7</b>	<b>2.0</b>	<b>10.7</b>

*Source: BRE Global, Cebr analysis*

As the table shows, **the environmental impact of warehouse fires in England & Wales is estimated at £10.7 million per annum**, of which £7.6 million is incurred through emissions of CO<sub>2</sub> – the value Cebr attaches to the annual release of 136,000 tonnes of CO<sub>2</sub> as a result of warehouse fires.

The losses to business and to the economy can be turned on their head and represented as the savings or returns that derive from the installation of AFSS that would have prevented the damage in the first place. This can act to guide policy towards fire protection in England and Wales. Specifically, our results suggest that there are significant costs to be saved if every effort is undertaken to minimise the spread of large fires. Three courses of action through which this outcome can be realised have been identified:

- Firstly, increasing awareness about the benefits that can be derived from the installation of AFSS among the parties making up the fragmented ownership and operational structures in the warehousing industry can increase the currently sub-optimal, under-provided levels of AFSS.
- Secondly, Government action has the power to correct the failure of the market to provide sufficient levels of AFSS through discussion with businesses, education and information sharing on the benefits that can be derived through their installation, thus indirectly ensuring that they are aware of the incentives for increasing the rollout of AFSS.
- Thirdly, while current regulations are guided principally by minimising the loss of life, the business, economic and environmental impacts – as reflected in the findings of our study - suggests that it is in

<sup>3</sup> These estimates are limited to the valuation of carbon dioxide and the resource costs of the water used to fight the fire.

the Government's interests to go further. As such, Cebr recommends that Government should review the building regulations, specifically the requirement for only those newly-built warehouses that exceed 20,000 m<sup>2</sup> to install AFSS.

Reducing this threshold would, moreover, be consistent with what appears to be best practice when considered in an international context. For example, in other jurisdictions, such as Germany, the Netherlands, Belgium and France, the threshold that triggers an automatic requirement to install AFSS ranges from between 1,000 m<sup>2</sup> and 5,000 m<sup>2</sup>. Given our findings that 73 per cent of the financial, economic and environmental impacts of fires are concentrated in warehouses of under 10,000 m<sup>2</sup>, a review of the threshold would appear to be the natural starting point for change.

## 1 INTRODUCTION AND BACKGROUND

This is a report by Centre for Economics and Business Research (Cebr) on the costs of warehouse fires at the business and economy-wide level. It is specifically focussed on fires occurring in warehouse buildings which are not protected with automatic fire sprinkler systems (AFSS). Fires in warehouses that do not have AFSS make up the vast majority of cases. The study was commissioned by the Business Sprinkler Alliance (BSA).

### 1.1 Purpose of the study

The purpose of the study was to provide a quantitative assessment of the financial costs incurred by business and the impacts (in terms of lost GVA<sup>4</sup> and employment) on the economy of England and Wales, on the UK Government (through lost taxation) and on the environment as a result of warehouse fires. The cost to the economy of warehouse fires without AFSS can then be turned on their head and represented as the economic benefits of preventing warehouse fires through the installation of AFSS.

When quantifying the financial cost to business, we aimed to capture the cost of damage to the building, as well as its contents, stock, and machinery. We also sought to capture the cost (or losses) arising from the activities of the business being interrupted and the lost opportunity for business growth during the period of interruption. We highlight the business-critical element of the risks fire disruption poses to businesses as represented by the number of business failures resulting from warehouse fires and the associated losses.

We then sought to analyse how warehouse fires impact on the economy. These are felt through the loss of GVA generated by and employment in the warehousing industry. These impacts filter through to other industries that support warehousing activity through its supply chain and through the lost employee spending impacts – calculated using Cebr’s estimates of multiplier impacts for the warehousing industry. We also consider disruption in the supply chain of businesses that rely on goods distributed through warehousing and logistics service providers.

Based on lost direct and (indirect and induced) multiplier impacts, we estimated the accompanying impacts on the Exchequer in terms of lost tax revenues. Specifically, we aimed at quantifying the loss in earned and taxed income and national insurance contributions associated with employment losses from warehouse fires. Direct GVA losses were also identified as a source of revenue losses to the Exchequer in terms of corporation tax and business rates.

Finally, we analyse the disruption felt at the local and regional level. This refers to the disruptive effects of fire on businesses in and around the vicinity for the duration of the fire, and to the longer-lasting effects on the local economy as a result of the disruption, and sometimes failure, of the fire-affected business.

<sup>4</sup> GVA or gross value added is a measure of the value from production in the national accounts and can be thought of as the value of industrial output less intermediate consumption. That is, the value of what is produced less the value of the intermediate goods and services used as inputs to produce it. GVA is also commonly known as income from production and is distributed in three directions – to employees, to shareholders/financiers and to government. GVA is linked as a measurement to GDP – both being a measure of economic output. That relationship is (GVA + Taxes on products - Subsidies on products = GDP). Because taxes and subsidies on individual product categories are only available at the whole economy level (rather than at the sectoral or regional level), GVA tends to be used for measuring things like gross regional domestic product and other measures of economic output of entities that are smaller than the whole economy, such as the warehousing industry.

## 1.2 Structure of the report

The remainder of this report is structured as follows:

- Section 2 introduces the legal, policy, and commercial background within which our economic analysis of fires in warehouse premises is undertaken.
- Section 3 provides an overview of the importance of the warehousing industry in England and Wales. This will assist in developing an understanding of the estimated magnitude of the financial and economic losses that result from warehouse fires.
- Section 4 outlines the methods and assumptions used in our assessment of the financial and economic costs of fires in the UK warehousing industry.
- Section 5 delves deeper into the valuation of the financial losses to business as a result of warehouse fires.
- Section 6 looks at the macroeconomic impact in England & Wales as a whole, but also examines local economy impacts, which can be expected to be more severe and permanent than the view from the national level.
- Section 7 presents our methods and estimates for the environmental costs imposed by warehouse fires.
- Section 8 provides some key conclusions from the findings of the report.

## 2 WAREHOUSE FIRES IN CONTEXT

This section introduces the legal, policy, and commercial background within which our economic analysis of fires in warehouse premises is undertaken. The aim is to uncover the factors at play in determining the installation of Automatic Fire Sprinkler Systems (AFSS). The incentives to engage in active fire protection measures can be externally imposed on businesses through relevant government laws and regulations, or may arise naturally through market forces when the economic benefits they bring to the agent in question are great enough to justify their installation.

Sub-section 2.1 examines the relevant policy and legal frameworks governing fires in commercial buildings in England and Wales, and places this in an international context by providing a comparison with equivalent policy in other countries. Sub-section 2.2 looks into the market incentives for the installation of AFSS by examining the fragmented pattern of ownership, use and management of warehouses in England and Wales. Finally, sub-section 2.3 provides further context to the reality behind the numbers presented in this report by examining the impact of warehouse fires at the local level for two representative case studies.

### 2.1 Government policy on warehouse fires

Government policy towards fires occurring in commercial buildings is shaped by two pieces of legislation. The Building Act (1984) provides the framework for the UK to respond to the challenges posed by fires in commercial premises and dwellings. That framework includes powers to make building regulations that require the implementation of fire safety measures for all new, extended and altered buildings.

The Act, therefore, allows the Government to set minimum requirements in relation to the design of commercial premises, and the fire detection and/or prevention measures to be incorporated.<sup>5</sup> The purpose of these regulations is, ultimately, to slow the spread of fire on the commercial premises, to ensure safe and effective means of escape for those on-site and to provide access and facilities for the fire service.

There are also the fire safety requirements of the Fire Safety Order (2005) for England and Wales, which involve compliance measures from the businesses occupying commercial premises. The Order imposes a duty on occupants to ensure that the necessary fire precautions are taken to provide for the safety of the people using the premises and those in the immediate vicinity. This is realised through fire risk assessments that enable businesses to identify, manage and reduce the risk of fire. These are generally tailored to the various uses to which the premises are put.

Approved documents issued by the Secretary of State provide the practical guidance on how to meet the building regulations on fire safety. The role that AFSS play in reducing the risk of loss of life and the degree of damage is acknowledged in the current guidelines, which allow businesses to substitute other fire safety measures for these AFSS technologies (for example, firewalls within a building or minimum distances between adjacent buildings).

<sup>5</sup> The Secretary of State publishes 'Approved Documents'. Approved Document B addresses directly fire safety within buildings and provides guidance on ways to comply with the building regulations.

In England, it is recommended that newly built commercial warehouse buildings which exceed 20,000 square metres in floor space should have AFSS installed.<sup>6</sup> By comparison, the recommendations for installing AFSS in retail outlets are set at premises that exceed 2,000 m<sup>2</sup> in area.

By European standards, England & Wales have some of the least rigorous requirements for the use of AFSS when considering different-sized warehouses. Table 6 illustrates current legislation on minimum floor space requirements for commercial warehouses in a range of European countries – buildings that are larger than these areas require AFSS to be installed.

**Table 6: Maximum floor spaces for which there is no requirement for commercial warehouses to install AFSS, 2013**

Country	Maximum recommended floor space without fire sprinklers (m <sup>2</sup> )
Netherlands	1,000
Germany	1,200
Austria	1,800
Spain	2,000
France	3,000
Belgium	5,000
Ireland	14,000
England	20,000

*Source: Business Sprinkler Alliance, Cebr analysis*

There is clearly a significant difference in fire safety standards expected in commercial warehouses with respect to implementation of AFSS. As outlined in later sections of this report, the versatility of warehouses' use for a range of retail, manufacturing, packing and distribution activities, as well as proven trends in the growth in internet-based retail distribution (see section 3.4) are leading to escalating financial costs to businesses beset by warehouse fires.

Furthermore, given the specific ownership and occupying structure of commercial warehouses (as described in section 2.2) it is clear that lack of information between the different parties (e.g. developer, owner and occupier of the premises) can result in a market failure whereby the technology to address the problem is underprovided. As such, better sharing of information on the potential costs of warehouse fires between parties and a review of current recommended guidance of minimum floor space sizes for installation of AFSS should be considered.

## 2.2 Commercial incentives to invest in Automatic Fire Sprinkler Systems (AFSS)

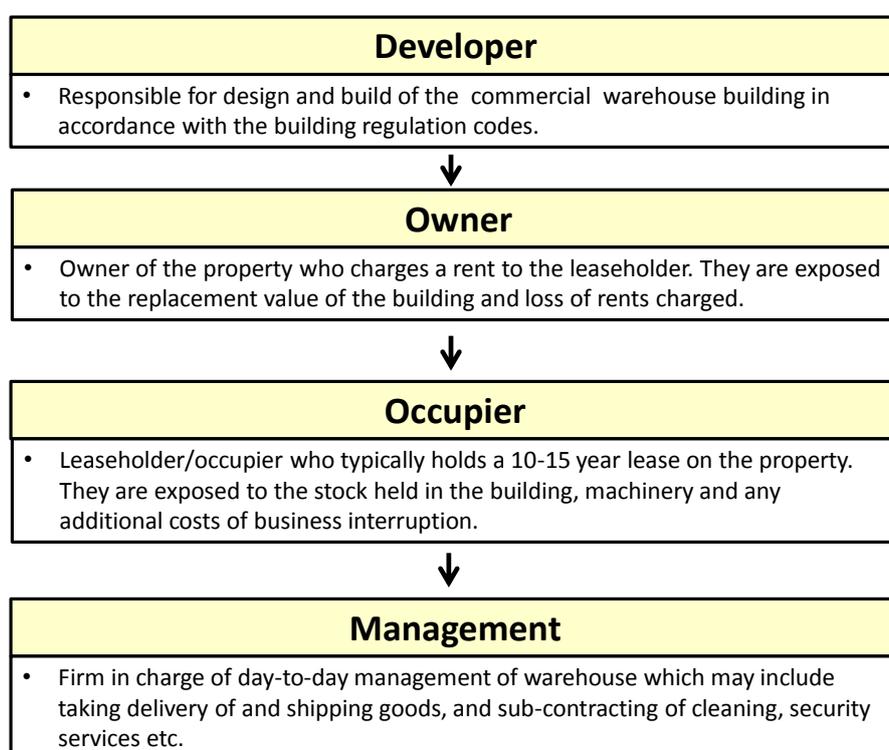
There is, therefore, little provision in the current legislation for the protection of the premises itself and its physical contents, which can include valuable inventory and capital assets like machinery and equipment. This reflects the fact that it primarily seeks to guard against: (i) the loss of life; and (ii) the spread of fire to surrounding commercial premises. The regulations do not include measures to actively protect commercial built assets and reduce the damage caused by fire, measures that would also indirectly

<sup>6</sup> Approved document B – Vol. 2 – Buildings other than dwelling houses, [http://www.planningportal.gov.uk/uploads/br/BR\\_PDF\\_AD\\_B2\\_2013.pdf](http://www.planningportal.gov.uk/uploads/br/BR_PDF_AD_B2_2013.pdf)

serve the primary objectives anyway, that is, to reduce the risk of loss of life and of fires escalating and spreading.

Such provisions would, we expect, provide the incentives for the parties to these kinds of premises – from their conception through to occupation and use – to take the initiative and invest in active fire protection (AFP) measures (such as, for example, AFSS) to secure the protection of their built assets. Figure 1 illustrates the main parties involved in the design, build, ownership and operation of a commercial warehouse building.

**Figure 1: Main parties involved in design, build, ownership, occupancy and control of a commercial warehouse**



Source: BSA, Cebr analysis

The parties that adopt these measures would benefit through increases in the value of the premises, the reduced risk of business losses and a corresponding reduction in insurance premiums. But the incentives can be clouded by the arrangements governing ownership and control of commercial premises – and particularly in warehousing. The combination of a lack of education, the nature of the division of responsibilities and the information asymmetries between the relevant parties to the premises result in uncertainty surrounding the benefits that each party can expect to reap from choosing to invest in active fire protection measures. The result is a chronic under-provision of AFP measures:

- *Developers* – those who design and build the commercial premises tend to have limited information about its intended use and are therefore less able to elicit a premium from buyers who would value AFP measures that are appropriate for the economic activities being undertaken on-site;

- *Owners* – owners may not have the luxury – especially in the current economic environment – of choosing between current or prospective tenants who would value AFP measures and those who do not by virtue of the nature of their business. This, as well as the fact that owners will also have limited information about prospective occupiers' activities, creates a disincentive for installing AFP measures as owners will be unable to recover the cost of their investment through higher rents if confronted with claims by tenants that AFP measures are of no value to them;
- *Occupiers* – for occupiers, the benefits associated with the reduced risk of stock losses, business interruption and lower insurance premiums may not be realised given the short time horizon of the lease for commercial warehouses. The lower probability of a fire within this finite horizon and the high fixed monetary costs associated with the installation of AFP measures - which require use over a long horizon for the investment to pay off - reduce occupiers' willingness to pay a rent premium for premises with AFP measures or to invest in such measures themselves;
- *Management* – those in charge of the day-to-day management of warehouses tend not to own the stock, contents or the commercial building itself and, therefore, have little incentive to install AFP measures, other than that their introduction would create additional maintenance and testing responsibilities for this party, for which they would probably need to increase the fees charged to occupants.

We have explained that the typical ownership and use structure of a warehouse leads to a lack of information shared between parties on the potential costs of fire. This deters investment in AFP measures (like AFSS) to address the problem.

Investment is also less likely to occur due to perceived inflexibility in the type of AFSS that ought to be installed given the multitude of uses that warehouses could be put to. The initial outlay on the necessary water and pump installation form a base investment which can precede any decisions on the use of the warehouse. However, the design and installation of all pipework needed to support the workings of the AFSS will depend on the nature of the goods expected to be stored in the warehouse in question and how they need to be stored. For example, whether goods need to be stored in racks rather than on shelves will influence the choice of AFSS and the corresponding pipework design.

This cost of pipework installation usually constitutes a significant proportion of the cost, especially for larger warehouses. For smaller and medium-sized warehouses, the water and pump system installation forms the bulk of the cost. This suggests that it should be easier for warehouses in these size categories to eschew the failure that results from information asymmetry because occupiers can take charge of the less costly installation of pipework in a manner that fits their particular needs after moving into a warehouse that is already equipped with a pump and tank by the developers. But even this is not happening at present.

Other obstacles to AFPs and particularly to AFSS, may include lack of awareness amongst developers that installing AFP facilitates can lower the required boundaries necessary between buildings and therefore enable higher density building to take place. This can accentuate developers' lack of incentive to install such measures and reduces the likelihood of AFPs ever being installed given the much higher costs of retrofitting once the building is completed.<sup>7</sup>

<sup>7</sup> The cost of installation or retrofitting has not been taken into account within Cebr's modelling framework. The purpose of this study is to quantify the costs of I fires in warehouses that do not have fire sprinklers or other AFP measures. The scope of our study did not extend to undertaking a full cost-benefit analysis of fire sprinkler systems themselves, so we had no need to consider the cost of installation.

## 2.3 Sample case studies of warehouse fires

To support our understanding of the financial and economic impacts of warehouse fires, we have examined a total of 12 case studies. Two of these case studies are examined in detail below.

### Sony warehouse fire, London, August 2011

This fire occurred at the Sony Warehouse in Enfield on Monday 8th August 2011. The warehouse was 25 thousand square metres in area. The fire resulted in the loss of the building's structural integrity, as well as 3.2 million units of stock including over 1.5 million CDs and other media. The damage done to the building alone was estimated to amount to a cost of £10 million, and over £80 million were paid out in insurance for the burnt and damaged contents.

Furthermore, £0.21 million was the cost of the London Fire Brigade's attendance at the fire, which burned for 14 days. Neither was the cost of fire contained within the Sony business itself, as the fire caused severe disruption to many other businesses' supply chains, with 150 businesses directly affected by damage to their stock. This indirect damage to the warehouse's downstream supply chain was severe, to the extent that a national campaign was formulated to help prevent independent record labels from going bust. Unfortunately, in the end, many independent companies went into administration following the fire.

On top of these longer-term supply-chain disruptions, the fire had an immediate impact on the businesses in close proximity to the warehouse and to activities in the local area. Figure 2 illustrates the surrounding geography. This includes a series of other warehouses in the Solar Way Business Park (to the West) which had to be closed for a time as a result of the fire. The Premier Inn in the Innova Park to the south west of the warehouse had to be evacuated for one night, and the roads surrounding the warehouse had to be closed, affecting the functionality of the distribution centres and warehouses in the vicinity. Solar Way was still closed due to dangerous levels of smoke three days later, indicating extensive impact on the businesses in the Business Park served by the road.

Figure 2: Map of the Sony Warehouse area, Enfield, London



Source: Google Maps, Cebr Analysis

### NEY Ireland, Coventry, August 2012

The fire at NEY Ireland's head office and plant in Coventry occurred on the 8th of August 2012. The plant acted both as a factory and warehouse facility for woodworking materials intended for use by furniture

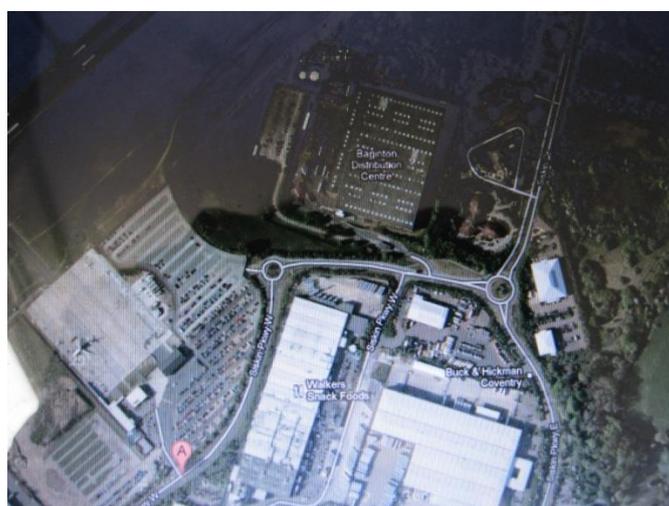
manufacturers. The fire destroyed at least 95 per cent of the building and, within days of the fire, the building itself was already in the process of being completely demolished. The majority of the building's contents and machinery used for production purposes were also lost in the fire, damaging the factory's productive capability.

This also provides a second example of a fire that resulted in major disruptions to the local area. Figure 3 presents a satellite image of Siskin drive, the main distribution road that provided access to the Middlemarch industrial estate within which the NEY Ireland warehouse was located.

The fire caused a major blockage to traffic to and from the industrial estate, as well as to the neighbouring area because a 400 metre exclusion zone was put in place around the site by the fire brigade (for one day only) as a precautionary measure amid fears that acetylene cylinders present inside the factory could explode. A total of 30 companies occupying the industrial estate were affected by this restricted access and egress to and from their premises, and local businesses in the immediate and surrounding Coventry area can also be expected to have been disrupted by at least a day and a half owing to the closure of Siskin Drive.

The fire further forced the closure of Coventry airport, situated adjacent to the industrial estate, for over fourteen hours, resulting in the disruption and cancellation of many flights. There were also some minor disruptions to the airport control tower and surrounding airport buildings.

**Figure 3: Map of Siskin Drive area, Coventry**



*Source: Google maps, BSA analysis*

### **Summary thoughts based on 12 case studies**

In addition to the Sony and NEY Ireland warehouses examined in detail above, some information on an additional ten case studies of warehouse fires was provided to Cebr by the BSA. These were treated in this study as a representative, random (unbiased) sample of observations and were used to inform our assumptions when no other data were available. Table 7 below summarises the key facts surrounding all twelve case studies.

Table 7: Businesses affected by fire

Location	Company	Date	Warehouse Size	Type	Local businesses affected	Recovery time
<b>Bicester</b>	Polestar	Jun-13	Small	Magazine Depot	<b>10</b>	<b>3 months</b>
<b>Coventry</b>	Ney Ireland Ltd	Aug-12	Medium	Industrial	<b>30</b>	<b>10 months</b>
<b>Dunhelm</b>	Dunhelm Mill	Oct-11	Large	Retail	<b>7</b>	<b>12 months</b>
<b>Enfield</b>	Sony	Aug-11	Large	Retail	<b>30</b>	<b>13 months</b>
<b>Loughborough</b>	Jayplas	Apr-11	Medium	Recycling	<b>3</b>	
<b>Heathrow</b>	Servisair	Jul-10	Medium	Air Cargo	<b>4</b>	<b>15 months</b>
<b>Leominster</b>	Skymark Packaging	Jun-09	Medium	Packaging	<b>60</b>	<b>Total Loss</b>
<b>Longbenton</b>	Newcastle Productions	Jan-09	Large	Industrial	<b>10</b>	<b>18 months</b>
<b>Atherstone</b>	Undisclosed	Nov-07	Large	Food Packaging	<b>25</b>	<b>Total Loss</b>
<b>Barking</b>	Videotech Systems	Apr-07	Small	Retail	<b>0</b>	<b>Total Loss</b>
<b>Cromwell</b>	Momarts	May-04	Small	Art	<b>31</b>	<b>Total Loss</b>
<b>Milton Keynes</b>	Electrolux Dist. Cent.	Jun-99	Large	Distribution Centre	<b>42</b>	<b>20 months</b>

Based on our review of 12 case studies, therefore, we find that, on average, around 21 businesses are affected in and around the surrounding area for a typical fire. This average can range from 0 (no surrounding businesses affected) to 60. Fires in warehouses located in industrial parks tend to be the most disruptive to surrounding businesses as they often result in closures of roads both within the industrial park itself and of the wider surrounding road network. But, as well as the other warehouses and factories operating near the fire-affected premises that are affected, the fire will often also disrupt the activities of a variety of industries including logistics, transport, professional services and retail.

The case studies in table 4 above have also informed our assumptions about the rate of business failure as a consequence of warehouse fires. These were used to inform our modelling of the impact of these business failures on the economy. Specifically, the case studies show that, in most cases, the fire resulted in a closure of the business for longer than a year. Meanwhile, in four of the 12 cases, the businesses failed to recover at all. This included the fires in small (Momarts, Videotech Systems), medium (Skymark packaging), and large (Newcastle productions) warehouses, highlighting the fact that fire can pose a critical risk to all businesses irrespective of their size.

### 3 ECONOMIC OVERVIEW OF THE WAREHOUSING INDUSTRY

This section provides an overview of the importance of the warehousing industry in England and Wales. This will assist in developing an understanding of the estimated magnitude of the financial and economic losses that result from warehouse fires.

#### 3.1 The “Warehousing and Support Services for Transportation” industry<sup>8</sup>

Some key facts about the warehousing industry in England and Wales:

- The total Gross Value Added (GVA) contributed to the economies of England and Wales by the warehousing industry was £14,267 million in 2011. This is equivalent to an estimated £14,504 million in 2012 prices, the benchmark year used throughout this study. Real-terms growth in the industry’s GVA contribution has averaged 1.4 per cent annually since 1997.<sup>9</sup>
- The warehousing industry in England and Wales employed 277,299 people in 2012, each earning on average £31,388 per annum.<sup>10</sup>
- There are a total of 81,020 warehouse buildings in the England and Wales with a combined total floor space of 118.5 million square metres, suggesting an average workspace density of approximately 605 square metres per employee.<sup>11</sup>

Table 8 below shows the breakdown of the headline employment number of 277,299 employees quoted above for 2012 across the different supporting activities. The majority (51.5 per cent) of employees in the industry are employed in warehouse and storage facilities that support land transport activities. Services incidental to land, air and water transportation employ another 30.7 per cent of employees. These two broad categories together cover the vast majority of employee posts in the warehousing industry. The remaining posts are occupied by cargo handling activities and other transportation support activities including those to do with passenger – rather than goods – transport.

This breakdown of employment in the wider warehousing industry provides valuable insights for the purposes of this report. Firstly, it shows that the majority of employees in this sector are directly linked to the needs of the warehouse. Fires that destroy warehouses will, as such, be more likely to be associated with an increased risk of redundancy as a result of fires. This is another important element of our estimates of the economic costs that results from such fires.

<sup>8</sup> This covers the “Warehousing and Support Services for Transportation” industry from the national accounting framework. The relevant 2-digit SIC code is 52. This definition will be used for the term “warehousing industry” throughout the report unless otherwise specified.

<sup>9</sup> See ONS Supply-Use tables, 2011.

<sup>10</sup> See ONS Business Register and Employment Survey (BRES) and Annual Survey of Hours and Earnings (ASHE).

<sup>11</sup> Based on Cebr’s analysis of Valuation Office Agency data

Table 8: Employment in the Warehousing Industry in England &amp; Wales

SIC code <sup>12</sup>	Industry Name	Number of jobs	Percentage of total
52.103	Operation of warehousing and storage facilities for land transport activities	194,293	51.5%
52.219	Other service activities incidental to land transportation	57,853	15.3%
52.290	Other transportation support activities	55,659	14.8%
52.230	Service activities incidental to air transportation	38,705	10.3%
52.220	Service activities incidental to water transportation	19,316	5.1%
52.242	Cargo handling for air transport activities	4,723	1.3%
52.212	Operation of rail passenger facilities at railway stations	4,073	1.1%
52.241	Cargo handling for water transport activities	1,744	0.5%
52.101	Operation of warehousing and storage facilities for water transport activities	328	0.1%
52.243	Cargo handling for land transport activities	252	0.1%
52.213	Operation of bus and coach passenger facilities at bus and coach stations	230	0.1%
52.102	Operation of warehousing and storage facilities for air transport activities	68	0.0%
52.211	Operation of rail freight terminals	55	0.0%

Source: Office for National Statistics, Nomis

### 3.2 The supply chain that supports warehousing

The supply chain that supports the warehousing and distribution sector undertakes a range of economic activities which keep the warehouse operational. Table 9 shows the distribution of economic activities which make up the supply chain of the warehousing and distribution industry.

We can see that the warehousing sector demanded a total of £20.6 billion in goods and services from other industries in 2011. The majority of this expenditure remained within the wider transportation and storage sector (which includes demands for services from other warehouses), accounting for £9.7 billion of the warehousing sector industry's supply chain. Administrative and support services such as rental and leasing, cleaning and security services, represent the next highest element of the supply chain, receiving £2.5 billion from warehouses in 2011.

There is also significant spending on professional services and manufacturing activities which account for £2.4 billion and £1.5 billion of intermediate spending respectively.

<sup>12</sup> The "SIC code" column refers to the Standard Industrial Classification code assigned to each sub-sector for the purpose of formally recording economic activity in the national accounts.

Table 9: Warehousing and storage supply chain, 2011 £m<sup>13</sup>

Industry	Intermediate demand
Transport and Storage	9,658
Administrative and support service activities	2,509
Professional, scientific and technical activities	2,372
Manufacturing	1,500
Information and communication	1,081
Construction	1,056
Financial and Insurance activities	999
Real estate activities	270
Education	226
Wholesale and retail trade	219
Other	726
<b>Total</b>	<b>20,615</b>

Source: ONS Annual Business Survey 2011, Cebr analysis

Multipliers show the ratio of an induced change in national income to an initial change in the level of final demand spending, where the multiplier effect denotes the phenomenon whereby some initial increase (or decrease) in the rate of spending will bring about a more than proportionate increase (or decrease) in national income. This is the Keynesian macroeconomic multiplier which measures the impact of final demand expenditures, such as investment.

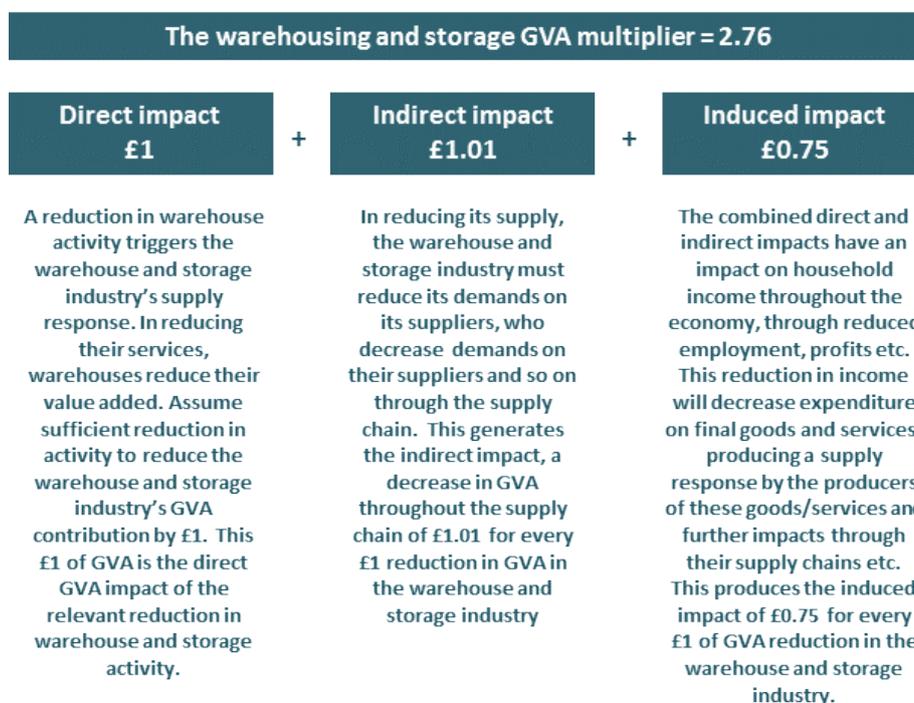
But, underlying the macro multiplier is a series of production-based multipliers, which capture the impact of the productive activities of businesses or, as in this case, the loss of such productive activity (as a result of warehouse fires). There are two types of production multiplier – Type I, capturing direct and indirect (or supply chain) impacts and Type II, capturing direct, indirect and induced (or employee spending) impacts.

Cebr's proprietary input-output models provide the appropriate multipliers to capture the likely indirect and induced impacts of warehouse fires. For the warehousing industry, every £1 fall in the industry's GVA results in a further reduction of £1.76 in GVA with £1.01 of this reduction occurring through the industry's supply chain (indirect effects) and £0.75 occurring through lost employee spending (as a result of job losses and the loss of earnings). This is summarised Figure 4 below.

There are, likewise, indirect and induced impacts on employment. Cebr's input-output model estimates that, for every FTE job lost within the warehousing industry, there are a further 1.6 FTEs lost elsewhere in the economy – due to the reduced demands and activity in the supply chain and due to the loss of the final demand stimulus to the wider economy that is given by employees (in both warehousing and its supply chain industries) spending their earnings in the wider economy. This is presented in Figure 5 below.

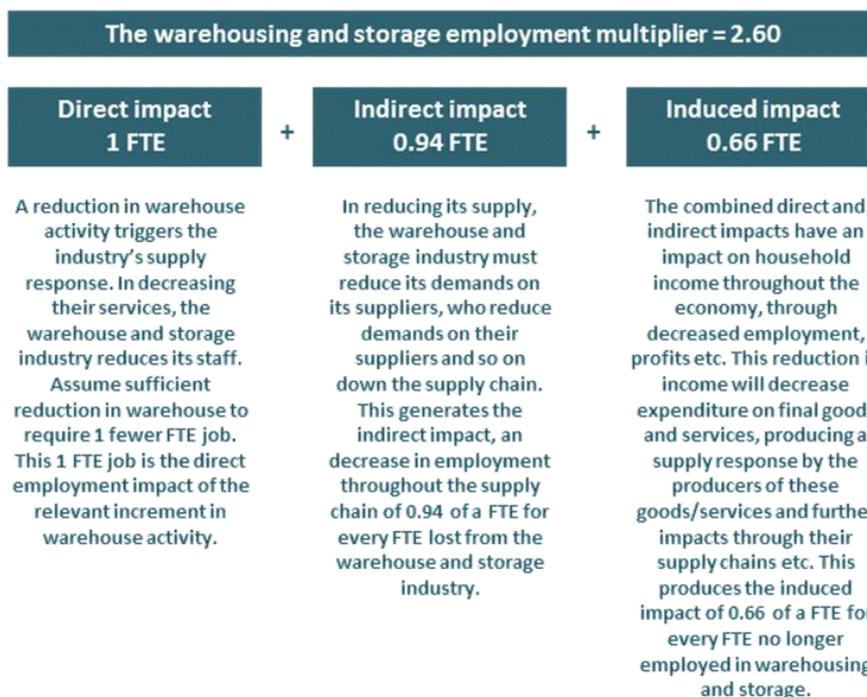
<sup>13</sup> This covers the "Warehousing and Support Services for Transportation" industry from the national accounting framework. The relevant 2-digit SIC code is 52.

Figure 4: Warehousing and storage industry GVA multiplier



*Source: Cebr Analysis*

Figure 5: Warehousing and storage industry employment multiplier



*Source: Cebr Analysis*

These estimates of the multipliers for the warehousing industry provide an important basis for our assessment of local and national economic impacts of fires in warehouses that do not contain AFSS technologies.

### 3.3 Warehousing's role in the supply chain of other sectors

There are businesses which rely on the goods and services provided by the warehousing industry and that, as such, feel the impacts of disruptions caused by warehouse fires. These 'forward' supply chain linkages primarily affect the wider transport and storage sector – of which the warehousing industry forms part – and the wholesale and retail trades, as illustrated in the table below.

**Table 10: Spend by broad industry groups on warehousing services, 2011, £m and % of output of those industries<sup>14</sup>**

Industry name	£m	Percentage of output of the dependent industry
<b>Transport and Storage</b>	16,948	12.0%
<b>Wholesale trade</b>	8,949	8.3%
<b>Wholesale and retail of motor vehicles</b>	656	1.4%
<b>Financial and Insurance activities</b>	2,103	0.9%
<b>Retail trade</b>	1,020	0.8%
<b>Administrative and support service activities</b>	861	0.8%
<b>Information and communication</b>	1,014	0.6%
<b>Accommodation and food service activities</b>	380	0.5%
<b>Water supply, sewerage, waste management</b>	114	0.3%
<b>Professional, scientific and technical activities</b>	543	0.3%
<b>Arts, entertainment and recreation</b>	90	0.2%
<b>Other service activities</b>	91	0.2%
<b>Manufacturing</b>	882	0.2%
<b>Public administration and defence</b>	210	0.1%
<b>Agriculture, forestry and fishing</b>	35	0.1%
<b>Education</b>	130	0.1%
<b>Electricity, gas, steam and air conditioning</b>	102	0.1%
<b>Human health and social work activities</b>	124	0.1%
<b>Real estate activities</b>	124	0.1%
<b>TOTAL / AVERAGE %</b>	34,476	1.2%

*Source: ONS, Cebr analysis*

The broad transportation and storage sector itself is the most heavily dependent on warehousing, with 12 per cent of the sector's output (the economic equivalent of turnover) accounted for by spending on warehousing services. Table 10 demonstrates how important warehousing is to the operations of the wholesale trade, the second-most warehouse-dependent industry. While the dependence of manufacturing is relatively significant in absolute terms, it is of relatively little significance to the manufacturing sector as a whole.

<sup>14</sup> The 'percentage of output of the dependent industry' column measures the importance as the proportion of output (the economic equivalent of turnover) of the dependent industries that is accounted for by their intermediate expenditure on warehousing services.

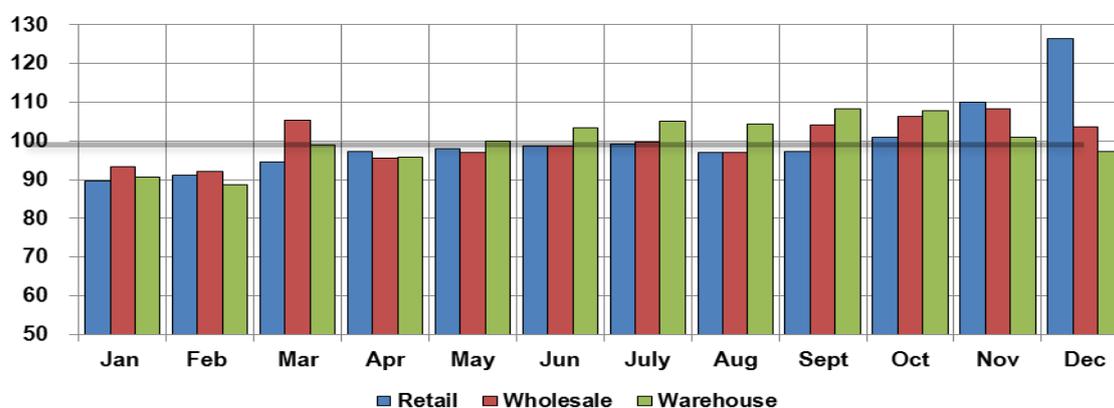
The motor vehicle trade is the third-most warehouse-dependent industry, while the general wholesale and retail trades also show evidence of relatively higher reliance on warehouses. However, the financial, ICT and administrative and support services industries also have relatively significant dependencies on warehousing in both relative and absolute terms. Cebr predicts that the dependencies of the knowledge-based sectors may be related to developments like the centralisation of IT hardware through newly-emerged technologies like cloud computing, which involves the development of 'data warehouses' to house large server and data storage capacity. These are the industries then that are most likely to be negatively impacted by the disruption caused by interrupted supply from warehouses that have suffered fire.

There are other industries in which trends suggest that 'forward' supply chain impacts could have exceptionally disruptive effects. Two specific examples include:

- **Automotive manufacturing sector** – the UK car manufacturing industry is increasingly operating based on 'just-in-time' and 'bespoke parts' manufacturing. This means that cars and car parts are increasingly being made-to-order rather than being produced for generic purposes. The effect of disruption to the delivery of bespoke components can therefore have significant impacts on output and productivity at manufacturing plants.
- **Pharmaceuticals sector** – the UK has the third largest share of global pharmaceutical R&D expenditures (behind the US and Japan), the industry having invested a total of £4.9 billion in R&D in 2011, accounting for roughly 30 per cent of all R&D expenditures by UK business.<sup>15</sup> This industry relies on extremely time-critical delivery of goods which must be stored and packed to bespoke specifications. As such, disruptions due to fires can have significant impacts on the integrity and value of the goods being shipped.

The timing of a fire in a given calendar year can also influence the size of the impact. Figure 6 presents an index showing the variations in warehouse turnover in different months of the year, alongside the same for the wholesale and retail industries. As can be observed, retail turnover peaks in December due to the Christmas boost in demand, but wholesale and warehouse turnover levels peak in the preceding months, that is, in November for wholesale and September/October for warehousing.

Figure 6: Retail, wholesale, and warehouse turnover index, annual average = 100



Source: ONS, Cebr Analysis

15 Office for National Statistics, Business Enterprise Research and Development 2011

### 3.4 Emerging economic trends and the role of warehousing

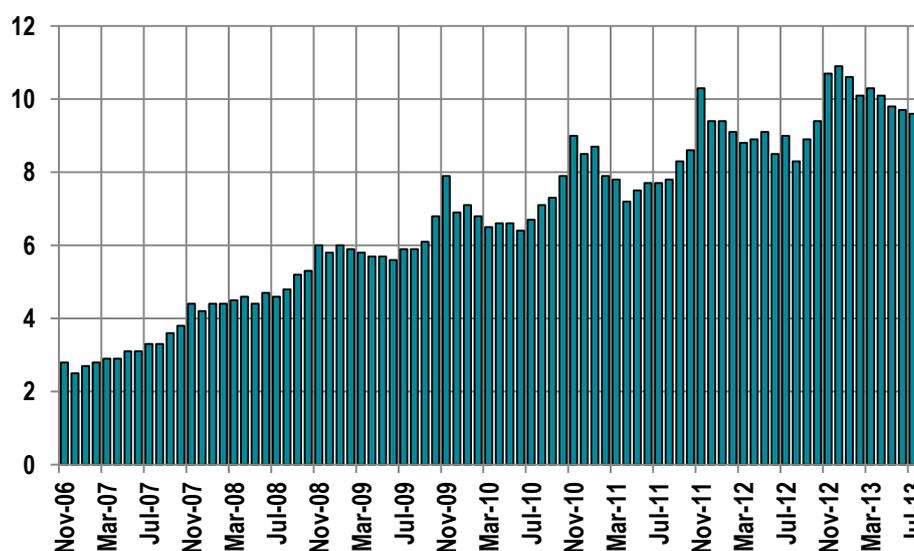
Looking ahead, the activities undertaken in warehouses are likely to become increasingly important due to two main trends.

#### Rise of the internet economy

The warehousing industry is expected to assume greater importance as consumer spending shifts towards the internet. In order for internet retailers to compete with high-street retailers, access to a well-connected distribution network facilitated by a wide selection of well-located warehouses is required. Demand for warehousing services which enable fast and efficient delivery will grow as preferences to shop online increase. Businesses following an internet-based growth strategy are, as such, likely to increase spending on warehousing and distribution services to ensure that there is an adequate supply of warehouses to meet demand in key consumer regions.

Given that around 14 per cent of the UK's population is located in the top 24 cities by population size, it is likely that the economy will require a sufficient support network of warehouses in the most populous areas as internet retailing gains more prominence. Figure 7 below illustrates the rise in importance of internet retailing since late 2006.

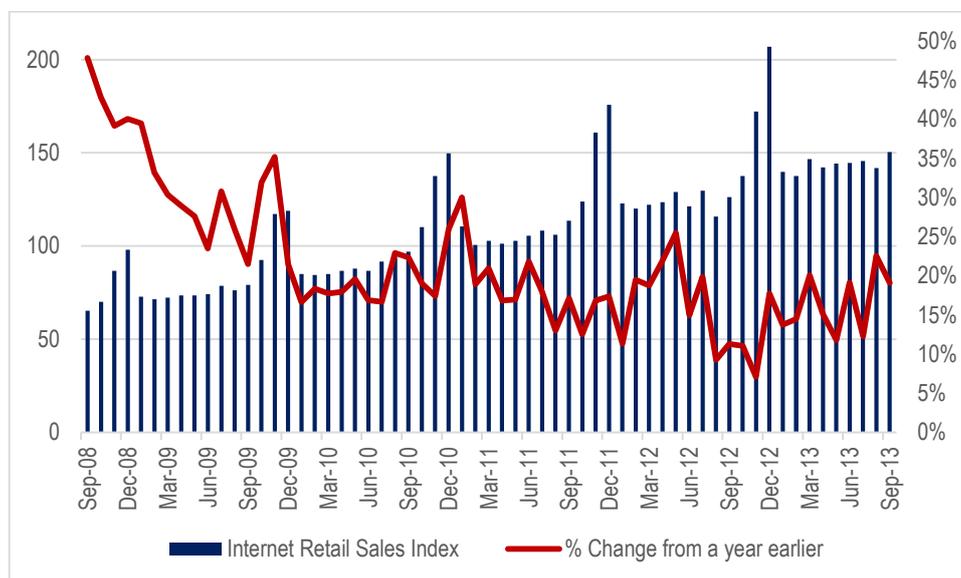
Figure 7: Online retail sales, quarterly percentage of total retail



Source: Office for National Statistics, Cebr analysis

From under 3 per cent seven years ago, online retail sales now account for 10 per cent of the entire retail sector. Furthermore, the sector has continued to record stellar growth over recent years - the latest year-on-year growth data for September 2013 reads 19.1 per cent, compared to growth of only 2.2 per cent in the retail sector as a whole. Internet retail sales have been growing at a double-digit rate for the past 11 months, as shown in Figure 8 below.

Figure 8: Online retail sales index and percentage change from same month a year ago<sup>16</sup>



Source: Office for National Statistics, Cebr analysis

Cebr expects that internet retail will continue to record double-digit growth in the coming years. This is, in turn, expected to place further demands on the warehousing industry, as higher volumes of internet retail require ever-growing support networks of dedicated warehouse and distribution centres to facilitate the delivery process.

### Increased versatility of the use of warehouses

The increasing importance of online retailing could have further knock-on effects on the warehousing industry. That is the potential for the cost of damage following a fire to increase, given the increased number of activities having to take place in a warehouse that also serves as the first stage in the delivery process of online orders. For example, complex sorting, packing and machinery will be housed within these sites, the loss of which would be in addition to the lost stock of goods being stored.

This could also increase the risk of fires in comparison to more 'traditional' warehouses where goods simply enter, are stored and then removed. This is because the presence of equipment such as conveyors, hydraulic cranes, flying bridges, shrink wrapping equipment, and large amounts of combustible packaging could all increase the overall risk of fire.

Such warehouses can be challenging in terms of the installation of AFSS. They require a more sophisticated design of the engineering of the AFSS to ensure that the installation yields a benefit. Sub-optimal design could result in AFSS failing to control fires in warehouses where chemicals and flammable liquids are stored, such as in the cases of Ford Cologne (1977) and K-Mart Pennsylvania (1982). A further case study is provided in Box 1.

#### Box 1: The increased risk of fire stemming from more versatile warehouses

A recent fire in a warehouse also acting as a production and packaging facility for crisps demonstrates the growing risks associated with fires in warehouses housing more complex activities.

<sup>16</sup> The high growth rates seen in the early years of this illustration is most likely explained by lower base levels of internet retail than today.

The fire at the Real Crisps factory in Caerphilly, Wales started in September 2012 when one of the factory's employees threw his lit cigarette away in a hurry, worried that he might be caught smoking in the storeroom on the factory floor. The cigarette landed in a pile of crisp packet wrappers, and quickly spread to the rest of the factory through 60,000 litres of the cooking oil that is used to fry the crisps, which fuelled the blaze. Full of flammable materials such as plastics, paper, cardboard and palettes, the whole building was consumed by the fire within just ten minutes.

The judge handling the arson case against the worker described the factory as "a tinderbox". The prosecutor also referred to the nature of the factory as a source of added risks of fire by saying that "one is dealing with extremely flammable materials in an extremely volatile environment". In the end, it took more than 60 firefighters to put the fire under control.

This case demonstrates the increased risks of fire as warehouses become increasingly versatile, especially when they house significant stores of flammable materials.

## 4 CEBR'S UNDERLYING METHODOLOGY AND ASSUMPTIONS

This section of the report outlines the methodological framework used to estimate direct annual financial losses that result from fires in warehouses that are not equipped with automatic fire sprinkler systems (AFSS). We also explain how these financial losses filter through to direct and multiplier economic impacts - quantified in terms of Gross Value Added (GVA) and jobs lost to the economy of England and Wales.

The starting point for our research was the BRE Global report<sup>17</sup>, which estimates the value of the damage and disruption caused by warehouse fires. The BRE Global research draws on insurance data recorded by loss adjusters (in the FPA Large Loss Database) and data recorded by the fire and rescue authorities' (in DCLG's Incident Recording System (IRS) database). We explain the steps taken by BRE to transform these raw data into best estimates of the true costs of damage caused by warehouse fires.

We then explain how we used the BRE research to: (i) estimate additional losses which are not within the scope of the BRE's methodological framework; and (ii) translate these financial losses to direct and multiplier impacts on the economy.

### 4.1 Modelling approach and assumptions

The results of our study are based on a three-stage modelling approach. These three stages were:

- First, we estimated the financial losses and costs imposed on those directly affected by fires, including the losses to the various parties to the premises as a result of the damage to it and its contents and the business interruption losses of, in particular, the occupants of the premises. We also include those firms directly affected as a result of being in close proximity to the fire.
- Second, these are translated into 'direct' economic losses by analysing the financial losses and costs imposed by warehouse fires through the framework used by the ONS to estimate GDP. Particularly significant are occupant businesses losing their ability to supply and the consequent reduced capacity of the industry to add value to the economy, thereby sustaining and creating jobs.
- Third, we examine the knock-on effects of these direct economic losses in the wider local and national economy. These indirect impacts are transmitted through reduced demands on the industry's supply chain and, if jobs are lost, induced impacts through reduced employee spending in the wider economy.

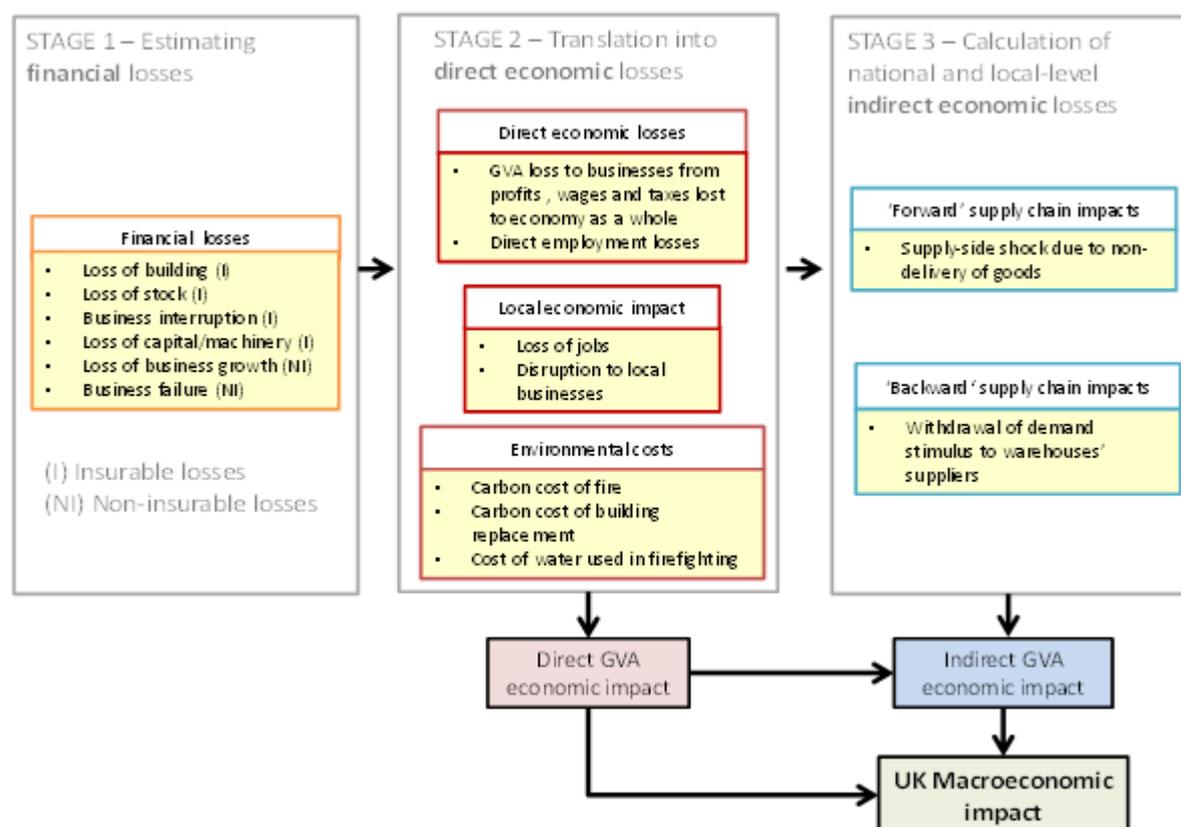
The most important point to note at this stage though is that the macroeconomic impact of warehouse fires can be expected to be lower than the sum of all impacts on local and regional economies that are negatively impacted by warehouse fires. This is because the occupant of the warehouse may find another warehouse in another location, sustaining existing or winning back old contracts, in which case the net loss to the macro economy can be expected to be less than the impact on the local community in which the original warehouse was located.

The national-level economic losses also result in lost tax receipts to the Exchequer, but the potential for bigger losses at the local economy level mean some local governments will be net losers while others might gain from a relocation of the business that occupied the premises affected by a fire.

<sup>17</sup> "An environmental impact and cost benefit analysis for fire sprinklers in warehouse buildings", BRE Global (October 2013).

Figure 9 below provides a schematic of the methods and assumptions used in our assessment.

Figure 9: Cebr's broad modelling approach



Source: Cebr analysis

The source of data used to calculate the financial value of damage and disruption – the natural starting point in our quantification process – is the BRE report. We provide, in what follows, an overview of the methodology used in the BRE report to value fire damage. BRE's findings, based on this methodology, form the primary ingredient for Cebr's estimates of the financial cost to warehouse businesses of commercial fires.

## 4.2 The BRE report: determining the value of fire damage and disruption

The purpose of the BRE report is to provide a financial cost-benefit analysis of AFSS and an examination of the environmental impact of fire sprinklers in warehouse buildings. Part of BRE's workings included a quantification of the total annual value of damage and disruption caused by warehouse fires. The scope of their valuation was warehouses that are and are not fitted with AFSS in England and Wales.

Their analysis was also split by size of warehouse and valuable information on how these losses are distributed across various categories of damage and disruption (as defined by insurers<sup>18</sup>) is also provided. It is this information that Cebr has drawn on to estimate the direct financial losses to businesses associated with warehouses that suffer fire damage. The BRE report provides enough information to facilitate a fairly deep understanding of how they approached the task. Having reviewed the relevant sections and methodological appendices of the BRE report, our understanding of how BRE estimated is summarised by the following sequence of steps:

- a) The starting point for BRE was insurers' loss data from the Fire Protection Association (FPA) Large Loss Database.<sup>19</sup> The extract of this database received by BRE when they commenced their study was for the three-year period spanning April 2009 to March 2012. This extract contained 181 warehouse fire records.
- b) Having reviewed these raw data, BRE discovered that loss adjuster estimates of the losses resulting from the fire (before any settlement of claims) were available for 171 cases, with a corresponding total estimate of the value of damage and disruption of £172 million. However, 'actual' final losses (or claims) were only available in 87 cases. The total 'actual' loss associated with these 87 cases was £48 million.
- c) The BRE report then notes that a large number of FPA records only had attached to them loss adjuster **estimates** of the damage and disruption. Therefore, for each record, the cases where **actuals** were also included were used to estimate a ratio between estimated and actual damage estimates (claim values) for the various categories of insurance (building, contents, stock etc.) and in aggregate were calculated. Frequency distributions were calculated for all insurance categories, showing the frequency of cases with ratios of different values. These suggest that the ratio of actuals to estimates is 1 in the largest number of cases for any single value, but is less than 1 in the majority of cases.
- d) These ratios are used to estimate "what the final loss should be" in the cases where only estimates were available. The average ratio of actual to estimated loss was estimated to be 0.78. In other words, typically, actual settled claims are 78 per cent of the loss adjuster estimates. But, at this point, BRE moves to a later extract of the FPA Large Loss Database, covering the period from January 2009 to May 2012, presumably so they could take account of new data that emerged since they commenced their study.
- e) Applying the methods outlined above to this new extract led BRE to an estimate of the "total final losses within the FPA large loss database, which they summed and categorised as 'warehouse', 'commercial' or 'other'". Separating out warehouses, BRE produce an estimate of the losses for 192 cases "in the database during January 2009 – May 2012". This estimate was £125.7 million.
- f) The £125.7 million figure is subsequently annualised from the three-and-a-half-year period over which it applies to conclude that "annual losses (recorded in the FPA large loss database) are therefore estimated to be £36.8 million for warehouses".
- g) At this point, BRE refers to statistics published by ABI showing the insured cost of commercial fires in 2008 at £1 billion, with the cost of fire damage being £0.865 billion. This makes it clear, BRE states,

<sup>18</sup> In other words, the categories used by BRE reflect the various lines of protection that insurance companies provide, such as buildings, contents, stock, business interruption etc.

<sup>19</sup> The FPA produces the "large loss database" on behalf of the RISC Authority and the Chartered Institute of Loss Adjusters (CILA). The loss adjusting teams contribute fire loss data into the database, which enables the RISC Authority to produce research into emerging trends in fire loss, to develop an understanding of the causes, why a fire spread and the costs associated with the fire. See Appendix A for a methodological note on how this data was used to calculate financial losses.

that “the losses recorded in the FPA large loss database represent a fairly small fraction of the estimated losses quoted by ABI”. This is followed by a hypothetical calculation as follows:

- i. The ratio of warehouse losses to all commercial losses (including warehouses) in the FPA large loss database is 0.15;
  - ii. If the same ratio applies to all fires (rather than large losses only, as featured in FPA), then the expected loss from all warehouse fires might be in the region of  $0.15 \times \text{£}1.3 \text{ billion} = \text{£}195 \text{ million}$ . They describe this as a cross-check on the number produced by the cost-benefit analysis (see later in this section).
- h) BRE also consider the ‘area of damage’ associated with the losses recorded in the FPA database, stating that “in order to evaluate reduced risk with sprinklers, it was necessary to establish the relationship between ‘area of damage’ in the FPA data and ‘fire area’ in the IRS data (and also establish the cost of damage per  $\text{m}^2$ )”. This amounted to undertaking a matching exercise, between records in the FPA database with records for the same fire in the IRS database to correlate the ‘area of damage’ in the FPA data with the ‘fire area’ in the IRS data. On this basis, they match 106 fires from the FPA data with the IRS data, but eliminate cases where the area damaged was not recorded. This left 91 records for the period April 2009 to March 2012.
- i) The report also discusses “Fire and Smoke Damage”, stating that “In order to improve the estimate of the fire losses within the cost benefit analysis, it was decided to categorise damage as being caused by either fire or smoke.” The area damaged by fire and smoke per fire is calculated based on Monte Carlo simulations informed by the relationships between building size, fire frequency and area damaged, which follow from analysis of the FPA and IRS databases. This means that the areas damaged were fixed and that, for a given number of fires, BRE’s modelling would return an estimate for the total area damaged.
- j) To obtain estimates of the value of damage and disruption per square metre of area affected by fire and smoke damage, BRE attributed ‘fire-related’ damage and disruption costs to the ‘fire area’ as given by the IRS database. In a similar vein, smoke-related damage was assigned to the total area damaged from the FPA database, which was assumed to be the best available estimate of the area over which smoke damage occurs. These calculations gave an **average value of fire-related damage of £506 per square metre** and of **smoke-related damage of £116 per square metre**. This analysis was based on 26 matched fire records from the initial sample of 91 - the result of excluding all records where smoke and fire damage area was less than 750 square metres. This was done to ensure that the unitary damage estimates (damage per square metre) were representative of all sizes of warehouse. Fire and smoke damage per square metre are allocated in order to maintain aggregate damages in the ratio 71% fire, 29% smoke.
- k) These unitary estimates of the value of damage were combined with the data on area damaged to generate representative estimates of financial losses per fire by warehouse size. These damage value estimates were then combined with actuals data on the number of fires to produce aggregate estimates of the annual financial value of the damage and disruption caused by all warehouse fires in England and Wales. BRE used an average of 588 fires per year across the three-year period 2009-2012 in warehouses that are not fitted with AFSS. This produced the **BRE ‘low case’ estimate of the annual value of damage and disruption of all warehouse fires of £85.9 million**. This is the starting point for Cebr’s analysis.

This estimate is **BRE’s ‘low case’** because, as their report notes, there are caveats to using the FPA large loss database, which imply that a full picture of the true cost of damage may not be captured through the

use of its raw data. For example, it does not contain a record of every fire that results in an insurance claim, nor does the amount of the claim necessarily reflect the full value of the losses from the fire. Box 2 provides an overview of the incompleteness of FPA database for our purposes.

### Box 2: Incompleteness of the FPA large loss database

#### *Large losses only*

The FPA large loss database only records fires that resulted in “large losses”. Fires with an estimated insurance loss below £100,000 are not recorded, unless they involve fatalities. Such thresholds result in the exclusion of many potentially useful data points.

#### *Underinsurance, self-insurance, and measurement errors*

Underinsurance is most common at times of economic hardship. Businesses (especially smaller ones) are more likely to underreport their value and hence to underinsure. The result, in case of a fire, is that the loss adjuster will often value a loss as higher than it is insured for. According to the FPA, actual losses are often “twice as high as insured losses”. The underinsured will not, however, be able to claim the full value of a loss in the event of a fire. Buildings that are insured for a fraction of what the insurer considers to be the correct amount will result in the claim being reduced to the same fraction. This may lead to some fires coming in below the £100,000 threshold for the purposes of the FPA database, when the losses might actually exceed that amount.

The FPA database is also, by its nature, restricted to losses covered by insurers that are members of the Association of British Insurers (ABI). This excludes some of the large insurers that are not members and, hence, underreporting of the total number of fires recorded in the database.

Moreover, some buildings may not be insured at all, or may be self-insured by their owners. This will be especially true for larger businesses. Finally, some types of losses are not actually categorised as subject to fire insurance even though the loss would not have occurred had it not been for a fire. For example, the loss of motor vehicles through fire will be categorised as falling under motor insurance rather than fire insurance, and will thus not appear in the figures for total insurance paid after a fire.

#### *Undeclared losses and agreed cash settlements*

To save on insurance, some parties may opt for not declaring damages in order to avoid paying a higher insurance premium in the future. This will be the case when damages are small enough that businesses can actually continue operating or even repair damage themselves without the need for the insurance to cover them. Such cases are considered to be a win-win situation, as both the insurer has to pay out less insurance and the business gets back the original value of the business without having to actually rebuild it.

Parties involved in an insurance claim may sometimes agree on a cash settlement that is lower than the value needed to rebuild a business. This tends to happen when it is thought that the time and effort required to rebuild their business will not prove to be a worthy exercise (for example because they were already considering retirement).

#### *Corporate market deductibles*

Claim values recorded in the FPA database – whether estimated or actual – tend not to include deductibles, and data on the amount of deductibles are not available in the database. Deductibles refer to the ‘excess’ or threshold amount of expenses that the fire-damaged business must pay before an insurer will consider a claim.

Deductibles will depend on individual insurance policies, and may also vary across different insurance categories (building, contents). The consequences are that some fires will be left out of the database if the value of the claim, net of deductibles, is below £100,000 when the actual cost of the fire may be far in excess of this amount when deductibles are included. According to the FPA, deductibles can be as high as £250,000 in some cases.

For all fires, therefore, the true costs of the damage and disruption that is their result may be under-recorded in the FPA database.

For these reasons, the BRE report also presents a ‘high case’ estimates of the financial value of damage and disruption caused by warehouse fires. These estimates are based on the concept of ‘total insured value’ (TIV) per square metre of area damaged, which were provided by the BSA. TIV assumes that, for each square metre of damage, the value of the damage caused by fire is equal to the entire insured value of the square metre. This captures not only the fact that some losses are not insured, it also assumes that all of the area damaged by fire is entirely (that is, 100%) destroyed. Consequently, the high case is BRE’s attempt to provide an upper-bound or an absolute worst-case scenario, rather than a reasonable estimate of the true cost.

The high case estimates of the damage per square are, in 2010 prices:

- £2,303 per square metre from fire and smoke damage;
- £1,952 per square metre from fire related damage; and
- £351 per square metre from smoke related damage.

Here the split between fire and smoke is again set to maintain the 71% fire to 29% smoke ratio as in the low case. When applied to the same average of 588 fires occurring in warehouses not fitted with AFSS, these square metre estimates produce **BRE’s high case estimate of the annual value of damage and disruption of all warehouse fires of £304.1 million.**

BRE, for the purposes of their analysis chose the mid-point between the low and high cases as the best available estimate of the true value of the damage and disruption. This **‘mid case’ estimate is £195 million** worth of damage and disruption caused by the same average 588 fires in warehouses without AFSS per year. This is the estimate that is adopted by Cebr and taken forward into the second and third stages of our modelling framework.

### 4.3 Going beyond BRE: other ‘uninsurable’ sources of financial loss

The BRE estimates are confined to damage and disruption that can be quantified through the use of insurance data. Cebr sought to go beyond BRE by examining losses that fall outside the insurance sphere.

There are, in other words, losses for which insurance does not exist as recourse for business directly affected by a warehouse fire. We define these as ‘uninsurable losses’, of which we consider two. The first is the disruption of the growth trajectory of the business. The second relates to circumstances in which the fire causes complete failure of the business operating at the warehouse premises.

Both elements are calculated using productivity estimates based on ONS estimates of GVA and employment for the warehousing industry. By supplementing BRE’s findings in this way provides a more rounded view of the financial and economic damage caused by fire. The workings of each of these uninsurable losses are set out below:

- **Loss of business growth** – insurance tends not to cover the future profitability of a business; it mainly seeks to return a business back to the same profit position as before the fire occurred. The longer the period of disruption, the higher the loss of business growth a firm is likely to suffer, particularly if the business environment in which a firm is operating in is growing. We have estimated a value for the loss of business growth by calculating average GVA per warehouse for different sizes and applying trend growth observed in the warehousing sector over the period of disruption.
- **Business failure** – similarly, insurance does not cover the complete failure of a business that results from the fire. Cebr is concerned with the annual ongoing costs of fire, we have accounted for one

year's loss in GVA for every business that fails. The business failure rate is based on the proportion of buildings which are demolished, not re-opened following the fire and unlikely (in Cebr's view based on the analysis of the sample data available to us) to have been re-opened elsewhere.

#### 4.4 Translating the financial value of fire damage into losses to the economy

The BRE mid-case estimate is segmented into the different damage and disruption categories according to BRE's findings on how the totals are distributed across insurance lines. Specifically, for example, the financial damage incurred as a result of the loss of the building and its contents tends to account for 44 per cent of the total loss. The next largest financial losses tend to be caused by the loss of stock and business interruption.

The nature of these financial losses is important when considering the extent to which there is an *economic loss* and what *type of economic loss* it is. Some have an impact on ongoing economic performance and will, therefore, have an impact on headline GDP. Those that do not tend to have consequences for the distribution of wealth or 'net worth' (the balance between assets and liabilities) across different parties to the warehouse.

The assumption is that BRE's 'low case' represents the proportion of the best (or 'mid case') estimate of the value of damage **that was insured**. However, insurance can be thought of as buying protection against risks – like that of fire. Insurance companies pool this risk and the pool of premiums accumulated over time is used to compensate the parties affected by the realisation of the relevant risk – in our case, a warehouse fire.

When such catastrophe occurs, the insurer is simply returning the parties to the economic position they would have been in had the fire not occurred. The premiums paid by a business are value or accumulated wealth that has already been generated in the course of producing and selling the good or service of that business.<sup>20</sup> Likewise, the payment of a claim by an insurance company is simply a transfer of that value or accumulated wealth – and that of other premium payers with whom risks were pooled - back to one of the businesses that generated that wealth in the first place. Such transfers are redistributive in impact rather than impacting on ongoing economic activity and performance. There is, of course, an overall reduction in net worth (the difference between assets and liabilities) as a result of warehouse fires because insurance company reserves from which claims are made are reduced. Unexpected increases in the incidence of catastrophes like fires can, of course, be expected to eventually result in higher premiums.

The extent to which policyholders spend their insurance claim to replace buildings, machinery etc. would amount to a final demand stimulus to the economy. But the economic activity that takes place as a result is activity that would have taken place in the future anyway when those assets reached the end of their useful working lives and required replacement. It would not be appropriate to attribute the economic benefits of a demand stimulus that would most likely have taken place at some point in the future anyway to fires. This approach could, in any case, create perverse incentives for those with an interest in presenting the UK's economic performance in the best possible light. For these reasons, we do not consider such benefits as part of our approach.

The extent to which insurance does not cover the full extent of the true value of the damage caused by warehouse fires requires more careful consideration. The difference between the BRE 'mid-case' value of £195 million and the 'low case' value of £86 million is treated as the value of damage and disruption that

<sup>20</sup> Businesses, of course, treat insurance premiums as a cost. But it can also be thought of as taking away from the value generated in the production and sale of their products and services, value that would have been higher had the insurance premium not had to be paid.

is not insured (but could, in principle, have been). This amount of £109 million across all insurance lines is a key driver of the economic impacts on ongoing macroeconomic performance as a result of warehouse fires.

Table 11 shows the breakdown of Cebr's estimate of the financial value of the damage and disruption caused by warehouse fires. This incorporates BRE's 'mid-case' estimate of £195 million and Cebr's estimates of uninsurable losses – business failure and loss of growth trajectory. This gives Cebr's estimate of total financial loss of £230.2 million per year.

**Table 11: Direct financial and economic losses by loss category, 2012, millions of pounds**

Loss Category	Financial Loss	Economic Loss (loss in GVA)
Building	81.3	-
Contents	3.3	-
Machinery	18.7	-
Stock	39.7	-
Business Interruption	38.8	21.7
Loss of rent	6.2	-
Other	7.1	-
Business failure	23.8	23.8
Loss of growth	3.6	3.6
Local business disruption	7.7	7.7
<b>Total</b>	<b>230.2</b>	<b>56.8</b>

*Source: Fire Protection Association, BRE Global, Cebr Analysis*

The BRE 'low case' of £86 million is the part of this £230.2 million estimate that is, of course, covered by insurance. For the shares of the various categories of damage that are not insured, their treatment must be considered in the context of the framework outlined above. This is outlined as follows:

- *Buildings, contents and machinery*: the uninsured damage to the building amounts to a reduction in the firm's assets, thereby reducing its net worth. This reduces the productive capacity of the business to add value to the economy, but this is already captured by the losses from business interruption, business failure and loss of growth trajectory.
- *Stock*: stock is inventory which, much like buildings, contents and machinery, is an asset on which returns would have been earned when it was sold in the future. Again, the capacity of the business to add value to the economy is hampered when stock is lost that was not insured, but these lost returns are also captured by the losses from business interruption, business failure and loss of growth trajectory.
- *Business interruption*: losses from business interruption that are not insured do translate into a reduced contribution of the warehousing industry to GDP. To the extent that they are not insured, they are counted as a loss to the economy and its ongoing economic performance.

- *Loss of rental income*: lost rental income that is not insured can be expected to have an impact on GDP. However, this is best measured as an indirect impact by modelling the loss of rental income to the warehouse owner as a loss to one element of the supply chain of the occupant business. This is reflected in the results presented later.
- *Business failures and loss of growth*: these ‘uninsurable’ losses can also be considered as a loss in ongoing economic performance. GDP is reduced to the extent of the value that would have been generated by the failed business had the fire not occurred and it had survived, as well as to the extent that firms that did survive could have been larger and contributing more to the economy had the fire not occurred.
- The losses arising from “business interruption” do translate into direct impacts on the warehousing industry’s ability to add value to the economy. Business interruption is generally insured, but the growth that the business could have achieved during the period of interruption will not be insured for loss and this translates into a net loss to the economy. But, we also note that, even businesses that are covered by business interruption insurance will have reduced demands on their suppliers, which imposes indirect economic losses.
- *Local business disruption*: this is not covered by insurance either. We do, however, allow for the fact that the value of the losses sustained during disruption can and will be made up through extra effort in the period immediately following the cessation of the disruption. However, this will not always be the case.

It is also necessary to add the lost earnings of employees of the fire-affected businesses because these will not be captured within business interruption, which is concerned with profitability only. These are estimated and added to the £56.8 million reduction in the warehousing industry’s contribution to GDP (shown in Table 11 above) later in the report (Section 6).

#### 4.5 Multiplier impacts

The direct economic impact can, in turn, generate multiplier impacts when the assessment is broadened to consider the losses to other businesses that are commercially and spatially related to it. We use the multiplier estimates outlined in sub-section 3.2 above, and this constitutes stage 3 of the modelling process.

We note, however, that in estimating the indirect losses through the supply chain, we take account of all business interruption losses whether insured or not. The loss of stimulus to the supply chain is not insured and will, therefore, be the same regardless of whether the warehouse was insured for business interruption. The direct impact on warehousing and indirect impact on the supply chain can be expected to lead to job losses, in turn causing induced losses associated with reduced employee earnings and spending in the wider economy.

The direct and multiplier impacts are of course additive. The stage 2 ‘direct’ economic impacts are what counts in measuring the losses to a local or regional economy or to the GDP level and growth at the national level. These negative economic impacts will be reflected in the industry’s structural business and economic statistics – specifically, those outlined above for the warehousing industry. The stage 3 impacts are the wider losses to the economy that are much less concentrated in terms of who and what they affect.

## 4.6 Local impacts

To understand how the effect of warehouse fires is felt at the local level, we isolate three exemplary case studies and apply the methodology described above to these particular cases. We examine how the cost of damage to the businesses affected could be expected to translate into direct and multiplier impacts on the local economy. These case studies are used to highlight the fact that the impact of warehouse fires can be severe and permanent when considered at the national level.

## 4.7 Environmental impacts

The methodology used to calculate the environmental impacts of fires in warehouses that do not have AFSS installed sits outside the core assessment and methods outlined thus far. This is covered, therefore, in Section 7 below, where we also present the results of our analysis.

## 5 FINANCIAL CONSEQUENCES OF FIRE DAMAGE TO WAREHOUSES

This section presents our analysis of financial value of damage and disruption to business as a result of warehouse fires. It expands on the £230.2 million estimate and its breakdown across insurable and uninsurable categories of damage and disruption as presented in Table 11 in section 4.4 above.

We aimed to capture the cost of damage to the building, as well as its contents, stock, and machinery. We also sought to capture the cost (or losses) arising from the activities of the business being interrupted and the lost opportunity for business growth during the period of interruption. We highlight the business-critical element of the risks fire disruption poses to businesses as represented by the number of business failures resulting from warehouse fires and the associated losses. We also consider businesses in close proximity to the fire, which can also suffer disruption and incur direct financial losses as a result.

Over and above these direct losses, there are knock-on impacts on those firms in the ‘forward’ supply chain (for example, wholesalers and retailers), which rely on the goods being stored and moved by the warehouse in order to turn a profit. There are also ‘backward’ impacts on those firms which are embedded in the supply chain of a warehouse that is disrupted by fire.

Job losses can also be expected as a consequence, not only for staff employed in the affected premises, but also for those employed indirectly through warehousing’s supply chain and in the wider economy. These job losses can have a significant impact at the local level depending on the importance of the warehouse in sustaining growth and jobs in the community.

### 5.1 Direct financial losses to the owners and occupants of the premises

On average, a total of 621 warehouse fires occur annually in England & Wales, of which 588 are in warehouses without AFSS. These incidents impose financial costs on businesses through the damage caused to the premises as well as to the stock and machinery held within. The loss of these assets has a disruptive effect on the businesses occupying the premises which in turn lowers their profits and reduces their ability to pay wages.

#### The financial cost of insurable damage and disruption

Table 12 presents BRE’s ‘mid-case’ or best estimates of the financial value of damage and disruption by category of loss and for different warehouse sizes. The ‘Total’ column showing absolute values for the various insurance lines is already built into Table 11 above.

**Table 12: Total direct financial losses by loss category, annual average between April 2009 and March 2012, £millions**

Loss category	Small (< 2,000 m <sup>2</sup> )	Medium (2,000 m <sup>2</sup> to 10,000 m <sup>2</sup> )	Large (>10,000 m <sup>2</sup> )	Total	% of total
Building	24.5	33.0	23.8	81.3	42%
Stock	12.0	16.1	11.6	39.7	20%
Business interruption	11.7	15.7	11.3	38.8	20%
Machinery	5.6	7.6	5.5	18.7	10%
Other	2.1	2.9	2.1	7.1	4%
Loss of rents	1.9	2.5	1.8	6.2	3%
Contents	1.0	1.3	1.0	3.3	2%
<b>Total</b>	<b>58.8</b>	<b>79.1</b>	<b>57.1</b>	<b>195.0</b>	<b>100%</b>

Source: Fire Protection Association, BRE Global, Cebr analysis

We estimate on this basis that a total of £230 million per year is lost by business in financial terms as a result of fires in warehouses not fitted with AFSS. There are a range of parties affected by these events:

- Owners of the property suffer a loss of £81 million per year through damage to the premises and a further £6m per year through the loss of rental income. Around 7 per cent of buildings affected by commercial fire are completely demolished, with this figure rising to 16 per cent for medium-sized warehouses (2,000 square metres to 10,000 square metres).<sup>21</sup>
- Disruption to businesses occupying and using affected warehouses results in reduced profits and wages earned as firms are unable to operate (or if so, at a reduced capacity) for an extended period of time after the fire has taken place. This may occur for a number of reasons such as delays in relocating or reopening premises, being unable to fulfil contracts or damage caused to company reputation resulting in lower customer demand. Business interruption results in estimated financial losses of £39 million per year.
- Owners of the stock and machinery are estimated to incur losses of, respectively, £40 million and £19 million per year through fire (and smoke) damage. The warehousing sector is feeding growing internet retail distribution activity. This trend is likely to drive increases in the value of stock stored in warehouses, and the machinery required to process, package and distribute goods purchased through the internet.

Interestingly, the largest direct financial costs are realised in medium-sized warehouses (2,000 square metres to 10,000 square metres). This is because, whilst only 9 per cent of warehouse fires actually occur in warehouses of this size category compared to 86 per cent in small-sized warehouses, the cost imposed by each individual fire is significantly higher. We also note that medium-sized warehouses are smaller than the floor space threshold beyond which AFSS are a legal requirement. This means, in other words, that a very significant share of the total direct financial cost imposed by these fires could be avoided altogether if buildings of this size were required to install fire sprinklers.

### The financial cost of ‘uninsurable’ damage and disruption

The ‘uninsurable’ losses introduced in sub-section 4.3 were estimated on the following basis:

- **Loss of growth trajectory:** long-run average GVA growth in the warehousing sector was 1.41 per cent per year between 1998 and 2011. Our analysis of the 12 case studies presented in subsection 2.3 suggests that the average disruption to business lasts for approximately twelve months. Twelve months of disruption would result in an average loss of £3,147 of profits that would have represented growth on the previous year. Given the strong expected growth in warehousing, as highlighted in section 1.2 above, due to robust and growing demand for online retailing, the average loss could be expected to rise.
- **Business failures:** an analysis of a selection of twelve case studies informed the assumptions built into the modelling developed to capture this cost of business failures. The information pertaining to these case studies can be found in Table 7 in an earlier section, in which can be seen several cases of ‘total loss’ (i.e., business failure). As outlined already, warehouses that were demolished, not re-opened following the fire and unlikely (in Cebr’s view to have been re-opened elsewhere were assumed to fail, resulting in an estimated business failure rate of 6.2 per cent for business affected by warehouse fires.

21 BRE Global report ‘An environmental impact and cost benefit analysis of fire sprinklers in warehouse buildings’ (October 2013)

Based on these assessments, our findings suggest that the total direct financial losses associated with business failures is £23.8 million and the loss of business growth £3.6 million per year<sup>22</sup>.

### Summary of direct financial losses to business

Taking the sum of all direct financial losses discussed so far, we estimate that warehouse fires result in a **direct financial loss of £230 million to business in England and Wales**. This was already presented in Table 11 above, including how it breaks down across the various categories of insurable and uninsurable losses.

The direct financial losses to business are not, however, the end of the story. These direct impacts produce knock-on impacts on other businesses that either use warehousing and distribution services or that supply goods and services to the warehousing industry.

## 5.2 Indirect financial loss to business

The financial effects can be expected to run deep into the upward supply chain of economic activities that support operations at the warehouse. The effects are also felt in the downward supply chain - retailers and wholesalers that rely on the goods stored at and moved to and from warehouses suffer disruptions to their activities and inventory levels. Finally, there is disruption to local businesses, schools and transport firms in and around the local area where the fire occurs as key infrastructure (e.g. closure of roads, airports and denial of access to adjacent buildings) is shut down.

### Backward supply chain impacts

The industries described in subsection 3.2 above are those that suffer the 'knock-on' effects caused by any business disruption or failure at the premises where the fire occurs. With these supply chain linkages, disruption to warehousing activities generates ripple effects throughout the economy. The financial effects cannot be estimated without more information on the supply chains supporting warehouses that suffer fire. However, the impact on the economy that is the result of the loss of demand for providers in the supply chain can be determined using Cebr's in-house input-output models. This is done in Section 6 below.

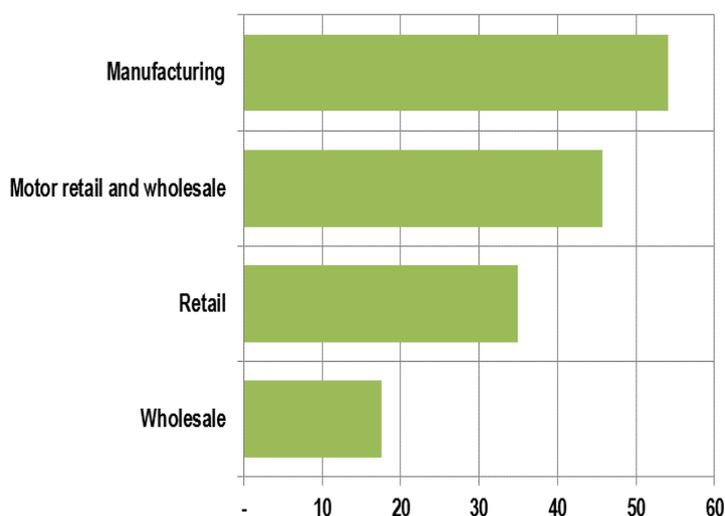
### Forward supply chain impacts

The industries highlighted in subsection 3.3 above as being dependent on the services provided by the warehousing industry are those most likely to be negatively impacted by the disruption caused by interrupted supply from a warehouse that has suffered a fire. For wholesalers, retailers and manufacturers, the extent of their exposure will depend on their own inventory levels and on the ease with which alternative supplies can be sourced. To illustrate the former, Figure 10 uses data from the Office for National Statistics' Annual Business Survey (2011 edition) to show the number of days, on average, that the typical wholesale, retail and manufacturing business could continue to trade in the event that they could not replenish their stock levels.

Wholesalers are by far the most vulnerable to a supply-side shock, holding just 18 days of inventories. Within the sector, fuel, food and beverage wholesalers held the lowest levels of inventories, while wholesalers of machinery and other equipment held significantly larger inventories. Relative to rates of turnover, retailers held inventory levels almost twice as large as those of wholesalers. But, while the average retailer could potentially continue trading for 35 days on their existing stock of goods, there was substantial variation across the sector.

<sup>22</sup> The direct financial costs of business failure are based on an assumption that one year of GVA (profits and wages) generated by the failed business is lost

Figure 10: Days of inventory held by selected industries, average 2008-11



Source: ONS Annual Business Survey 2011, Cebr analysis

Figure 11 provides an illustration of typical inventory levels held by a range of different retailers in terms of the average number of days' worth of stock held. Petrol stations and department stores, for example, held stock levels of 11 and 21 days respectively, while more specialised stores, such as jewellers and art galleries held 62 days of inventory on average.

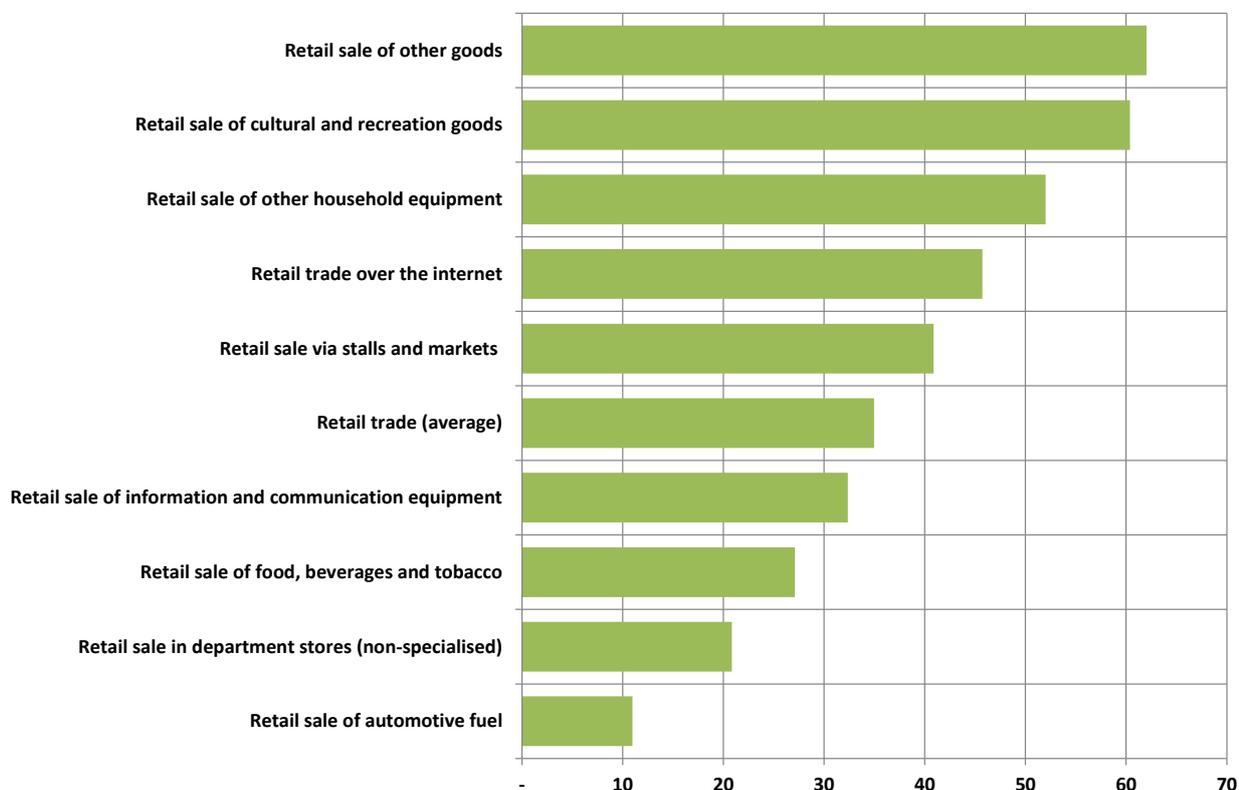
Motor vehicle traders and manufacturing businesses tend to hold relatively large stock buffers. The average motor vehicle trader holds 46 days' worth of inventories, while the typical manufacturer holds 54 days-worth. The lower average frequency of sales in these sectors, coupled with the additional effect of pipelines of work in progress in the case of manufacturing, contributes to a relatively lower level of exposure to warehouse disruption on this measure.

While it is clear, therefore, that the short term impacts on individual wholesalers and retailers could be significant, it will depend on inventory levels and how quickly alternative supplies can be sourced. The impact on final consumers, however, is unlikely to be significant, given the vast choice of retailers to choose from in the event of stock-outs. The overall impact on the macro economy is, therefore, unlikely to be significant.

Some loss to the macroeconomy can always be expected due to imperfect information and the resulting difficulties of matching demand with supply, but also due to the potential delays if alternative suppliers cannot meet the demand immediately and/or if the supplies must be transported over long distances. These macroeconomic effects can be amplified when the goods that are damaged, destroyed or not delivered on-time are of extremely high value or are tailored as inputs into bespoke manufacturing processes, such as the manufacture of cars.

But because the consumer will generally always be satisfied – even if it is later than expected – we would expect these impacts to wash out of the system. For instance, retailer and wholesaler margins could be squeezed but, so long as shortfalls are not met by imports from abroad, this squeeze will benefit other suppliers in the economy and the logistics and transportation providers that have to move the goods required to meet shortfalls arising from warehouse fires.

Figure 11: Days of inventory held by selected retailers, average 2008-11



Source: ONS Annual Business Survey 2011, Cebr analysis

### Disruption to business in close proximity to warehouse fires

The direct effects of warehouse fires are not confined to the parties to the premises that suffered the fire. Businesses that occupy premises in close proximity to the fire can suffer disruption due, for example, to the closure of key roads and infrastructure in order to tackle the blaze and manage evacuation from the premises. Businesses, schools and key transport infrastructure (motorways, airports and stations) could be disrupted in this manner.

To support our understanding of the financial and economic impacts of warehouse fires to the wider local business community, we have examined a total of 12 case studies and have presented a more detailed analysis of the local impacts for two such case studies below.

## 6 ECONOMIC CONSEQUENCES OF WAREHOUSE FIRES

Having established the financial cost to business associated with warehouse fires, we then sought to analyse how warehouse fires impact on the economy. These impacts on ongoing economic performance are felt through the loss of GVA generated by and employment in the warehousing industry. These impacts filter through to other industries that support warehousing activity through its supply chain and through the lost employee spending impacts – calculated using Cebr’s estimates of multiplier impacts for the warehousing industry. We also consider disruption in the supply chain of businesses that rely on goods distributed through warehousing and logistics service providers.

Based on lost direct and (indirect and induced) multiplier impacts, we estimated the accompanying impacts on the Exchequer in terms of lost tax revenues. Specifically, we aimed at quantifying the loss in earned and taxed income and national insurance contributions associated with employment losses from warehouse fires. Direct GVA losses were also identified as a source of revenue losses to the Exchequer in terms of corporation tax and business rates.

We do this by applying the national accounting framework used by the ONS in measuring GDP<sup>23</sup> to estimate the loss to the economy as a result of the financial losses caused by warehouse fires. These economic losses also result in lost tax receipts to the Exchequer, which we also seek to quantify in this section. We also use Cebr’s input-output model to determine the potential economic losses resulting from the ‘ripple’ effects in the wider economy (otherwise known as the indirect and induced multiplier impacts).

### 6.1 Macroeconomic impact on the economy of England and Wales

#### Direct impacts on GDP, employment and taxes in England and Wales

Table 13 re-presents the results of our exercise of translating the financial value of damage and disruption into impacts on the economy and our finding that a £56.8 million loss to GDP flows from the various insurable and uninsurable losses.

**Table 13: Direct financial and economic losses by loss category, 2012, millions of pounds**

Loss Category	Financial Loss	Economic Loss (loss in GVA)
Building	81.3	-
Contents	3.3	-
Machinery	18.7	-
Stock	39.7	
Business Interruption	38.8	21.7
Loss of rent	6.2	-
Other	7.1	-
Business failure	23.8	23.8
Loss of growth	3.6	3.6
Local business disruption	7.7	7.7

<sup>23</sup> The impacts are stated in terms of lost GVA, rather than GDP. But note that GDP is just economy-wide GVA plus taxes less subsidies on products (goods and services), which are not available at the sub-economy level.

Loss Category	Financial Loss	Economic Loss (loss in GVA)
<b>Total</b>	<b>230.2</b>	<b>56.8</b>

Source: Fire Protection Association, BRE Global, Cebr Analysis

But, as already noted, to this must be added the lost earnings of the employees of the fire-affected businesses. We estimate that 384 jobs are lost directly to the economy due to fires in warehouses. This is based on an assumed average employment density of 605 square metres per employee.<sup>24</sup> This rises to 939 for large warehouses and falls to 544 for small warehouses based on typical job loss estimates from a range of case studies for different-sized warehouses.<sup>25</sup> The average salary in the warehousing and distribution sector is £31,388 per year.<sup>26</sup> This means that a total direct job loss of 384 leads to a loss in annual earnings of £6 million given that workers are likely to be unemployed for varying amounts of time as illustrated in Table 14.

**Table 14: Proportion of those unemployed by duration, September 2013**

Duration of unemployment	Percentage of those unemployed
<b>Less than 6 months</b>	45.9%
<b>6 to 12 months</b>	18.0%
<b>12 to 24 months</b>	18.9%
<b>Over 24 months</b>	17.3%

Source: Office for National Statistics, Cebr Analysis

Our analysis shows that it is likely that around 54 per cent of workers will be unemployed for a period greater than 6 months.

Adding this £6 million in lost employee earnings to the £56.8 million from our translation of financial losses into economic losses gives a **total reduction in GDP of £62.8 million as a result of warehouse fires**.

The loss to GDP will also mean impacts on the Exchequer. The **direct loss to the Exchequer is estimated at £8.2 million**. This includes corporation taxes, business rates, employers' and employees' national insurance contributions and income taxes from employee salaries.

Table 15 summarises these direct economic impacts on GVA, taxes and employment split by warehouse size.

<sup>24</sup> This is calculated by taking total employed in the warehousing and distribution sector (277,299) and dividing by total warehouse floor space (118.5 million square meters). As such, it is including those likely to be directly employed in the logistics and distribution activities by the warehouse.

<sup>25</sup> Based on evidence collected from case studies, employment densities (employees per meter squared) tend to fall as warehouse size rises. The calculation of employment densities for each warehouse size has been modelled by Cebr based on this assumption and using the total number of employees in the sector and the total floor space covered by warehouse premises as inputs in this calculation.

<sup>26</sup> Annual Survey of Hours and Earnings 2012, Office for National Statistics

**Table 15: Total direct annual loss in GVA, tax and employment due to warehouse fires, 2012**

£ millions	Small (< 2,000 m <sup>2</sup> )	Medium (2,000 m <sup>2</sup> to 10,000 m <sup>2</sup> )	Large (>10,000 m <sup>2</sup> )	Total
<b>Total direct loss in GVA (£m)</b>	11.4	33.7	17.8	62.8
<b>Total direct tax loss to the Exchequer (£m)</b>	2.0	4.2	2.1	8.2
<b>Total direct employment losses</b>	155	164	64	384

Source: Fire Protection Association, BRE Global, Cebr Analysis

### Multiplier impacts on GVA and employment in England and Wales

Section 3.2 presented Cebr's estimates of the multiplier impacts of the warehousing industry. These provide the basis for our estimates of the indirect and induced multiplier impacts on the economy of warehouse fires. Recall that the indirect impact represents the loss of demands on the warehousing industry's supply chain and that induced impacts represent the lost demands on producers of final goods and services on which employees spend their wages and salaries.

Applying the multipliers from sub-section 3.2 to the direct economic impacts from above provides our estimates of the lost absolute impacts on GDP, employment and tax takings. These are presented in Table 16 below.

**Table 16: Total annual multiplier losses in GVA, tax and employment due to warehouse fires, 2012**

	Small (< 2,000 m <sup>2</sup> )	Medium (2,000 m <sup>2</sup> to 10,000 sqm)	Large (>10,000 m <sup>2</sup> )	Total
<b>Total indirect economic costs (£m)</b>	28.2	65.8	33.1	127.1
<b>Total indirect tax loss to the Exchequer (£m)</b>	5.3	12.0	6.0	23.4
<b>Total indirect employment losses</b>	248	261	103	612

Source: Fire Protection Association, BRE Global, Cebr Analysis

Our findings show that a total of £127.1 million per year is lost indirectly due to fires and a total job loss of 612 employees is also realised. Through indirect impacts, the Exchequer loses some £23.4 million per year as a result of fires.

### Summary of impacts on the economy of England and Wales

Table 17 combines the estimates of the direct, indirect and induced impacts on the economy from above to produce our estimates of aggregate economic impacts.

Table 17: Total annual loss in GVA, tax and employment due to warehouse fires, 2012

	Small (< 2,000 m <sup>2</sup> )	Medium (2,000 m <sup>2</sup> to 10,000 sqm)	Large (>10,000 m <sup>2</sup> )	Total
Direct economic costs (£m)	11.4	33.7	17.8	62.8
Indirect economic costs (£m)	28.2	65.8	33.1	127.1
Total economic costs (£m)	39.5	99.5	50.9	189.9
Total loss in employment	404	425	167	996
Total tax loss to the Exchequer (£m)	7.4	16.2	8.1	31.7

Source: Fire Protection Association, BRE Global, Cebr Analysis

Our findings show that fires cost the national economy £190 million in GVA annually and result in approximately 996 job losses every year. The aggregate tax loss to the Exchequer is estimated at £31.7 million.

## 6.2 Local economic impact case studies

Delving deeper into local-level impacts reveals that impacts at this level have the potential to be more severe and permanent, particularly if a warehouse business that has suffered fire fails completely or reopens in a different location. We have estimated total GVA losses for a number of case studies below. However, in the absence of better information, these impacts are analysed through the lens of the national modelling framework. The estimates are purely assumptions-based, therefore, and purely illustrative in order to demonstrate how the impacts on local areas negatively impacted by fire can suffer disproportionately relative to the national picture.

### Real Crisps warehouse fire, Wales, September 2012

The fire at the Real Crisps factory in Caerphilly County in Wales occurred, as already noted, in September 2012. The implications of the fire for the local economy look as if they have been long-lasting, despite the successful prosecution of the arsonist.

The business itself suffered damage of £7 million and the fire resulted in a total financial loss of £25 million to the Tayto Group, which owned the warehouse. Moreover, the fire and the resulting closure of the warehouse had an impact on the social and economic conditions of the local area as it resulted in a loss of 80-100 jobs. This, according to a local councillor was “pretty devastating for an area of high unemployment”.

While the factory’s owners offered jobs at their plants in Ireland and England, few from those affected took up the opportunity. As argued earlier in this report, while the impact on a national level might have been lessened through the creation of new jobs in England (new jobs in Ireland would also be a loss to England and Wales), the impact on the local economy is likely to be long-lasting, if not permanent, as Tayto decided not to re-build the facility. The same local councillor further noted that “the hope in the community is that a company will come in and take one of the factories on the site. We’ve got a number of empty factories within the Crumlin area.”

### Sony warehouse fire, London, August 2011

The Sony warehouse in Enfield, London suffered a fire in August 2011 which resulted in the immediate loss of stock in the form of CDs and other media owned by music and film labels. The insured loss of stock was

worth £80 million and its destruction is likely to have diminished potential profits earned by these labels if the stock had been sold on.

In the aftermath of the fire, the Sony warehouse was closed for 13 months resulting in significant impacts on the local economy as the business ceased to operate and a total of 750 jobs were suspended. The loss of annual GVA generated by the warehouse was estimated to be £4.5 million on an annual basis when filtered through our national modelling framework.<sup>27</sup> This includes lost profits as a result of business interruption and lost employee earnings.

During the closure of the Sony warehouse, there was likely to have been a reduced demand for goods and services from the warehouse's supply chain. And the loss of employee earnings is likely to have led to less income being spent in the local economy. Cebr's input-output model has regional functionality also, producing separate multipliers that account for the fact that, at the regional level, the propensity to import is higher (because it is necessary to import from other regions of the domestic economy as well as from abroad) so some of the impacts spill over into other regions. However, there can also be feedback effects when the loss of demand on suppliers in other regions has the effect of reducing demand on their suppliers if they happen to be located in the region being analysed.

The regional GVA multiplier for the London warehousing industry (the location of the Sony warehouse) of 2.14 illustrates that for every £1 of GVA produced, a further £1.14 is generated in the region through the indirect and induced effects. On this basis, the multiplier loss to the London region of the Sony warehouse fire is estimated at £5.1 million, producing an aggregate loss to London GDP of £9.6 million.

This could also result in job losses or temporary lay-offs in the supply chain if the demands on these suppliers from the Sony warehouse are not replaced by demands from other warehouses that are picking up the slack that resulted from the fire. However, the Sony warehouse was operational again within 13 months, so the loss of jobs in the Sony warehouse can be seen as temporary, as can any job losses in the supply chain which will be boosted again by the re-opening of the warehouse.

### **Skymark packaging warehouse, June 2009**

The fire at the Skymark packaging warehouse in Leominster, Herefordshire in June 2009 resulted in failure to re-open the warehouse, the activities of which were redistributed to different bases around the country, including Scunthorpe in North Lincolnshire. Some workers were given the opportunity to re-locate whilst others have stayed in Leominster to work from a temporary base close to the previous site.

In the months following the fire, the local impact would have been mitigated had another firm been able to capitalise on the relative scarcity of packaging facilities in the affected area. At the national level, the subsequent relocation of the business would have brought benefits to firms and workers in other localities which mitigates the impact on the national economy.

But because the relocation of the packaging activities that took place at the warehouse resulted in a permanent loss of activity for the local area, there would also have been permanent indirect and induced impacts in the local economy.

### **Findus frozen food warehouse, January 2009**

A fire at Findus's frozen food factory in Longbenton, Newcastle in January 2009 resulted in 420 workers losing their jobs at the factory and the owner of the factory going into administration. The facility reopened 18 months later with the help of funding from the North East Regional Development Agency.

<sup>27</sup> This figure is based on the average annual GVA of a large-sized warehouse (< 10,000 m<sup>2</sup>) in England and Wales.

During the 18-month period of interruption, the lost economic activity reduced profits and wages earned in the local economy, thus depressing the supply chain on which it depended as well as depressing consumer spending of earnings.

The effects would have been less damaging at the national level as other plants may have stepped up capacity to meet the reduced food supply caused by destruction of the factory. When the firm reopened under new ownership, the business went into administration once again with around 150 workers being made redundant. As the plant reopened at a reduced capacity, there was a long-lasting effect on the local economy as a result of the fire that extended beyond the 18-month period of disruption. But at the national level, demands will have been met from elsewhere, stimulating activity in other local areas and thereby mitigating the loss where the original warehouse was located.

### **Summary of local economic impacts**

The key takeaway from the above analysis is, of course, that impacts on the local economy can be more severe and permanent, especially in cases where the business fails completely, where activities resume at reduced capacity or are located elsewhere entirely.

At the national level, the impacts can be expected to look much less severe because there are positive impacts on other local economies that benefit from businesses that have suffered fire re-locating to their area. While such gains mitigate the local losses when considered from the point of view of the England & Wales economy as a whole, the fact is that the local losses can be severe and permanent if nothing takes the place of the business that was once there.

## 7 ENVIRONMENTAL IMPACTS OF WAREHOUSE FIRES

Fires in warehouses also impact the environment and, in doing so, impose additional economic costs. Firstly, fires generate carbon emissions, both from CO<sub>2</sub> released during the fire itself and from CO<sub>2</sub> generated during the replacement and rebuild phase following the fire. Table 18 below shows how these environmental costs vary for a typical fire by warehouse size.

**Table 18: Environmental costs per fire (tonnes of CO<sub>2</sub> & litres of water)**

	Small	Medium	Large	Total
<b>CO<sub>2</sub> released during fire</b>	21.0	280.5	280.0	581.5
<b>CO<sub>2</sub> embodied in replacement</b>	56.5	745.5	745.0	1547
<b>CO<sub>2</sub> embodied in rebuild</b>	11.0	91.0	68.5	170.5
<b>Water used in firefighting</b>	2986	4986	3373	11345

*Source: BRE Global*

The annual average of 588 fires occurring in warehouses without AFSS is estimated to cause the release of 136,000 tonnes of CO<sub>2</sub>. These are the CO<sub>2</sub> emissions estimated to be caused by the destruction of the building and its contents and by the rebuilding of these facilities where that occurs.<sup>28</sup>

We have used a value of £56.0 per tonne of CO<sub>2</sub> to calculate the economic cost of these emissions which capture the 'non-traded' value of carbon in 2012 as outlined by the Department of Energy and Climate Change.<sup>29</sup> This is the most appropriate value to apply given that the emissions generated by fires cannot arguably be included as part of the traded sectors for carbon.

Further to this, thousands of litres of water are used to control fires, resulting in additional costs. Finally, fires will also create air pollution and generate unnecessary waste and use of resources to rebuild destroyed property. The total quantifiable environmental costs associated with warehouse fires are summarised in Table 19 below. These are calculated based on the data in Table 18 above, using £56.0 per tonne as the appropriate monetary value of the CO<sub>2</sub> emissions and based on a total number of fires of 588 per year in total, in line with the key assumption for the number of fires used throughout the report.

As the table shows, **the environmental impact of warehouse fires in England & Wales is estimated at £10.7 million per annum**, of which £7.6 million is incurred through emissions of CO<sub>2</sub> – the value Cebr attaches to the annual release of 136,000 tonnes of CO<sub>2</sub> as a result of warehouse fires.

<sup>28</sup> This figure is similar to the 'low-case' reported in the Bureau Veritas report "Assessing the role for sprinklers" (April 2011), which reports a figure of 145,000 tonnes saved due to installing fire sprinklers in warehouses without AFSS. Strictly speaking, the Bureau Veritas estimate is not directly comparable. The estimate is of the net impact of sprinkler installation (once emissions released through the construction and maintenance of the sprinklers is accounted for), whereas the BRE estimates presented in Table 18 simply reports the total emissions released due to fires. The Bureau Veritas report also includes the emissions released due to disposal of the building waste caused by the fire, which are not accounted for in the BRE estimates. In any case, the Bureau Veritas report provides a more in-depth exposé of the environmental impacts of fires in warehouses and other commercial spaces, including elements that are less easily quantifiable.

<sup>29</sup> A brief guide to the carbon valuation methodology for UK policy appraisal (October 2011) [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/48184/3136-guide-carbon-valuation-methodology.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48184/3136-guide-carbon-valuation-methodology.pdf)

Table 19: Annual environmental costs (£ millions)

	Small	Medium	Large	Total
<b>CO<sub>2</sub> released during fire</b>	0.6	0.8	0.5	<b>1.9</b>
<b>CO<sub>2</sub> embodied in replacement</b>	1.6	2.2	1.3	<b>5.0</b>
<b>CO<sub>2</sub> embodied in rebuild</b>	0.3	0.3	0.2	<b>0.7</b>
<b>Cost of water used in firefighting</b>	2.5	0.4	0.2	<b>3.1</b>
<b>Total</b>	<b>5.0</b>	<b>3.7</b>	<b>2.0</b>	<b>10.7</b>

*Source: BRE Global, Cebr analysis*

## 8 CONCLUSIONS AND NEXT STEPS

This report has presented the analysis undertaken by the Centre for Economics and Business Research (Cebr) to quantify the total costs of fires in warehouses which are located in England and Wales and which are not fitted with AFSS.

The findings of this analysis suggest that there are significant financial costs of £230 million annually to businesses owning and operating warehouses in the event of a fire in their premises. The economic loss to GDP that flows from these financial costs is £56.8 million to which must be added £6 million in lost employee earnings, to give an aggregate direct impact on GDP of £62.8 million. This has knock-on impacts through the supply chain (indirect multiplier losses) and through the wider economy because of the reduced employee spending of their lost earnings. This produces a further lost multiplier impact of £127 million. **The aggregate loss in GDP is, therefore, estimated at £190 million.**

**These losses to GDP translate into reduced tax takings for the Exchequer of nearly £32 million and to nearly 1,000 job losses.**

**Environmental impacts are valued at £10.7 million.** Fires generate CO<sub>2</sub> emissions, both from the fire itself and from the replacement and rebuild of facilities following the fire. Thousands of litres of water are used to control fires, resulting in additional environmental resource costs.

The losses to business and to the economy can be turned on their head and represented as the savings or returns that derive from the installation of AFSS that would have prevented the damage in the first place. This can act to guide policy towards fire protection in England and Wales. Specifically, our results suggest that there are significant costs to be saved if every effort is undertaken to minimise the spread of large fires. Three courses of action through which this outcome can be realised have been identified:

- Firstly, increasing awareness about the benefits that can be derived from the installation of AFSS among the parties making up the fragmented ownership and operational structures in the warehousing industry can increase the currently sub-optimal, under-provided levels of AFSS.
- Secondly, Government action has the power to correct the failure of the market to provide sufficient levels of AFSS through discussion with businesses, education and information sharing on the benefits that can be derived through their installation, thus indirectly ensuring that they are aware of the incentives for increasing the rollout of AFSS.
- Thirdly, while current regulations are guided principally by minimising the loss of life, the business, economic and environmental impacts – as reflected in the findings of our study - suggests that it is in the Government's interests to go further. As such, Cebr recommends that Government should review the building regulations, specifically the requirement for only those newly-built warehouses that exceed 20,000 m<sup>2</sup> to install AFSS.

Reducing this threshold would, moreover, be consistent with what appears to be best practice when considered in an international context. For example, in other jurisdictions, such as Germany, the Netherlands, Belgium and France, the threshold that triggers an automatic requirement to install AFSS ranges from between 1,000 m<sup>2</sup> and 5,000 m<sup>2</sup>. Given our findings that 73 per cent of the financial, economic and environmental impacts of fires are concentrated in warehouses of under 10,000 m<sup>2</sup>, a review of the threshold would appear to be the natural starting point for change.

Finally, this report constitutes one element of research directed at enhancing the understanding of the business and economic losses associated with warehouse fires and avenues for future research on the subject remain open. The report briefly touched upon the idea that, as warehouses assume more

responsibilities that bring them to more closely resemble manufacturing plants, this also raises the costs following a fire due to the additional mechanical equipment present, the destruction of which is a considerable financial loss to businesses and which, on top of this, also increases the risk of fire. A fruitful direction for future research would thus be to examine how the financial and economic costs compare when looking at the manufacturing sector, as this is likely to further strengthen the case for active fire protection measures to be installed in an effort to contain the damaging effects of fires.