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Deliverable 2.4

Assessing the European Commission's target of essentially CO_2-free city logistics in urban centres by 2030

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CONTENTS

Executive summary

The objective of the CITYLAB project is to develop knowledge and solutions that result in roll-out, up-scaling and further implementation of cost effective strategies, measures and tools for emission free city logistics. In a set of living laboratories, promising logistics concepts will be tested and evaluated, and the fundament for further roll-out of the solutions will be developed.

CITYLAB Deliverable 2.4 is entitled **“Assessing the European Commission's target of essentially CO_2-free city logistics in urban centres by 2030”**. The purpose of Deliverable 2.4 is to investigate the extent to which urban freight initiatives, including those involved in CITYLAB implementations, are likely to bring about more sustainable urban freight transport, especially in relation to the European Commission’s vision of essentially CO_2-free city logistics in major urban centres by 2030. Deliverable 2.4 is concerned with assessing the potential of urban freight initiatives involving behaviour change, including those implemented in the CITYLAB project and comparing and contrasting their potential to reduce carbon emissions from urban freight transport operations with technological change to vehicles and fuels that may emerge over this timescale.

This report is intended to provide the reader with a better understanding into:

- Potential business-as-usual trends in urban freight transport operations by light and heavy goods vehicles (LGVs and HGVs) by 2030
- The potential uptake and impact of urban freight initiatives in European urban areas by 2030
- The potential scope for a package of such urban freight measures to positively influence the key parameters of freight operations and hence bring about reductions in the associated CO_2 emissions in European urban areas by 2030
- The potential of other logistics measures (i.e. that are not specifically urban in focus) to reduce CO_2 emissions in European urban areas by 2030

It is hoped that this report will provide European freight transport policy makers, operators, customers and researchers with guidance and insight into:

- The urban freight initiatives that may be necessary in order to reduce CO_2 emissions in towns and cities,
- Which of these urban freight initiatives may have the greatest effect on reducing CO_2 emissions
- The role that urban freight initiatives can potentially play in conjunction with other logistics measures (i.e. that are not specifically urban in focus) in reducing CO_2 emissions
- The overall extent of policy maker and company action that may be necessary to achieve essentially CO_2-free urban logistics in Europe by 2030

1 Introduction

CITYLAB Deliverable 2.4 is entitled **“Assessing the European Commission's target of essentially CO_2-free city logistics in urban centres by 2030”**. The purpose of Deliverable 2.4 is to investigate the extent to which urban freight initiatives, including those involved in CITYLAB implementations, are likely to bring about more sustainable urban freight transport, especially in relation to the European Commission’s vision of essentially CO_2-free city logistics in major urban centres by 2030 (European Commission, 2011a). This is part of a goal of reducing transport greenhouse gas emissions by at least 60% by 2050 with respect to 1990 (with an intermediate target of reducing these emissions to 20% below their 2008 level by 2030 – which would still leave them at 8% above the 1990 level), and reducing total greenhouse gas emissions to 80% below 1990 levels by 2050, with intermediate milestones of cutting these emissions by 40% by 2030 and 60% by 2040 (European Commission, 2011a; 2011b). Deliverable 2.4 is concerned with assessing the potential of urban freight initiatives involving behaviour change, including those implemented in the CITYLAB project, to reduce CO_2 emissions from freight vehicle operations in European urban areas by 2030. In addition, the potential of these urban freight transport initiatives to reduce carbon emissions from urban freight transport operations are compared and contrasted with other measures aimed at technological change to vehicles and fuels and behavioural changes without a specific urban focus that may emerge over this timescale.

This report is intended to provide the reader with a better understanding into:

- Potential business-as-usual trends in urban freight transport operations by light and heavy goods vehicles (LGVs and HGVs) by 2030
- The potential uptake and impact of various urban freight initiatives in European urban areas by 2030
- The potential scope for a package of such urban freight measures to positively influence the key parameters of freight operations and hence bring about reductions in the associated CO_2 emissions in European urban areas by 2030
- The potential of other logistics measures (i.e. that are not specifically urban in focus) to reduce CO_2 emissions in European urban areas by 2030

It is hoped that this report will provide European freight transport policy makers, operators, customers and researchers with guidance and insight into:

- The urban freight initiatives that may be necessary in order to reduce CO_2 emissions in towns and cities,
- Which of these urban freight initiatives may have the greatest effect on reducing CO_2 emissions
- The role that urban freight initiatives can potentially play in conjunction with other logistics measures (i.e. that are not specifically urban in focus) in reducing CO_2 emissions
- The overall extent of policy maker and company action that may be necessary to achieve essentially CO_2-free urban logistics in Europe by 2030

All of the survey data and spreadsheet modelling results contained in this report concerning carbon emissions are expressed in terms of carbon dioxide equivalent (CO_2e) which, in addition to carbon dioxide (CO_2), includes the Kyoto protocol basket of greenhouse gases relevant to road freight transport operations (these being methane (CH_4), and nitrous oxide (N_2O)). (Department of Energy & Climate Change and Department for Environment, Food and Rural Affairs, 2016).

Deliverable 2.4 consists of the following elements:

- The presentation of the existing context of the seven CITYLAB implementation cities and their road freight transport operations (see **sections 3.1 and 3.2**).

- The methodologies used to forecast likely CO_2 emissions from road freight operations in European urban areas by 2030 (see sections **2** and **7.1**).

- The expectations of survey respondents concerning the likely change in demand for, and hence CO_2 emissions resulting from, road freight transport operations in European urban areas by 2030 assuming business-as-usual conditions (i.e. no change in the existing freight transport initiatives and measures already in place, and therefore due instead to factors resulting in demand changes for freight transport services - see **section 3.3**).

- The expectations of survey respondents concerning the likely impact of a wide range of potential urban freight transport initiatives on CO_2 emissions from road freight transport operations in European urban areas by 2030 – as well as the findings of other studies on this topic (see **section 4**).

- The expectations of survey respondents concerning the likely impact of other logistics measures concerning vehicle and fuel technology and driver training and behaviour on CO_2emissions from road freight transport operations in European urban areas by 2030 – as well as the findings of other studies on this topic (see **section 5**).

- The combined views of survey respondents about the future demand for freight transport in European urban areas, and the likely impact of urban freight transport initiatives and other logistics measures on CO_2 emissions are presented in **section 6**.

- A framework for analysing the relationship between the key variables in urban road freight transport operations and their outputs (in terms of vehicle kilometres and CO_2 emissions) is presented in **section 7** along with a worked example of the relationships and consequent performance indicators for six British urban areas. This example is intended to help illustrate the diversity of the activity and intensity of road freight patterns between urban areas, and therefore the need for solutions that meet these varied situations in order to meet efficiency, traffic and sustainability objectives (see **section 7**)

- The framework presented in **section 7** has been applied to data concerning road freight transport operations in the three CITYLAB cities for which the required operating data was available in **section 8**, in order to model the likely impacts of changes in road freight transport variables (as a result of the implementation of urban freight transport initiatives) on vehicle kilometres and CO_2 emissions in European urban areas by 2030. This draws on the views of survey respondents as well as the literature review presented in **section 4**. The application of the framework was then extended to take account of the future demand for freight transport services in European urban areas by 2030, as well as the potential impacts of other logistics measures focused on fuel and vehicle technology and driver training and behaviour (see **section 8**).

- The Conclusions are presented in **section 9**.
- **Appendix I** provides the standard deviations for the tables of survey results provided in the main body of the report.
- **Appendix II** provides the results of the test application of the spreadsheet model to HGV operations in six urban areas in the UK.

2 Methodology

There are several components to the research methodology used in the research presented in this report. These are explained below.

Literature review work has been used to:

- Obtain current operating statistics for the seven CITYLAB cities (see **section 3.1**).

- Identify the most promising urban freight initiatives in terms of their potential to reduce the CO_2 emissions and other negative impacts of urban freight transport that were incorporated into the survey work carried out (see **section 4**). This review of urban freight initiatives (that could be taken by both public and private sector organisations) draws on the work carried out in CITYLAB task 2.3 (see CITYLAB Deliverable 2.3 for more information of this literature review work).

Survey work has been carried out to obtain the views of experts on the:

- Business–as-usual trends in light and heavy goods vehicle (LGV and HGV) operations in European urban areas to 2030
- Potential of urban freight and other logistics initiatives to reduce CO_2 emissions in European urban areas by 2030
- Relationships between a package of urban freight transport initiatives and the sustainability of freight vehicle operations in European urban areas by 2030

The survey was designed and carried out as a spreadsheet survey. It was circulated to CITYLAB participants in each of the seven CITYLAB implementation cities as well as to experts in urban freight transport who are not directly involved in the CITYLAB project. It was completed and returned by email by 28 expert respondents. These respondents can be grouped into three categories: (i) urban freight researchers, (ii) city authority freight planners and policy makers, and (iii) urban freight industry practitioners (including freight transport operators, customers and other third party providers). As mentioned, these respondents were drawn both from within the CITYLAB project and from outside it. **Table 2.1** shows the breakdown of these 28 respondents across these three categories.

Table 2.1: Categories of respondent participating in the survey work

Category	Number of respondents
Urban freight researchers	18
City authority planners & policy makers	5
Urban freight industry practitioners	5
TOTAL	**28**

See **sections 3-6** for the presentation of the findings of this survey work.

Analytical work has been carried out to:

- Calculate indicators of the current urban freight performance of the seven CITYLAB cities (see **section 3.1**)

- Demonstrate the relationships between urban freight transport operations and the data key variables and outputs. An illustration of the relationships between urban road freight transport variables and outputs has been including making use of HGV data for urban areas in the UK, together with performance indicators that can be derived from this data. The example provided is intended to illustrate the diversity of patterns of activity and intensity of activity of road freight transport operations in urban areas. It is intended to indicate that freight transport initiatives will have differing effects in various urban areas, depending on the type of urban area and current freight transport arrangements, and thereby highlights that varying combinations and specification of freight transport initiatives will be required in different urban areas in order to bring about the desired efficiency, traffic and sustainability outcomes (see **sections 7 and 8**).

- Construct plausible scenarios of the potential impacts of packages of urban freight transport initiatives and other logistics measures on key logistics operations parameters by 2030 (see **section 8**).

- Conduct spreadsheet modelling in which these scenarios have been tested in order to assess their potential impact on CO_2 emissions from freight vehicle operations in European urban areas by 2030 (see **section 7** for further details of the framework and methodology used in this spreadsheet modelling and **section 8** for further details of the scenarios).

Two approaches have therefore been applied to assess the potential of urban freight transport initiatives to reduce CO_2 emissions in European urban areas by 2030. The first is via the direct responses of the experts surveyed (see **sections 4-6**). A second approach was used to validate the results of the first approach. This involved the use of an existing framework that relates key variables of freight transport operations to outputs and the development of a spreadsheet model capable of applying this framework to urban freight operations by light and heavy goods vehicles. Three scenarios were constructed based on survey respondents' views about how these key variables of urban freight operations would change in European urban areas by 2030. The spreadsheet model was then used to calculate the outputs measured in terms of total vehicle kilometres travelled and carbon emissions in the CITYLAB cities to which the framework was applied (see **sections 7** and **8** for further details of the framework used and the spreadsheet modelling approach).

3 The CITYLAB implementation cities

There are seven CITYLAB cities in which urban freight implementations are being carried out. These are:

- Amsterdam
- Brussels
- London
- Oslo
- Paris
- Rome
- Southampton

3.1 Context of the CITYLAB cities

The population size, spatial area, population density, average household size and the extent of residential land use (as a proportion of total city area) are provided for the seven CITYLAB cities in **Table 3.1**. The data reflects the differences between these cities in terms of these factors.

3.2 Freight transport operations in the CITYLAB cities

Light goods vehicles (LGVs) are commercial vehicles up to and including 3.5 tonnes gross weight in EU member states. Heavy goods vehicles (HGVs) are commercial vehicles with gross weights of above 3.5 tonnes in EU member states. Only data about the freight transport activity (in terms of tonnes of goods lifted) is generally collected by national statistics agencies in EU member states (as this is required from member states by Eurostat). By contrast vehicle activity data (in terms of vehicle kilometres travelled) is typically collected for both HGVs and LGVs both nationally, and for major urban areas.

Table 3.2 provides freight transport operating statistics and performance indicators for the CITYLAB cities based on tonnes of goods lifted on journeys to from and within the urban areas by HGVs, CO_2 emissions by HGVs within the urban areas, and the ratio between HGV and LGV vehicle kilometres travelled within the urban areas. The goods lifted and CO_2 emissions by HGVs have been expressed in absolute terms as well as per urban inhabitant and per km^2. These can be seen to vary markedly between the various cities.

It is important to recognise that the economic purpose and significance of these cities also varies markedly (in addition to spatial area, population size and population density), which in turn affects the demand for freight transport operations. The type of industry that exists within an urban area will also influence freight transport demand. Also, urban areas with major port and airport infrastructure that therefore act as national and international gateways will also be generators of freight flows associated with these facilities, which in turn affects freight transport activity levels on roads within the urban area.

Table 3.1: Population, geographical area and population density of the CITYLAB cities

	Amsterdam	Brussels	London	Oslo	Paris	Rome*	Southampton
Population (million)	0.8	1.2	8.7	0.7	2.2	4.4 (2.9)	0.2
Geographical area (km^2)	165	161	1,572	454	105	5,352 (1,285)	50
Population density (population / km^2)	5,069	7,360	5,518	1,450	21,154	813 (2,232)	4,686
Average household size (persons)	1.9	2.9	1.6	1.9	1.9	(2.1)	2.3
Residential land use (as % of total area)	21	29	9	12	45	(18)	50

Note: Most currently available data for each city.
* **-** in the case of Rome the unbracketed data is for the Province of Rome (also called the Metropolitan city of Rome), while the data in brackets is for the city of Rome.
Source: Collected and provided by CITYLAB project partners.

Table 3.2: Freight transport operating statistics and performance indicators for the CITYLAB cities

	Amsterdam	Brussels	London	Oslo	Paris	Rome[1]	Southampton
Goods lifted by HGVs per year[2] (million tonnes)	17	9	136	48	N/A	41.8	17
HGV goods lifted per person per year (tonnes)	20	7	16	72	N/A	10	70
HGV goods lifted per km^2 per year (1000 tonnes)	103	54	87	105	N/A	8	348
HGV vehicle kms per year[3] (million)	N/A	54	1,015	176	286	648	N/A
HGV vehicle kms per person per year	N/A	46	117	268	128	149	N/A
HGV vehicle kms per km^2 per year (thousands)	N/A	337	645	388	2,713	121	N/A
CO_2 emissions by HGVs per year (thousand tonnes)	N/A	N/A	609	160	265	N/A	N/A
CO_2 emissions by HGVs per person per year (tonnes)	N/A	N/A	0.07	0.24	0.12	N/A	N/A
CO_2 emissions by HGVs per km^2 per year (tonnes)	N/A	N/A	387	353	2,518	N/A	N/A
Ratio of LGV to HGV traffic volume	5.0	2.6	4.1	4.0	1.3	(5.7)	5.1

Notes:
1 - in case of Rome the unbracketed data is for the Province of Rome (also called Metropolitan city of Rome), while data in brackets is for the city of Rome.
2 – Goods lifted on HGV journeys to, from and within the urban area.
3 – CO_2 emissions by HGVs within the urban area.
Absolute operating statistics data (shaded rows) is most recently available for each city.
Ratio of HGV: LGV traffic volume - London, Amsterdam and Oslo are based on vehicle kilometres, other cities are based on vehicle traffic counts. For Southampton LGV also includes medium-sized HGVs.
'N/A' – not available.
Using most currently available data for each city.
Source: Operating statistics (shaded) provided by CITYLAB project partners. Performance indicators calculated using data in Tables 3.1 and 3.2.

3.3 Business-as-usual trends in urban freight operations

Survey respondents were asked to forecast the extent to which they expected total vehicle kilometres travelled by heavy goods vehicle (HGV – over 3.5 tonnes gross weight) and light goods vehicle (LGV – up to and including 3.5 tonnes) in urban areas in Europe to change by 2030 assuming no new interventions by companies and policy makers to ameliorate this.

This therefore involved respondents in assessing the likely demand for freight transport services to change by 2030 assuming no alteration in how freight transport was regulated or controlled by public sector interventions. Factors that respondents would therefore have potentially taken account of in making these forecasts of urban freight demand and activity levels in this business-as-usual scenario include economic and population change, fuel price change, changes in the availability of logistics facilities in urban areas, and substitution between the use of HGVs and LGVs. **Table 3.3** shows that, on average, respondents expected vehicle kilometres to rise for both HGV and LGV urban freight activity compared with now. However, LGVs were expected to rise considerably more strongly. However, there was major variance in the expectations of the respondents concerning the extent of change

Table 3.3: Change in HGV and LGV vehicle kilometres in European urban areas by 2030 expected by respondents (compared with now) (median and average)

Vehicle type	Change in vehicle kilometres	
	Median	Average
HGV	+10%	+11%
LGV	+21%	+24%

These results can be compared with urban and national HGV and LGV road traffic estimates from the UK. Road traffic forecasts for London estimate that HGV traffic will remain unchanged between 2011 and 2031, while LGV traffic will increase by 22% (Allen and Browne, 2013).

In the UK as a whole, the Department for Transport's current national road traffic forecasts estimate that HGV traffic will increase nationally by 12% between 2015 and 2030, while LGV traffic will increase by 41% (Department for Transport, 2015).

These survey findings concerning change in HGV and LGV traffic activity in European urban areas by 2030 can be seen to be within a similar range to existing road traffic estimates in London and the UK.

It is important to note that estimating change in LGV use is more difficult than for HGV use. This is due to the fact that HGVs are generally only used for the transportation of goods. By contrast, LGVs perform a far greater range of activities, including the movement of goods, and the provision of a wide and varied range of servicing activities (Commission for Integrated Transport, 2010).

4 Analysis of the CO_2 emissions reduction potential of urban freight transport initiatives

4.1 Individual impact of urban freight transport initiatives

Respondents were asked to provide estimates of the extent to which they expected a range of urban freight transport initiatives to affect the total vehicle kilometres travelled and hence total CO_2 emissions from LGV and HGV freight operations in European urban areas by 2030 compared with now. These initiatives were grouped into three categories. Those that have the potential:

- to reduce HGV/LGV vehicle kilometres travelled for goods collection/delivery (and hence reduce fuel use and thereby CO_2 emissions)
- to reduce LGV vehicle kilometres travelled for servicing activities (and hence reduce fuel use and thereby CO_2 emissions)
- to lead to the retiming of HGV/LGV trips and to reduce vehicle queuing at delivery/collection points, thereby improving vehicle flow speeds and reducing stop-start operations (and hence reduce fuel use and thereby CO_2 emissions)

In order to arrive at their estimates of reduction in total HGV and LGV vehicle kilometres travelled for goods transport (and to help prevent respondents from mistaken over-estimations), respondents were asked to assess the following factors for each of the urban freight transport initiatives:

- The maximum potential HGV/LGV urban freight activity that the initiative could apply to (expressed as a proportion of total urban HGV/LGV vehicle kilometres)
- The proportion of potential HGV/LGV urban freight activity (in terms of vehicle kilometres) that the respondent felt has already implemented this initiative
- The proportion of potential HGV/LGV urban freight activity (in terms of vehicle kilometres) that the respondents felt will have implemented this initiative by 2030
- The percentage reduction in HGV/LGV vehicle kilometres for those operators that implement the initiative

The same approach was used to investigate respondents' views of the likely impacts of initiatives aimed at reducing the vehicle kilometres associated with service activities (i.e. not goods transport) carried out by LGVs.

Based on their answers to these questions, the spreadsheet then provided the respondents with their estimate of the impact of the initiative on reducing total HGV/LGV urban freight vehicle kilometres by 2030 (in terms of its reduction potential). It was assumed that the potential impact of the initiative on reducing total HGV/LGV vehicle CO_2 emissions by 2030 was proportional to these estimated vehicle kilometre reductions (however, it is important to note that in reality this will also be influenced by other factors including the size and weight of vehicle, the load carried, and the operating environment).

In the case of urban freight initiatives aimed at retiming goods vehicle trips and reducing vehicle queuing at delivery/collection points, these would not be expected to reduce vehicle kilometres but have the potential to reduce vehicle fuel use (due to fewer stop-start operations and improved vehicle flow speeds, as well as to reduce total vehicle peak-time traffic). For these retiming initiatives respondents were therefore asked to estimate the following:

- The maximum potential HGV/LGV urban freight activity that the initiative could apply to (expressed as a proportion of total urban HGV/LGV vehicle kilometres)
- The proportion of potential HGV/LGV urban freight activity (in terms of vehicle kilometres) that the respondent felt has already implemented this initiative
- The proportion of potential HGV/LGV urban freight activity (in terms of vehicle kilometres) that the respondents felt will have implemented this initiative by 2030
- The percentage reduction in HGV/LGV fuel use for those operators that implement the initiative

Based on their answers to these questions, the spreadsheet then provided the respondents with their estimate of the impact of the initiative on reducing total HGV/LGV urban fuel use by 2030 (in terms of its reduction potential). Again, it was assumed that the potential impact of the initiative on reducing total HGV/LGV vehicle CO_2 emissions by 2030 was proportional to these estimated vehicle kilometre reductions.

The survey results for the potential impacts of each of these urban freight transport initiatives are shown in **Tables 4.1** to **4.6.** These provide the average expectations for all survey respondents. **Table 4.1** shows the results for HGVs of those initiatives that are expected to reduce vehicle kilometres, and hence CO_2 emissions, based on consolidation, reverse logistics, procurement, and logistics land use planning, charging regimes (road user charging and on-street loading bay charging), the use of alternative road vehicles, higher capacity vehicles non-road modes, home delivery operations, partnership working, the use of autonomous vehicles and drones. **Table 4.2** shows the results for HGVs of those initiatives based on vehicle delivery/collection retiming and vehicle queuing reduction that are expected to reduce CO_2 emissions due to improved vehicle speeds and reduced stop-start operations. **Tables 4.3** and **4.4** show these same survey results for LGVs. **Table 4.5** shows the results for those initiatives specifically based on using LGVs for service activities which are expected to reduce vehicle kilometres and hence CO_2 emissions. The urban freight initiatives in each of these tables have been listed in descending order of survey respondents' expectations of their impact on CO_2 emissions.

If the CO_2 emissions reductions estimated for HGVs and LGVS by 2030 for each of these individual urban freight transport initiatives are summed together, this indicates total reductions of 20.5% for HGVs and 23.8% for LGVs. However, in reality if all these individual urban freight transport initiatives were implemented the combined effects would be expected to be lower as some of these initiatives would have similar effects on vehicle operations. The next section (**section 4.2**) provides the expectations of survey respondents about total CO_2 emissions reductions by 2030 if such a combined package of urban freight initiatives were introduced.

Table 4.1: Survey results for freight initiatives expected to reduce HGV vehicle kilometres and CO_2 emissions in European urban areas by 2030 (averages) (listed in descending order of their expected impact)

Initiative	Maximum potential HGV urban freight activity this initiative could apply to (expressed as % of total urban HGV vehicle kilometres)	% of potential HGV urban freight activity that respondents think has already implemented this initiative (in terms of HGV vehicle kms)	% of potential HGV urban freight activity that respondents think will have implemented this initiative by 2030 (in terms of HGV vehicle kms)	% reduction in HGV vehicle kilometres that respondents think operators that implement this initiative will achieve	Expected % impact of this initiative on reducing total HGV urban freight vehicle kilometres and CO_2 emissions by 2030
Urban consolidation centres / mobile depots for retail goods and parcels	29%	7%	27%	26%	2.4%
Collaborative logistics operations between freight companies to improve vehicle loads	19%	7%	20%	23%	1.7%
Use of rail freight	22%	12%	24%	31%	1.6%
Reverse logistics to improve empty running	23%	11%	24%	24%	1.4%
Road user charging for freight vehicles	40%	15%	32%	12%	1.1%
Vehicle routeing and scheduling tools	32%	27%	38%	13%	1.1%
Partnership working in the supply chain operations	16%	6%	22%	23%	1.1%
Use of higher capacity vehicles	15%	6%	21%	18%	0.9%
Logistics land use planning (to make logistics depot land available in urban areas and reduce stem distances to delivery/collection areas)	16%	8%	21%	18%	0.9%
Urban consolidation centres for construction materials	15%	5%	18%	21%	0.8%
Increase price charged for home deliveries of online shopping according to delivery lead time requested	14%	8%	18%	15%	0.7%
Sustainable construction logistics - reducing the number of material suppliers used	13%	5%	16%	16%	0.6%
Sustainable procurement practices - using the same goods suppliers as other neighbouring businesses	15%	4%	15%	14%	0.6%
Charging / booking system for on-street loading bays	19%	5%	22%	10%	0.6%
Use of waterborne freight	14%	8%	21%	26%	0.6%
Sustainable procurement practices - ordering goods less frequently (and holding more stock on site)	18%	6%	15%	20%	0.5%

Table 4.1 (continued): Survey results for freight initiatives expected to reduce HGV vehicle kilometres and CO_2 emissions in European urban areas by 2030 (averages) (listed in descending order of their expected impact)

Initiative	Maximum potential HGV urban freight activity this initiative could apply to (expressed as % of total urban HGV vehicle kilometres)	% of potential HGV urban freight activity that respondents think has already implemented this initiative (in terms of HGV vehicle kms)	% of potential HGV urban freight activity that respondents think will have implemented this initiative by 2030 (in terms of HGV vehicle kms)	% reduction in HGV vehicle kilometres that respondents think operators that implement this initiative will achieve	Expected % impact of this initiative on reducing total HGV urban freight vehicle kilometres and CO_2 emissions by 2030
Sustainable procurement practices - reducing the number of goods suppliers used	18%	8%	16%	19%	0.5%
Use of locker banks (for online shopping)	12%	9%	17%	11%	0.5%
Increase price charged for home deliveries of online shopping according to delivery lead time requested	16%	6%	15%	9%	0.3%
Use of drones for urban freight deliveries and collections	8%	1%	4%	12%	0.2%
Use of click and collect services and other collection points in retail stores (for online shopping)	11%	9%	15%	10%	0.2%
Use of electrically-propelled cargocycles operating from central micro-hubs	8%	4%	13%	16%	0.2%
Increase delivery lead time for home delivery of online shopping (fewer same-day and next-day deliveries)	10%	4%	10%	9%	0.1%
Use of autonomous (driverless) vehicles for urban freight collections and deliveries	8%	1%	9%	7%	0.0%

Table 4.2: Survey results for freight initiatives expected to improve HGV fuel use and CO_2 emissions in European urban areas by 2030 (averages) (listed in descending order of their expected impact)

Initiative	**Maximum potential HGV urban freight activity this initiative could apply to (expressed as % of total urban HGV vehicle kilometres)**	**% of potential HGV urban freight activity that respondents think has already implemented this initiative (in terms of HGV vehicle kms)**	**% of potential HGV urban freight activity that respondents think will have implemented this initiative by 2030 (in terms of HGV vehicle kms)**	**% reduction in HGV fuel use that respondents think operators that implement this initiative will achieve**	**Expected % impact of this initiative on reducing total HGV urban fuel use and CO_2 emissions by 2030**
Better information provision about roadworks and road traffic problems (to reduce vehicle queueing)	34%	25%	46%	10%	0.8%
Retiming of logistics operations (companies accepting deliveries and collections outside the daytime peak)	27%	13%	28%	13%	0.6%
Retiming of logistics operations (companies relaxing existing delivery time windows)	28%	13%	28%	12%	0.6%
Common logistics operations for a major multi-tenanted building or area (staff in loading bay take responsibility for receiving goods and distributing within building (to reduce vehicle dwell time, and queueing)	18%	8%	22%	8%	0.3%
New service in which goods vehicles deliver goods to public staff at the kerbside who make final delivery (so that driver can depart immediately after unloading to reduce queueing and circulating for kerbside space)	18%	7%	16%	8%	0.2%
Companies making off-street parking space available for delivery and collection vehicles (to reduce vehicle queueing and circulating)	21%	23%	36%	9%	0.1%

Table 4.3: Survey results for freight initiatives expected to reduce LGV vehicle kilometres and CO_2 emissions in European urban areas by 2030 (averages) (listed in descending order of their expected impact)

Initiative	Maximum potential LGV urban freight activity this initiative could apply to (expressed as % of total urban LGV vehicle kilometres)	% of potential LGV urban freight activity that respondents think has already implemented this initiative (in terms of LGV vehicle kms)	% of potential LGV urban freight activity that respondents think will have implemented this initiative by 2030 (in terms of LGV vehicle kms)	% reduction in LGV vehicle kilometres that respondents think operators that implement this initiative will achieve	Expected % impact of this initiative on reducing total LGV urban freight vehicle kilometres and CO_2 emissions by 2030
Urban consolidation centres / mobile depots for retail goods and parcels	31%	7%	29%	32%	2.8%
Logistics land use planning (to make logistics depot land available in urban areas and reduce stem distances to delivery/collection areas)	21%	7%	24%	26%	1.9%
Collaborative logistics operations between freight companies to improve vehicle loads	23%	7%	21%	23%	1.8%
Use of electrically-propelled cargocycles operating from central micro-hubs	23%	7%	24%	31%	1.7%
Road user charging for freight vehicles	45%	17%	35%	12%	1.2%
Reverse logistics to improve empty running	22%	11%	25%	25%	1.2%
Partnership working in the supply chain operations	19%	7%	20%	22%	1.0%
Vehicle routeing and scheduling tools	37%	23%	38%	13%	0.9%
Sustainable procurement practices - reducing the number of goods suppliers used	19%	7%	18%	21%	0.8%
Charging / booking system for on-street loading bays	28%	8%	25%	12%	0.8%
Use of higher capacity vehicles	21%	8%	18%	15%	0.8%
Use of rail freight	13%	10%	16%	23%	0.7%
Sustainable procurement practices - ordering goods less frequently (and holding more stock on site)	17%	6%	15%	22%	0.7%
Sustainable procurement practices - using the same goods suppliers as other neighbouring businesses	14%	4%	16%	16%	0.7%
Sustainable construction logistics - reducing the number of material suppliers used	14%	6%	16%	17%	0.6%

Table 4.3 (continued): Survey results for freight initiatives expected to reduce LGV vehicle kilometres and CO_2 emissions in European urban areas by 2030 (averages) (listed in descending order of their expected impact)

Initiative	Maximum potential LGV urban freight activity this initiative could apply to (expressed as % of total urban LGV vehicle kilometres)	% of potential LGV urban freight activity that respondents think has already implemented this initiative (in terms of LGV vehicle kms)	% of potential LGV urban freight activity that respondents think will have implemented this initiative by 2030 (in terms of LGV vehicle kms)	% reduction in LGV vehicle kilometres that respondents think operators that implement this initiative will achieve	Expected % impact of this initiative on reducing total LGV urban freight vehicle kilometres and CO_2 emissions by 2030
Use of click and collect services and other collection points in retail stores (for online shopping)	17%	8%	22%	15%	0.5%
Use of locker banks (for online shopping)	20%	11%	22%	14%	0.5%
Urban consolidation centres for construction materials	14%	5%	17%	23%	0.5%
Increase price charged for home deliveries of online shopping according to delivery lead time requested	21%	11%	24%	15%	0.4%
Increase price charged for home deliveries of online shopping according to delivery lead time requested	18%	6%	19%	11%	0.4%
Use of waterborne freight	12%	9%	14%	20%	0.3%
Increase delivery lead time for home delivery of online shopping (fewer same-day and next-day deliveries)	14%	5%	16%	12%	0.3%
Use of drones for urban freight deliveries and collections	10%	2%	5%	13%	0.3%
Use of autonomous (driverless) vehicles for urban freight collections and deliveries	20%	2%	11%	6%	0.0%

Table 4.4: Survey results for freight initiatives expected to improve LGV fuel use and CO_2 emissions in European urban areas by 2030 (averages) (listed in descending order of their expected impact)

Initiative	Maximum potential LGV urban freight activity this initiative could apply to (expressed as % of total urban LGV vehicle kilometres)	% of potential LGV urban freight activity that respondents think has already implemented this initiative (in terms of LGV vehicle kms)	% of potential LGV urban freight activity that respondents think will have implemented this initiative by 2030 (in terms of LGV vehicle kms)	% reduction in LGV fuel use that respondents think operators that implement this initiative will achieve	Expected % impact of this initiative on reducing total LGV urban fuel use and CO_2 emissions by 2030
Better information provision about roadworks and road traffic problems (to reduce vehicle queueing)	34%	23%	43%	10%	0.9%
Retiming of logistics operations (companies accepting deliveries and collections outside the daytime peak)	27%	14%	27%	12%	0.5%
Retiming of logistics operations (companies relaxing existing delivery time windows)	25%	12%	26%	11%	0.4%
Common logistics operations for a major multi-tenanted building or area (staff in loading bay take responsibility for receiving goods and distributing within building (to reduce vehicle dwell time, and queueing)	16%	8%	22%	9%	0.4%
New service in which goods vehicles deliver goods to public staff at the kerbside who make final delivery (so that driver can depart immediately after unloading to reduce queueing and circulating for kerbside space)	19%	7%	17%	8%	0.2%
Companies making off-street parking space available for delivery and collection vehicles (to reduce vehicle queueing and circulating)	21%	22%	35%	8%	0.2%

Table 4.5: Survey results for servicing initiatives expected to reduce LGV vehicle kilometres and CO_2 emissions in European urban areas by 2030 (averages) (listed in descending order of their expected impact)

Initiative	Maximum potential LGV urban freight activity this initiative could apply to (expressed as % of total urban LGV vehicle kilometres)	% of potential LGV urban freight activity that respondents think has already implemented this initiative (in terms of LGV vehicle kms)	% of potential LGV urban freight activity that respondents think will have implemented this initiative by 2030 (in terms of LGV vehicle kms)	% reduction in LGV vehicle kilometres that respondents think operators that implement this initiative will achieve	Expected % impact of this initiative on reducing total LGV urban freight vehicle kilometres and CO_2 emissions by 2030
Sustainable procurement practices - using the same service providers as other neighbouring businesses	22%	8%	20%	21%	0.9%
Use of collection points (for spare parts and tools for service engineers)	17%	6%	18%	17%	0.6%
Use of locker banks (for spare parts and tools for service engineers)	14%	5%	15%	17%	0.5%

4.2 Combined impact of the urban freight transport initiatives

As well as being asked to estimate the CO_2 emissions reduction potential of various urban freight transport initiatives by 2030, survey respondents were also asked to estimate the combined potential of these initiatives. As explained in **section 4.1**, the combined potential would be expected to be less than the sum of the potential of the individual initiatives as some would have similar effects on HGV and LGV operations.

Survey respondents were asked two further questions to obtain their views on the extent to which packages of urban freight transport initiatives that they expected to have been implemented by 2030 would have in reducing CO_2 emissions for HGVs and LGVs in European urban areas. As in **section 4.1**, respondents were asked about their expectations for these packages of measures:

- to reduce HGV/LGV vehicle kilometres travelled for goods collection/delivery and servicing activities (and hence reduce fuel use and thereby CO_2 emissions)
- to lead to the retiming of HGV/LGV trips and to reduce vehicle queuing at delivery/collection points, thereby improving vehicle flow speeds and reducing stop-start operations (and hence reduce fuel use and thereby CO_2 emissions)

In the first of these questions, respondents were asked to simply provide their estimate of the combined percentage impact of all of the urban freight initiatives listed on total CO_2 emissions from HGVs and LGVs engaged in urban freight activity by 2030 (compared with the current situation). **Table 4.6** shows the average and median results provided by survey respondents to this question. The responses suggest that all urban freight initiatives together could lead to CO_2 emission reductions of approximately 7-11% for HGVs and 7% for LGVs by 2030 in European urban areas.

Table 4.6: Respondents' estimates of the combined impacts of urban freight initiatives to reduce CO_2 emissions from HGV and LGV in European urban areas by 2030 (median and average)

Category of package of urban freight initiatives	**HGVs**		**LGVs**	
	Median	**Average**	**Median**	**Average**
Aimed at reducing vehicle kilometres travelled	-5%	-8%	-5%	-3%
Aimed at retiming operations and reducing queuing	-2%	-3%	-2%	-4%
Total impact of all combined measures	**-7%**	**-11%**	**-7%**	**-7%**

Notes:
'+' signifies an increase
'-' signifies a decrease

4.3 Findings of relevant UK studies

This section summarises research from relevant UK studies that have examined the extent to which freight transport initiatives could help to reduce the vehicle kilometres and CO_2 emissions associated with goods vehicles. The results of these other studies presented in this section can therefore be compared with the results presented in **sections 4.1** and **4.2**.

CO_2 emissions from freight operations can be achieved through a range of operational initiatives including supply chain rationalisation (through procurement practices) and improved vehicle utilisation (through better vehicle fill rates and reduced empty running). Evidence produced for the UK Committee on Climate Change in 2010 suggested that freight transport initiatives could bring about a 6.5% reduction in vehicle kilometres and associated reduction in CO_2 emissions by 2030 relative to baseline projections (Committee on Climate Change, 2010). A more recent analysis of the potential benefits of such operational freight transport initiatives has suggested that they could reduce CO_2 emissions by 9% for small rigid HGVs and 11% for articulated HGVs by 2030. The research also indicated that if other barriers could be overcome, including safety concerns about longer, heavier vehicles, these savings could be increased to 11% for small rigid HGVs and 25% for articulated HGVs. A central assumption of 10% for HGV vehicle kilometre reductions by 2030 relative to the baseline scenario was used in modelling work (Committee on Climate Change, 2015).

Modelling work carried out for the Committee for Climate Change to assist its estimates made use of several assumptions concerning the potential impact of a range of freight transport and logistics measures on fuel use (Greening et al., 2015). It is important to note that this research was based on national HGV operations rather than specifically considering urban freight transport operations. This work assumed an 8.2% reduction in fuel used as a consequence of efforts to implement backhaul operations and thereby reduce HGV empty running (Greening et al., 2015 – this assumption was based on research by Palmer and McKinnon, 2011 and assumes that time constraints are relaxed, permitting a greater coordination of delivery and pickup windows). Earlier research into the issue of empty running had concluded that approximately 2% of empty HGV journeys could be backhauled resulting in a 2% reduction in kms driven (McKinnon and Ge, 2006).

In terms of efforts to improve HGV load consolidation both through the individual efforts of operators together with collaboration between companies to share, modelling has suggested that fuel consumption could be reduce by between 0.8%-5% depending on how radical the solutions implemented may be (Palmer and McKinnon, 2011).

In terms of the use of Urban Consolidation Centres (UCCs), the Starfish project modelled the impact of UCCs across the supply chain and its scenarios assumed a 3.7% reduction in fuel used by HGVs as a result (Palmer and McKinnon, 2011).

Previous research has indicated that fuel use could be reduced by up to 13% by using longer and heavier HGVs (Knight, Newton et al. 2008). However such an initiative has little application to urban freight transport, and would instead deliver benefits on long-haul transport, using the inter-urban road network.

It has been estimated that relaxing time constraints (and thereby increasing the number of collections and/or deliveries that can be made during the course of an HGV journey could reduce the vehicle kilometres driven by 3% (Greening et al., 2015).

The retiming of HGV delivery and collection work to outside of peak periods helps to avoid congestion, reduces travel time and improves fuel efficiency due to improved speeds. It has been assumed in another study that that benefit of rescheduling HGV activity outside peak times could lead to a 4.25% reduction in kilometres travelled (due to improved vehicle fill and the reduced number of journeys as a consequence of more efficient journey plans) (Greening et al., 2015). The carbon reduction benefits as a result of retiming which allows operations to take place outside of congested periods are difficult to estimate as the fuel efficiency of a vehicle is dependent on the stop-start nature of vehicle use. However carbon savings could be expected to be at least equivalent to kilometre savings.

5 Analysis of the CO_2 emissions reduction potential of other logistics measures

The survey respondents were also asked to provide their expectations about the impacts of other logistics measures on CO_2 emissions by 2030. These measures were not specifically urban, and would potentially apply to all HGV and LGV operations. They contain a mixture of technological and behavioural measures. These other logistics measures that were studied were:

- Uptake of HGVs and LGVs in urban areas that are CO_2-free (e.g. electric) at the point of use
- The extent of the use of biofuels in diesel for conventionally-fuelled HGVs and LGVs
- Improvements in new, conventionally-powered HGVs and LGVs to improve their fuel efficiency (and hence CO_2 emission reductions)
- The extent to which fuel saving equipment can be retrofitted to existing HGVs and LGVs to improve their fuel efficiency (and hence achieve CO_2 emission reductions) for conventionally-powered HGVs and LGVs
- The extent of HGV and LGV driver training and performance monitoring to achieve fuel savings (and hence CO_2 emission reductions)

As with the analysis of urban freight transport initiatives (see **section 4**), respondents were asked to provide answers to one or more questions in connection with each logistics measure in order to gain insight into their expectations and to help them reflect on their predictions. These questions that respondents were given are shown in the following sections for each of the logistics measures analysed, together with the survey results.

5.1 Uptake of HGVs and LGVs in urban areas that are CO_2-free (e.g. electric) at the point of use

Respondents were asked to estimate the proportion of HGV and LGV kilometres run in urban areas that they expected will be performed using CO_2-free fuel sources by 2030.

The survey findings shows that respondents expected, on average, that approximately 20% of HGV vehicle kilometres travelled in European urban areas will be performed using vehicles that are CO_2-free at the point of use by 2030. By contrast, they expected that approximately 40% of LGV vehicle kilometres travelled in European urban areas will be performed using vehicles that are CO_2-free at the point of use by 2030. This would lead to a proportional reduction in CO_2 emissions from HGVs and LGVs.

5.2 The extent of the use of biofuels in diesel for conventionally-fuelled HGVs and LGVs

Respondents were asked to estimate the proportion of diesel fuel for HGVs and LGVs they expected to be derived from biofuels by 2030. For reference purposes, respondents were told that it was assumed that 3% of fossil road fuels are currently supplied by biofuels, 60% of which meets the sustainability criteria (based on UK data – UK Department for Transport, 2016). Biofuels are counted as zero carbon at the point of combustion as the carbon released equates to that taken up from the atmosphere during crop growth (however, carbon emissions do occur in the supply chain of biofuel production as a result of fertiliser use on crops, crop and fuel transport, and fuel processing) (Committee for Climate Change, **2010)**.

The survey findings shows that, on average, respondents expected that approximately 20% of fossil road fuels used in Europe would be derived from biofuels by 2030 (compared with current levels of less than 5%). This would result, on average, in CO_2 emission reductions of 9% and 5% for HGVs and LGVs respectively by 2030 (taking into account respondents' expectations about the penetration of CO_2-free HGVs and LGVs by this date – see above).

5.3 Improvements in new, conventionally-powered HGVs and LGVs to enhance fuel efficiency

Respondents asked to estimate the percentage improvement in the fuel and hence (CO_2 efficiency) of new, conventionally-powered HGVs and LGVs by 2030. Respondents were told that it was assumed that this improvement in the CO_2 efficiency of new HGVs and LGVs would be reflected in all new urban freight vehicles. The survey findings shows that, on average, respondents expected the fuel efficiency of new, conventionally-powered HGVs and LGVs to improve by 24% and 28% respectively by 2030.

Respondents' expectations about the uptake of CO_2-free HGVs and LGVs in European urban areas by 2030 (see above), were taken into account in calculating the proportion of the urban HGV and LGV fleet that would benefit from this measure. The respondents therefore expect that improved fuel efficiency of goods vehicles will result, on average, in CO_2 emission reductions of 19% and 16% for HGVs and LGVs respectively by 2030.

5.4 The extent to which fuel saving designs would be retrofitted to existing conventionally-powered HGVs and LGVs to improve their fuel efficiency

Respondents were asked to estimate the proportion of conventionally-powered HGVs and LGVs that they expect will be retrofitted with fuel saving (and hence CO_2 emission reduction) equipment by 2030, and the percentage improvement in fuel efficiency for HGVs and LGVs that they expect implementing these designs and equipment will achieve. It was explained to respondents that such fuel-saving equipment included: using trailers with sloping front roof (double deck/high cube vehicles); using tear-drop trailers; installing cab roof fairing; fitting low rolling resistance tyres and automatic tyre pressure monitors; installing body / trailer side panels; installing side skirts; installing boat tails; adopting automated manual vehicle transmission; fitting speed limiters; and using low viscosity lubricants, and fuel additives.

The survey findings shows that, on average, respondents expected the inclusion of fuel saving fuel designs and equipment on conventionally-powered HGVs and LGVs will result in CO_2 savings of 3% for both in European urban areas by 2030, taking into account the size of the fleet that these can be fitted to by this time (as some of these designs and equipment are likely to be fitted as factory standard by that time.

5.5 The extent of HGV and LGV driver training and performance monitoring to achieve fuel savings (and hence CO_2 emission reductions)

Respondents were asked to estimate the proportion of HGV and LGV drivers they expect will have received driver training & monitoring to reduce fuel consumption by 2030, and the percentage improvement in fuel efficiency for HGVs and LGVs that implementing training and monitoring will achieve.

The survey findings shows that, on average, respondents expected 37% of HGV drivers and 28% of LGV drivers to have received driver training and be subject to performance monitoring in relation to fuel savings by 2030. Respondents estimated that HGV and LGV drivers receiving this training and monitoring would achieve 16% and 14% savings in fuel consumption respectively. Overall, it was expected that by 2030 driver training and monitoring would lead, on average, to fuel savings and CO_2 emissions reductions of 5% and 3% for HGVs and LGVs respectively (taking into account respondents' expectations about the penetration of CO_2-free HGVs and LGVs by this date – see above).

5.6 Summary of survey responses about other logistics measures

Table 5.1 summarises the respondents' answers concerning the extent to which they expect each of these logistics measures to reduce CO_2 emissions from HGV and LGV operations in European countries (and thereby in urban areas also) by 2030. Overall, on average, the respondents expect these logistics measures to reduce CO2 emissions from HGVs and LGVs in European urban areas by 57% and 68% respectively. Median values provide a lower estimated CO2 emission reduction potential for HGVs of 45%, but the same value of 68% for LGVs.

Table 5.1: Respondents' expectations about the extent to which other logistics measures will change CO_2 emissions from HGVs and LGVs in European urban areas by 2030 (median and averages)

Logistics measures	HGVs		LGVs	
	Median	**Average**	**Median**	**Average**
Use of CO_2-free vehicles	-18%	-21%	-45%	-41%
Greater use of biofuels in diesel	-6%	-9%	-4%	-5%
Improvements in fuel efficiency of new conventional vehicles	-16%	-19%	-16%	-16%
Retrofitting vehicles with fuel saving equipment	-1%	-3%	-2%	-3%
Driver training and performance monitoring	-4%	-5%	-1%	-3%
TOTAL	**-45%**	**-57%**	**-68%**	**-68%**

Notes:
'-' signifies a decrease

5.7 Findings of relevant UK studies

This section summarises research from relevant UK studies that have examined the extent to which vehicle and fuel technology and driver training could help to reduce the CO_2 emissions associated with goods vehicles operations. The results of these other studies presented in this section can therefore be compared with the results presented in **sections 5.1-5.6**.

Zero-emission vehicles: Work commissioned by the UK Committee on Climate Change has identified that battery electric and plug-in hybrid electric vehicles (BEVs and PHEVs) are promising options for cutting surface transport emissions in the 2020s and beyond. This work identified that potential battery cost reductions and increased range mean that electric vehicles can be a cost-effective option in the longer term, and identified that by 2030, from an economic perspective, electric vehicles would be a cost-effective abatement option against projected carbon prices. The analysis suggested that achieving a high uptake of electric vehicles by 2030 is possible given a good supply of vehicle models, and a package of measures to address current financial and non-financial barriers (such as including battery leasing to reduce purchase price premiums, a rapid charging network to complement vehicle charging at depots and homes, and marketing to improve consumer awareness and acceptance, together with other financial and/or non-financial support. Updated research by the Committee has indicated that electric LGVs are likely to become cost-effective during the 2020s and will be cost saving compared to conventionally-fuelled vehicles by 2030 (Committee on Climate Change, 2010). It has been suggested that the average electric range of battery electric vehicles could reach 300km for LGVs by 2030 (Committee on Climate Change, 2015).

Although HGVs are more difficult to electrify, due to their need for large, heavy batteries, plug-in electric smaller HGVs for operations in urban areas are technically feasible and analysis suggests they could become cost-effective during the 2020s. It has been estimated that small plug-in hybrid electric vehicle (PHEV) HGVs could have an electric range of 100 km by 2030, and that small battery electric vehicle (BEV) HGVs could have an electric range of 240 km by 2030 (Committee on Climate Change, 2015). In its modelling work the Committee on Climate Change has assumed that electric vehicles will comprise approximately 60% of new LGV sales and 40% of new small rigid HGVs sales by 2030. This would obviously need the implementation of a substantial electric vehicle recharging infrastructure and upgrades to the electricity supply in order to meet such demand (Committee on Climate Change, 2015). Other research is broadly in agreement with this estimate – a 2013 study which included a review of other project findings reported that European electric vehicle uptake (including cars) could be between 37% and 80% by 2030 (Cambridge Econometrics, 2013).

The Committee’s work also indicated that hydrogen fuel cell vehicles could also make a contribution to the ultra-low LGV fleet in urban areas by 2030, and that natural gas powered HGVs may also provide an opportunity by 2030 (Committee on Climate Change, 2010). Natural gas fuelled HGVs could potentially result in tailpipe CO_2 emissions reductions of approximately 10% compared to diesel fuelled HGVs (Committee on Climate Change, 2015).

Biofuels: Evidence suggests that biofuel and fossil fuel costs may well converge by about 2030. The extent of the potential of biofuels to reduce CO_2 emissions remains uncertain. However, the EU Renewable Energy Directive is important in stimulating the use of biofuels. This stipulates that 10% of transport energy must come from renewable sources by 2020 (Committee on Climate Change, 2015). The UK Committee on Climate Change has assumed that biofuels could meet 8% by energy of transport liquid fuel demand in 2020 and 11% of liquid fuel by 2030. (Committee on Climate Change, 2010; Committee on Climate Change, 2015). The situation is currently uncertain, but it is possible that biofuels may not be cost-effective compared to carbon values by 2030 (Committee on Climate Change, 2015).

Fuel efficiency of new, conventionally-powered vehicles: There are major opportunities to improve the fuel efficiency of conventional HGVs (through techniques including downsizing of engines with turbocharging, weight reduction through greater use of advanced lightweight materials; heat recovery; and increased hybridisation). These efforts will be supported by EU legislation - concerning targets for the average CO2 emissions of new LGVs will help to reduce the emissions from LGVs over time. For instance, new LGV CO_2 emissions fell by 4.9% to 188 gCO_2/km in 2012 (Committee on Climate Change, 2010). EU targets exist to reduce test-cycle emissions from new LGVs to 147 gCO_2/km by 2021 (Committee on Climate Change, 2015). Research carried out for the European Climate

Foundation predicts reductions in the costs of light duty vehicles, may lead to substantial reductions in CO_2 emissions in the long term (Cambridge Econometrics et al., 2013). It has been estimated that the average test-cycle CO_2 intensity for new vans could be 127 gCO_2/km by 2030 (if tested using the World Harmonised Light-duty vehicle testing Procedure (WLTP). Real-world CO2 emissions for conventional vehicles could be 26% higher than test-cycle emissions by 2030. This would result in an average real-world CO_2 intensity of 160g $CO_2$2/km for new vans by 2030 (Committee on Climate Change, 2015). Evidence suggests that HGV fuel efficiency could be improved to a real-world CO_2 intensity of 580-660 gCO_2/km by 2030 (AEA Technology, 2012).

It has been estimated that conventional LGV efficiency could potentially improve by 37% on a test-cycle basis and 33% on a real-world basis between 2010 and 2030. HGV fuel efficiency could improve by 13% for small rigid HGVs and by 33% for larger articulated HGVs between 2010 and 2030 (Committee on Climate Change, 2015). Central estimates of conventional vehicle efficiency improvements of 33% for LGVs and 24% for HGVs between 2010 and 2030 were adopted by the Committee on Climate Change in their modelling work for the Fifth Carbon Budget (Committee on Climate Change, 2015). However there are limits to the reductions in CO_2 emissions for conventional LGVs and HGVs, and alternative technologies would be required to achieve further reductions in CO_2 emissions once these limits have been reached (Committee on Climate Change, 2010).

The Committee on Climate Change has assumed that the combination of electric vehicles together with conventional vehicle efficiency improvements, will lead to a fleet-average, test-cycle CO_2 intensity of approximately 60 gCO_2/km for new LGVs in 2030 (Committee on Climate Change, 2015).

Retrofitting of fuel efficient equipment to existing, conventionally-fuelled vehicles: Existing conventionally-fuelled HGVs and LGVs can be retrofitted with a range of equipment to improve their fuel efficiency. This includes measures such as trailers with sloping front roof (double deck/high cube vehicles); using tear-drop trailers; switching from powered to fixed-deck trailers; fitting low rolling resistance tyres and automatic tyre pressure monitors; installing cab roof fairing; installing body / trailer side panels; installing side skirts; installing boat tails; fitting speed limiters; and using low viscosity lubricants, and fuel additives. Research into aftermarket improvements to vehicles.

Driver training and performance: Driver training and related driver initiatives including the avoidance of harsh braking and accelerating, and checking that vehicle tyres are correctly inflated can play an important role on fuel consumption. The Committee on Climate Change assumed that 20% of LGV drivers and 100% of HGV drivers would undergo driver training in such techniques by 2030, and assumed that this would lead to fuel savings of 3% for LGVs and 4% for HGVs compared to untrained drivers Committee on Climate Change, 2010). A more recent estimate of the benefits of these measures suggested that fuel efficiency could be improved by 13% for small rigid HGVs, and 22% for large articulated HGVs by 2030, with approximately 65% of these savings come from improved driver training and the remainder from retrofitting vehicles with fuel saving equipment. Given uncertainty over the extent to which smaller freight transport operators would implement these measures it was assumed that these measures would be implemented on somewhere between 50-100% of HGVs (Committee on Climate Change, 2015).

6 Summary of findings about the expected impacts of all freight transport and logistics measures

6.1 Summary of survey responses

This section brings together the survey respondents' expectations about:

a) the change in urban freight vehicle activity and CO_2 emissions in European urban areas due to economic, population and other structural changes, all other things being equal (see **section 3**)

b) the ability of urban freight transport initiatives to reduce CO_2 emissions by HGVs and LGVs in European urban areas by 2030 (see **section 4**)

c) the ability of other broader, mostly technology-based, logistics measures to reduce CO_2 emissions by HGVs and LGVs in European urban areas by 2030 (see **section 5**).

Table 6.1 provides a summary of the respondents' expectations about the likely contribution of these various initiatives and measures by 2030 (by subtracting their expectations concerning the business-as-usual situation in 2030, with their expectation concerning urban freight transport initiatives and other logistics measures that they expect to be implemented before then). The values for potential CO_2 emissions reductions by 2030 shown in Table 6.1 are based on average values (median values from the surveys provide a lower total impact of -38% by HGVs by 2030 while LGV impact remains unchanged).

These results can be compared with a survey of participants that took place at an international freight transport conference in Cambridge in December 2016. Participants were surveyed about whether they thought carbon free city logistics will be achieved by 2030 in the UK. No respondents strongly agreed with this statement, 7% agreed, 6% were neutral, 71% disagreed and 16% strongly disagreed. Only 26% of participants believed that an 80% reduction in carbon emissions from freight transport in the UK between 1990 and 2050 would take place. Ninety percent of participants felt that additional policies in addition to those already in place would be required to achieve this EU target of an 80% reduction in carbon emissions from UK freight by 2050 (Centre for Sustainable Road Freight, 2016).

The results in **Table 6.1** (and in **section 4**) indicate that survey respondents expect that urban freight transport initiatives have a part to play can play in reducing CO_2 emissions in European urban areas by 2030. However, the respondents expect that logistics measures focused on vehicle and fuel technology and driver behaviour will have a more important role in reducing CO_2 emissions in European urban areas by 2030 than will urban freight transport initiatives.

These results indicate the need for policy makers aiming to reduce CO_2 emissions from the urban freight transport sector, and attempting to meet the European Commission's vision for essentially CO_2-free urban logistics by 2030 will need to remain open-minded to a wide range of policies and interventions both focusing on behaviour change in the urban area, and behaviour change across all HGV and LGV drivers, as well as wider sector-wide vehicle- and fuel-based solutions. The survey results suggest that while this palette of initiatives and measures is likely to bring about important reductions in CO_2 emissions in urban freight transport operations by 2030, it will not necessarily achieve the full extent of the EU's vision by that date.

Table 6.1: Summary of respondents' expectations about changes in the CO_2 emissions from HGVs and LGVs in European urban areas by 2030 (based on averages)

Category of freight initiatives and logistics measures	**HGVs**	**LGVs**
Business-as-usual trends	+11%	+24%
Sub-total	**+11%**	**+24%**
Urban freight initiatives		
Package of urban freight initiatives aimed at reducing vehicle kilometres travelled	-8%	-3%
Package of urban freight initiatives aimed at retiming operations and reducing queuing	-3%	-4%
Sub-total	**-11%**	**-7%**
Other logistics measures		
Use of CO_2-free vehicles	-21%	-41%
Improvements in fuel efficiency of conventional vehicles	-19%	-16%
Greater use of biofuels in diesel	-9%	-5%
Retrofitting existing vehicles	-3%	-3%
Driver training and performance monitoring	-5%	-3%
Sub-total	**-57%**	**-68%**
TOTAL	**-57%**	**-51%**

Notes:
'+' signifies an increase
'-' signifies a decrease

Sections 7 and 8 consider a different method by which to assess the potential of urban freight transport initiatives to bring about reductions in the total vehicle kilometres and CO2 emissions of HGVs and LGVs in European urban areas by 2030.

7 Framework of freight transport operational variables and outputs

7.1 Explanation of the framework

Use was made in the research of an analytical framework that was constructed to reflect the key factors which influence freight traffic levels and related energy consumption (McKinnon and Woodburn, 1993; McKinnon 2007). This framework illustrates the links between freight transport operations and the economic activities that it serves. The framework links the raw materials used in the production of goods with the road freight transport activity used to transport goods to their destinations, together with the negative economic, social and environmental impacts of freight operations (including CO_2 emissions; as well as the contribution to traffic levels).

The framework identifies relationships between a series of determinants and key variables each of which converts one output value into another. For the purposes of this CITYLAB research, McKinnon's framework has been adapted for specific consideration of urban freight transport activities. Each of these key variables is summarised below.

- Handling factor – each tonne of product is typically handled more than once as it makes it way through the entire supply chain from point of production to point of sale/consumption. The handling factor determines how the goods produced and imported into the economy are translated into the total tonnes of lifted that require to be lifted by all transport modes. Goods are typically only handled once in urban areas, so the handling factor is of little relevance to consideration of this particular part of the supply chain and freight transport operations.

- Modal split – determines the quantity of goods produced and imported into the economy that are handled by road freight (as opposed to other freight transport modes including rail and water)

- Length of haul (or journey length) – the average length of links in the supply chain over which goods lifted are transported on road freight trips. The length of haul and the handling factor together determine the 'transport intensity' of an economy. The tonne-kilometres of road freight activity are a product of the total tonnes lifted by road and average length of haul.

- Load carried on laden trips (or the lading factor)– the quantity of goods carried on a road freight vehicle is one of the two determinants of the vehicle traffic (i.e. vehicle kilometres travelled) required to move these tonne-kilometres (the other being empty running). The average load on laden trips is in turn determined by the carrying capacity of the vehicle (i.e. how much it is capable of carrying) and the lading factor (i.e. the extent to which the carrying capacity of the vehicle is utilised on laden trips).

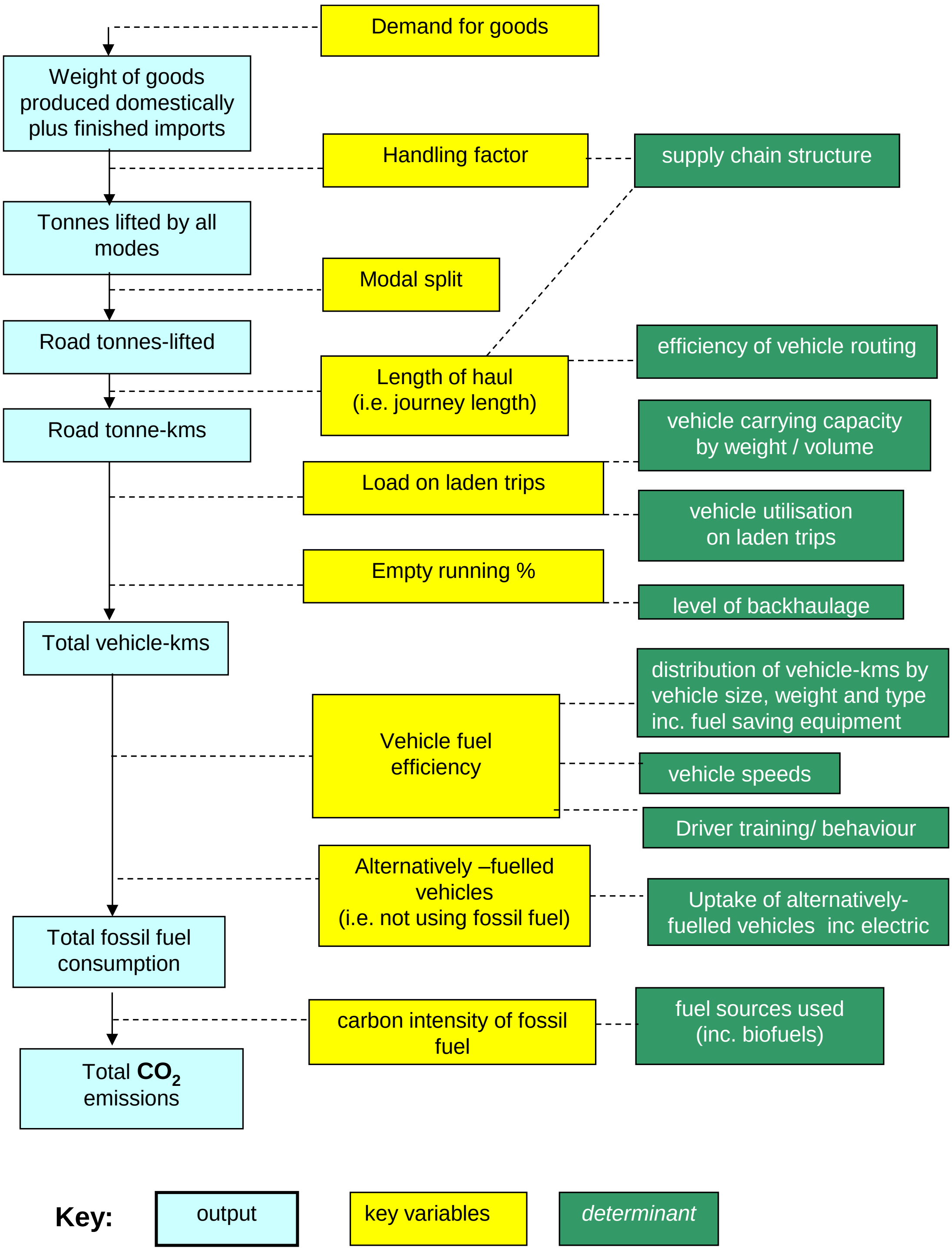
- Empty running – the other determinant of the vehicle kilometres travelled (together with the average load on laden trips) is empty running. This refers to the distance that the vehicle travels empty (i.e. without a load).

- The fuel efficiency of the vehicle determines the total quantity of fuel consumed on a journey. This depends on the mix of vehicle size, type and weight used, as well as the average vehicle speed, which depends on traffic levels and is influenced by the pattern, timing and location of road freight activities and the traffic conditions at these times on particular roads. Driver behaviour also plays a part.

- The carbon intensity of the fuel determines the total CO_2 emitted from the together quantity of fuel consumed.

The framework is depicted in Figure 7.1 which shows these relationships between determinants, variables and outputs of freight transport.

Figure 2.1: Relationship between determinants, key variables and outputs of road freight transport



Source: adapted from McKinnon, 2007.

The key variables are influenced by determinants that include factors such as travel times and prices, resource use, technology and organisation together with important supply chain decisions (including supply chain structures, vehicle fleet mixes, and backhaulage rates).

7.2 Applying the framework to HGV operations in selected UK cities

The framework described in **section 7.1** has previously been applied to forecast freight transport outputs in terms of total vehicle kilometres travelled and carbon emissions by heavy goods vehicles at a national scale (see Piecyk and McKinnon, 2010).

The decision was taken to test the validity of the framework and its ability to provide insight into urban freight transport variables and outputs for both heavy and light goods vehicles, as well as to indicate differences in urban freight operations and performance between urban areas.. In order to carry out this test of the validity of the approach data was obtained from the Freight Statistics Team in the UK Department for Transport showing the key freight operating variables for road freight transport journeys to, from and within six British urban areas in 2014. The Freight Statistics Team disaggregated and provided this data from that collected nationally as part of the Continuing Survey of Road Goods Transport (CSRGT – on-going survey of domestic HGV operators).

A spreadsheet model was developed to relate the determinants, key variables and outputs (as shown in **Figure 7.1**) using this CSRGT data. The spreadsheet model was used to analyse these variables and produce freight output statistics from them in terms of the total vehicle kilometres travelled and the related CO_2 emissions in urban areas. Performance indicators for HGV operations in these six urban areas were calculated with the use of population and spatial area statistics. The results of this analysis can be found in **Appendix II.**

8 Analysing the sustainability of urban freight transport by 2030

This section contains and explanation and the results of the application of the framework and spreadsheet model described in **section 7.1** to the CITYLAB implementation cities for which the required goods vehicle operational data was available.

8.1 Constructing scenarios for spreadsheet modelling

The survey respondents were asked to provide their expectations about changes in key road freight transport operating variables by 2030 for HGV and LGV operations. They were asked to provide estimates of the following road freight operating variables in European urban areas by 2030:

- Average journey length - % change, on average, in HGV and LGV journey distances on journeys serving urban areas
- Vehicle carrying capacity - % change in the average HGV and LGV vehicle size / weight serving urban areas
- Vehicle utilisation on laden trips - % change in the average load size carried on loaded vehicle journeys by HGVs and LGVs serving urban areas
- Empty running - % change in the average vehicle kilometres travelled empty by HGVs and LGVs serving urban areas
- Substitution of urban freight activity towards non-road modes - % change in quantity of freight lifted by non-road modes (i.e. water and rail freight) relative to HGVs and LGVs
- The extent of retiming of HGV and LGV operations - % change in total HGV and LGV journeys taking place outside of peak traffic periods (see section 4 for further details which also reports on results concerning this variable)

As explained in **section 7**, changes to the first five variables listed above result in changes to the vehicle kilometres travelled by HGVs and LGVs. By contrast the last bullet point, retiming of HGV and LGV operations does not affect the vehicle kilometres travelled, but instead affects fuel consumption rates due to improved traffic speeds and reduced vehicle queuing outside of peak periods.

The survey respondents were asked to provide their expectations about the extent of change in these road freight variables for HGVs and LGVs in European urban areas by 2030. **Table 8.1** provides the survey respondents views of expected changes in these road freight variables for European urban operations by 2030 in terms of the average and median response.

Table 8.1: Survey results for expected changes in road freight operating variables for European urban freight journeys by 2030 (averages)

Freight transport operating variables	HGVs		LGVs	
	Average	Median	Average	Median
Average journey length	-9%	-5%	-4%	-5%
Vehicle carrying capacity	+6%	+2%	+5%	+0%
Vehicle utilisation on laden trips	+12%	+10%	+14%	+10%
Empty running	-8%	-10%	-13%	-10%
Substitution of urban freight activity towards non-road modes	0%	+1%	0%	0%
Additional journeys retimed to outside of traffic peak periods	+3%	+2%	+4%	+2%

Notes:
'+' signifies an increase
'-' signifies a decrease
In the case of 'average journey length' and 'empty running' a negative percentage value implies a more sustainable outcome, whereas for all other indicators a positive value implies a more sustainable outcome.
Retiming of operations - respondents were asked about the CO_2 emissions reduction potential of retiming operations – this has been assumed to be equivalent to the proportion of total HGV and LGV journeys engaged in such retimed journeys)

Based on the analysis of survey respondents' views about likely changes in these road freight operating variables by 2030, plus study of historical changes in these road freight operating variables, and the authors' own expert judgement, three scenarios were defined: best case, central case and worst case. Given the uncertainty concerning how these variables will change, it was decided to use the same assumptions for change in each of the variable across the three scenarios based on the range of responses provided by those surveyed (with the exception of modal shift towards non-road modes given respondents' views that no such shift was likely over the time period concerned). An assumed improvement of 2% in the worst case, 4% in the central case and 6% in the best case scenario was used for each of the road freight variables. These scenarios are shown in **Table 8.2**.

Table 8.2: Changes in CO_2 emissions from HGVs and LGVs in European urban areas by 2030: worst, central and best case scenarios based on the survey work and literature review

Road freight operating variable	Worst case scenario	Central scenario	Best case scenario
	HGV + LGV	HGV + LGV	HGV + LGV
Average journey length	-2%	-4%	-6%
Average vehicle carrying capacity	+2%	+4%	+6%
Vehicle utilisation on laden trips	+2%	+4%	+6%
Empty running	-2%	-4%	-6%
Substitution of urban freight activity towards non-road modes	0%	0%	0%
Additional journeys retimed to outside of traffic peak periods	+2%	+4%	+6%

Notes:
'+' signifies an increase
'-' signifies a decrease

Ideally it would have been possible to estimate expected change by 2030 in the key freight variables specific to each of the urban areas studied. However survey respondents were only able to provide expectations about the way in which they expected key freight variables to change in general across European urban areas by 2030 rather than specifically for each CITYLAB city studied. This was due to survey respondents' perceived lack of sufficient information and evidence to be able to provide city-specific expectations. Therefore, although the scenarios assume the same change in the road freight variables for each urban area by 2030, in reality the changes in these variables will differ between urban areas due to factors including: economic, infrastructure, demographic, technological, land use, town planning and policy interventions.

8.2 Urban freight initiatives - results of the spreadsheet modelling work

Data was obtained from national government statistical departments in Norway, the UK, Italy and Belgium for existing urban road freight operations in five CITYLAB implementation cities: London, Southampton, Oslo, Rome and Brussels. The data required for the spreadsheet modelling work was unavailable in the case of the Netherlands and France. The "current situation" data is for 2014 in the case of London, Southampton and Brussels, and 2015 in the case of Oslo and Rome. HGV operating data was obtained for all five cities, while LGV operating data was obtained for London and Oslo. The LGV operations are the most difficult to analyse, given the relatively unavailability of statistical data about the operations of these vehicles both nationally and at a city level. However, with the application of informed assumptions by the CITYLAB researchers it was possible to construct the existing situation for LGV operations in London and Oslo and then apply the 2030 scenarios to these operations.

It is important to note that in the case of the HGV data for London, Southampton, Oslo, Rome and Brussels, the road freight operating variables and their associated outputs in terms of vehicle kilometres travelled and estimated CO_2 emissions refer to journey made by goods vehicles to, from and within these cities (the CO_2 emissions data therefore differs from that provided in Table 3.2 which only includes emissions within the urban area by HGVs).

For journeys to and from urban areas, the data obtained from the government statistical departments includes all of the vehicle activity that takes part outside of the city as part of these journeys. Therefore these vehicle kilometres and CO_2 emissions do not occur wholly within the city but over the course of these journeys that serve the city. In the case of London, Southampton, Rome and Brussels, the HGV journey distances are based on actual vehicle data supplied to these government statistical agencies by freight operators; whereas in the case of the Oslo the distances travelled to, from and within Oslo by HGVs had to be estimated by TOI the Norwegian CITYLAB partner (as this is not available from the Statistics Norway government survey). As a result, the Oslo HGV data may be subject to underestimation of journey lengths. In the case of the Oslo LGV data, although the estimates produced includes journey to, from and within the city, only the vehicle kilometres travelled within the city boundary are included; therefore the total vehicle kilometres and CO_2 emissions refer only to those associated with the goods vehicle activity within Oslo, and do not include the distances travelled outside. The unavailability of lading factor (i.e. vehicle utilisation on laden trips) data from the national statistics provided by ISTAT in Italy in the case of Rome and lading factor and empty running data from the national statistics provided by STATBEL in Belgium (via VUB-MOBI) in the case of Brussels meant that it was not possible to model future scenarios for these two CITYLAB cities.

The three scenarios shown in **Table 8.2** were analysed using the spreadsheet model developed to investigate their impacts on HGV and LGV vehicle kilometres and CO_2 emissions in European urban areas by 2030. The results are shown for each city and vehicle type in **Tables 8.3 – 8.8**. The actual values of the existing and projected road freight variables are provided. In the case of vehicle kilometres travelled and CO_2 emissions, the percentage change compared with the existing situation is provided for each of the three scenarios modelled.

Table 8.3: Potential vehicle kilometre and CO_2 emission reductions for HGV operations to, from and within London by 2030 as a result of urban freight transport initiatives to modify road freight variables

	Current situation	**Worst case scenario 2030**	**Central case scenario 2030**	**Best case scenario 2030**
Average journey length (km)	70	67	65	63
Average load on laden trips (tonnes)	9.7	10.1	10.5	10.9
Empty running	31%	30%	29%	28%
Additional vehicle km retimed to outside traffic peak periods (million)	-	25	47	65
Total HGV vehicle kilometres (million and % change compared to current)	1,338	1,250 (-7%)	1,167 (-13%)	1,091 (-19%)
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	447	409 (-8%)	374 (-16%)	343 (-23%)

Table 8.4: Potential vehicle kilometre and CO_2 emission reductions for HGV operations to, from and within Southampton by 2030 as a result of urban freight transport initiatives to modify road freight variables

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Average journey length (km)	138	135	132	130
Average load on laden trips (tonnes)	13.1	13.6	14.2	14.7
Empty running	31%	30%	30%	29%
Additional vehicle km retimed to outside traffic peak periods (million)	-	5	9	13
Total HGV vehicle kilometres (million and % change compared to current)	265	248 (-7%)	231 (-13%)	216 (-19%)
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	88	81 (-8%)	74 (-16%)	68 (-23%)

Table 8.5: Potential vehicle kilometre and CO_2 emission reductions for HGV operations to, from and within Oslo by 2030 as a result of urban freight transport initiatives to modify road freight variables

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Average journey length (km)	31	31	30	29
Average load on laden trips (tonnes)	11.8	12.3	12.8	13.3
Empty running	29%	28%	28%	27%
Additional vehicle km retimed to outside traffic peak periods (million)	-	3	6	9
Total HGV vehicle kilometres (million and % change compared to current)	176	165 (-7%)	154 (-13%)	144 (-18%)
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	59	54 (-8%)	49 (-16%)	45 (-23%)

Note: there may be underestimations in the current average journey length due to this having to be estimated by TOI, the CITYLAB partner, as it was not available from Statistics Norway from their survey work – see the second paragraph of section 8.2 (above) for further details).

Table 8.6: Potential vehicle kilometre and CO_2 emission reductions for LGV operations to, from and within London by 2030 as a result of urban freight transport initiatives to modify road freight variables

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Average journey length (km)	34	33	33	32
Average load on laden trips (tonnes)	0.23	0.24	0.25	0.26
Empty running	15%	15%	14%	14%
Additional vehicle km retimed to outside traffic peak periods (million)		38	71	99
Total HGV vehicle kilometres (million and % change compared to current)	2,001	1,878 (-6%)	1,763 (-12%)	1,656 (-17%)
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	207	191 (-8%)	176 (-15%)	165 (-20%)

Note: The UK Department for Transport was not able to provide current data concerning key freight variables for LGV operations in London. Therefore it was necessary to make use of findings from surveys of company use of LGVs in the UK from 2003-5 (Department for Transport, 2005) together with current estimates used by government in calculating greenhouse gas emissions Department for Business, Energy and Industrial Strategy, 2016).

Table 8.7: Potential vehicle kilometre and CO_2 emission reductions for LGV operations in Oslo by 2030 as a result of urban freight transport initiatives to modify road freight variables

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Average journey length (km)	45	44	43	42
Average load on laden trips (tonnes)	0.24	0.25	0.26	0.27
Empty running	39%	39%	38%	37%
Additional vehicle km retimed to outside traffic peak periods (million)	-	13	24	34
Total HGV vehicle kilometres (million and % change compared to current)	704	655 (-7%)	609 (-13%)	567 (-19%)
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	73	67 (-9%)	61 (-17%)	55 (-24%)

Note: In the case of the Oslo LGV data, although the variables above are based on journeys to, from and within the city, only the vehicle kilometres travelled within the city boundary are included; therefore the total vehicle kilometres and CO_2 emissions refer only to those associated with the goods vehicle activity within Oslo, and do not include the distances travelled outside the city.

Table 8.8: Current vehicle kilometre and CO_2 emissions situation for HGV operations to, from and within the Province of Rome

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Average journey length (km)	157			
Average load on laden trips (tonnes)	-			
Empty running	24%			
Additional vehicle km retimed to outside traffic peak periods (million)	-			
Total HGV vehicle kilometres (million and % change compared to current)	648			
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	216			

Note: Data for vehicle utilisation on laden trips is not available from the Italian government HGV survey work carried out by the national government statistics body ISTAT. Therefore it has not been possible to calculate the average load on laden trips or to use the spreadsheet modelling approach to estimate changes in the road freight variables and their impacts on total HGV vehicle kilometres travelled and CO_2 emissions. The Province of Rome is considerably larger than the city of Rome (with a geographical area of 5,352 km^2 (compared with 1,285km^2 in the city of Rome) and a population of 4.3 million people (compared with 2.9 million in the city of Rome).

Table 8.9: Current vehicle kilometre and CO_2 emissions situation for HGV operations to, from and within Brussels

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Average journey length (km)	89			
Average load on laden trips (tonnes)	-			
Empty running	-			
Additional vehicle km retimed to outside traffic peak periods (million)	-			
Total HGV vehicle kilometres (million and % change compared to current)	54			
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	18			

Note: Data for vehicle utilisation on laden trips and empty running are not available from the Belgian government HGV survey work carried out by the national government statistics body STATBEL. Therefore it has not been possible to calculate the average load on laden trips or to use the spreadsheet modelling approach to estimate changes in the road freight variables and their impacts on total HGV vehicle kilometres travelled and CO_2 emissions. The data refers to the Brussels Capital Region and was calculated by VUB-MOBI based on data from STATBEL.

Tables 8.3-8.7 suggest that in the central scenarios urban freight initiatives could reduce vehicle kilometres of HGVs and LGVs by approximately 12-13% and CO_2 emissions by 16% by 2030. By comparison, the best case scenario suggests vehicle kilometre and CO_2 emission reductions of approximately 17-19% and 20-24% respectively by 2030, and the worst case scenario suggests vehicle kilometre and CO_2 emission reductions of approximately 6-7% and 8-9% respectively by 2030.

Tables 8.3-8.7 do not show the change in the total proportion of HGVs and LGVs operated currently and in 2030 outside the peak traffic periods. However, to provide an example in the case of London hours, approximately 13% of LGV journeys and 17% of HGV journeys currently cross the central London traffic cordon between 20:00 and 06:00 on weekdays. The central scenario suggests that this would increase to 16% of LGV journeys and 20% of HGV journeys by 2030 (which would represent a 20% increase in operations outside the traffic peaks by HGVs and a 28% increase for LGVs).

8.3 Business-as-usual, urban freight initiatives and other logistics measures - results of the spreadsheet modelling work

As discussed earlier in this report (see **sections 3 and 5)**, in addition to the potential for urban freight initiatives to reduce CO_2 emissions in European urban areas by 2030, two other factors will have an important bearing on this, namely: business as usual trends (i.e. changes in the demand for HGV and LGV activity due to economic, demographic and other factors that will take place regardless of any initiatives or measures aimed at making freight more sustainable), and ii) other logistics measures including fuel and vehicle technology developments, and driver training that will take place at national and international levels that will assist in reducing the CO_2 emissions of HGV and LGV activity.

Scenarios were therefore developed for both of these factors and were applied in the spreadsheet modelling work in conjunction with the scenarios for changes in road freight transport variables (the results of which were presented in isolation in **section 8.3**) to investigate the potential combined overall effect of all the factors on CO_2 emissions in the cities studied from HGV and LGV operations by 2030. **Table 8.10** provides details of the business–as-usual and other logistics measures assumptions applied in the scenarios (that were applied in the spreadsheet modelling work in conjunction with the assumptions that were applied for urban freight transport initiatives, which are also shown).

Table 8.10: Changes in CO_2 emissions from HGVs and LGVs in European urban areas by 2030: worst, central and best case scenarios based on the survey work and literature review

Category of freight initiatives and logistics measures	Worst case scenario		Central scenario		Best case scenario	
	HGVs	LGVs	HGVs	LGVs	HGVs	LGVs
Business-as-usual trends						
Demand for freight transport	+20%	+30%	+10%	+20%	0%	+10%
Urban freight initiatives						
Average journey length	-2%	-2%	-4%	-4%	-6%	-6%
Average vehicle carrying capacity	+2%	+2%	+4%	+4%	+6%	+6%
Vehicle utilisation on laden trips	+2%	+2%	+4%	+4%	+6%	+6%
Empty running	-2%	-2%	-4%	-4%	-6%	-6%
Substitution of urban freight activity towards non-road modes	0%	0%	0%	0%	0%	0%
Additional journeys retimed to outside of traffic peak periods	+2%	+2%	+4%	+4%	+6%	+6%
Other logistics measures						
Use of CO_2-free vehicles (as % of total urban fleet)	+5%	+10%	+15%	+30%	+30%	+50%
Improvements in fuel efficiency of conventional vehicles (due to vehicle and engine design, retrofitting existing vehicles, and driver training and monitoring)	+10%	+10%	+20%	+20%	+30%	+30%
Greater use of biofuels in diesel (carbon intensity of fuel)	-2%	-2%	-5%	-5%	-10%	-10%

Notes:
'+' signifies an increase
'-' signifies a decrease

Tables 8.11-8.16 show the results of the spreadsheet modelling work into the combined impact of business-as-usual trends, urban freight initiatives and other logistics measures on HGV and LGV on fossil fuel consumption, vehicle kilometres and CO_2 emissions in European urban areas by 2030 in London, Southampton and Oslo. (The change in key freight variables as a result of the urban freight initiatives can be seen in **Tables 8.3-8.7**, and the two sets of tables can be compared to see the additional effects of business-as-usual trends and other logistics measures).

Table 8.11: Potential change in vehicle kilometres and CO_2 emissions for HGV operations in London by 2030 as a result of all factors modelled

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Total HGV vehicle kilometres (million and % change compared to current)	1,338	1,500 (+12%)	1,284 (-4%)	1,091 (-19%)
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	447	416 (-7%)	279 (-38%)	181 (-60%)

Table 8.12: Potential change in vehicle kilometres and CO_2 emissions for HGV operations in Southampton by 2030 as a result of all factors modelled

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Total HGV vehicle kilometres (million and % change compared to current)	265	297 (+12%)	254 (-4%)	216 (-19%)
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	88	82 (-7%)	55 (-38%)	36 (-60%)

Table 8.13: Potential change in vehicle kilometres and CO_2 emissions for HGV operations in Oslo by 2030 as a result of all factors modelled

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Total HGV vehicle kilometres (million and % change compared to current)	176	199 (+12%)	169 (-4%)	144 (-18%)
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	59	55 (-7%)	37 (-37%)	24 (-59%)

Table 8.14: Potential change in vehicle kilometres and CO_2 emissions for LGV operations in London by 2030 as a result of all factors modelled

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Total HGV vehicle kilometres (million and % change compared to current)	2,001	2,441 (+22%)	2,116 (+6%)	1,822 (-9%)
Total HGV CO_2 emissions (000 tonnes and % change compared to current)	207	199 (-4%)	118 (-43%)	62 (-70%)

Table 8.15: Potential change in vehicle kilometres and CO_2 emissions for LGV operations in Oslo by 2030 as a result of all factors modelled

	Current situation	Worst case scenario 2030	Central case scenario 2030	Best case scenario 2030
Total HGV vehicle kilometres (million and % change compared to current)	704	851 (+21%)	731 (+4%)	623 (-11%)
Total HGV CO_{2e} emissions (000 tonnes and % change compared to current)	73	69 (-5%)	41 (-44%)	21 (-71%)

Table 8.16 shows the combined impact of all of these factors (business–as-usual trends in freight transport demand, other logistics measures and urban freight transport initiatives) on the total current vehicle kilometres travelled and CO_2 emissions from HGV and LGV operations in London, Southampton and Oslo.

Table 8.16: Potential change in vehicle kilometres and CO_2 emissions for each of the vehicle types and cities studied by 2030

Vehicle type of city	Worst case scenario 2030	Central scenario 2030	Best case scenario 2030
Vehicle kilometres travelled by HGVs	+12%	-4%	-18 to -19%
CO_2 emissions from HGVs	-7%	-37 to -38%	-59 to -60%
Vehicle kilometres travelled by LGVs	+21 to +22%	+4 to +6%	-9 to -11%
CO_2 emissions from LGVs	-4 to -5%	-43 to -44%	-70 to -71%

Notes:
The spreadsheet modelling presented in the table above include: i) business-as-usual trends, ii) urban freight transport initiatives, and iii) other logistics measures by 2030.

The results indicate that in the central scenario CO_2 emission reductions of 37-38% and 43-44% would be expected for HGVs and LGVs in European urban areas by 2030. However, vehicle kilometres travelled would only fall by 4% in the case of HGVs and would rise by 4-6% in the case of LGVs.

The worst case scenario would only result in small CO_2 reductions for HGVs and LGVs (of 7% and 4-5% respectively) by 2030, while vehicle kilometres would increase by 12% and 21-22% respectively. By comparison, the best case scenario would be expected to lead to CO_2 reductions for HGVs and LGVs of 59-60% and 70-71% respectively by 2030, while vehicle kilometres would fall by 18-19% and 9-11% respectively.

Table 8.17 shows current and future (based on the central case scenario for 2030) performance statistics for these HGV and LGV operations in the CITYLAB cities studied.

Table 8.17: Urban area road freight performance measurements now and in 2030 (based on central case scenario for 2030)

	HGV						LGV			
	London		Southampton		Oslo		London		Oslo	
	Now	2030	Now	2030	Now	2030	Now	2030	Now	2030
Average distance travelled per tonne transported (kms)	10.4	9.1	15.2	13.3	3.7	3.2	173.9	153.3	306.1	264.8
Average distance travelled per km^2 (000 kms)	852	817	5,302	5,086	388	373	1,272	1,346	1,550	1,609
Average distance travelled per person (kms)	154	148	1,062	1,019	268	257	231	244	1,069	1,110
CO_2e emissions per tonne transported (kg)	3.5	2.0	5.1	2.9	1.2	0.7	18.0	8.5	31.7	14.7
CO_2e emissions per km^2 (tonnes)	284	177	1,769	1,105	130	81	132	75	161	89
CO_2e emissions per person (kg)	51	32	354	221	89	56	24	14	111	62

8.4 Comparing the spreadsheet modelling results with those of other UK studies

Using the views of the survey respondents together with other relevant research into traffic forecasts and the potential benefits of urban freight transport and other logistics measures to mitigate CO_2 emissions, three scenarios have been constructed about potential outcomes for HGVs and LGVs in European urban areas by 2030. The central scenario is based on the views of the survey respondents (as presented in previous sections). The worst and best case scenarios take account of the findings of other relevant research into these mitigation strategies (as reviewed in **section 5.7**). **Table 8.16** illustrates these three scenarios that have been produced as part of the CITYLAB research carried out as part of this report.

Comparing the results of these CITYLAB scenarios with the findings of other relevant research, the Committee on Climate Change in producing its Fifth Carbon Budget made use of the best available evidence to construct its scenarios for future carbon emissions from HGVs in the UK. Its 'Central' estimate assumes approximately a 50% reduction in CO_2 emissions from HGVs in Britain by 2030 compared with the baseline case (i.e. business-as-usual situation), while their 'Barriers' and 'Maximum' scenarios assume approximately 40%

and 56% reductions in in CO_2 emissions from HGVs in Britain by 2030 respectively (Committee on Climate Change, 2015).

Other modelling work (carried out for the Committee on Climate Change) estimated that supply-side improvements (i.e. due to the introduction of new, more efficient HGVs - the baseline scenario - which also took account of expected changes in the demand for freight transport services) would lead to an overall decrease in carbon emissions from HGVs in the UK of 8% by 2035. This same study also estimated that it would be possible to achieve carbon savings from the HGV sector in the UK of 34% by 2035 relative to the baseline scenario through demand-side measures (which comprised a combination of new vehicles powered by alternative fuel sources, aftermarket improvements to vehicles, improvements to driving styles, and freight transport operations measures to reduce kilometres driven). Of these demand-side measures, total carbon savings of approximately 40% was estimated to derive from improved driving styles, another 40% from improvements to freight transport operational efficiency and the remaining 20% from aftermarket improvements to HGVs (Greening et al., 2015).

9 Conclusions

This report has used several approaches (i.e. a literature review, a survey of expert respondents, and spreadsheet modelling work) to investigate the potential of urban freight initiatives and other logistics measures to reduce CO_2 emissions from goods vehicles in European urban areas by 2030. The results from each of these approaches indicate that there is scope for CO_2 reduction within this timescale.

9.1 The importance of urban freight initiatives in reducing CO_2 emissions in urban areas

Both the survey work and the spreadsheet modelling results suggest that urban freight initiatives are likely to have less of an impact on CO_2 emissions from goods vehicles than other logistics measures based on vehicle and fuel technologies and driver training to improve driving behaviour. The survey results indicate that a combination of urban freight initiatives could potentially reduce CO_2 emissions from HGVs and LGVs by approximately 10% by 2030, while the spreadsheet modelling results suggest a reduction of approximately 15% in the central scenario (together with a similar but slightly lower reduction in total vehicle kilometres travelled by HGVs and LGVs).

The survey results have also indicated respondents' expectation about the likely impact of each individual urban freight initiative on CO_2 emissions from HGVs and LGVs by 2030 taking into account the maximum potential uptake of each initiative by 2030, its current penetration rate, its likely uptake by 2030, and its potential to reduce vehicle kilometres travelled for those operators that implement it. These findings concerning individual urban freight initiatives thereby provide some insight into which urban freight transport initiatives are likely to have the greatest impact by 2030.

The survey results suggest that other logistics measures focused on vehicle and fuel technology and driver behaviour will have a more important role in reducing CO_2 emissions in European urban areas by 2030 than will urban freight transport initiatives. The survey results indicate that, on average, respondents believe that these other logistics measures have the potential to reduce CO_2 emissions from HGVs and LGVs in European urban areas by approximately 45-65% by 2030.

9.2 The implications of the demand for freight services on CO_2 emissions reduction

Survey respondents expect the demand for freight services in urban areas and hence the vehicle kilometres travelled by HGVs and LGVs to increase between now and 2030, all other things being equal. LGV traffic is expected to grow twice as much as HGV traffic in European urban areas over this period.

The survey results indicate that the experts questioned expect, on average, CO_2 emissions from HGVs and LGVs in European urban areas to reduce by 50-60% by 2030 (compared to now) when changes in the demand for freight transport services are also taken into account. The spreadsheet modelling work indicates a reduction in CO_2 emissions from HGVs and LGVs of approximately 38% and 44% over this period in the central scenario when accounting for changes in urban freight demand.

However, the spreadsheet modelling results for the central scenario indicate that vehicle kilometres travelled by HGVs and LGVs in urban areas by 2030 will be virtually unchanged by 2030. The best case scenario in the spreadsheet modelling work suggests CO_2 emission reductions for HGVs and LGVs of approximately 60-70% and vehicle kilometre reductions of 10-20% in European urban areas by 2030 when freight demand is taken into account. However, the worst case scenario suggests CO_2 emission reductions for HGVs and LGVs of approximately only 5-10% by 2030 together with increases in vehicle kilometres travelled by HGVs and LGVs of approximately 10% and 20% respectively.

9.3 A diversity of approaches

As previously stated (see **section 8.1**), ideally it would have been possible to estimate expected change by 2030 in the key freight variables specific to each of the urban areas studied. However there is currently insufficient evidence available to be able to achieve this. Therefore, although the scenarios in **section 8** assume the same change in the road freight variables for each urban area by 2030, in reality the changes in these variables will differ between urban areas due to factors including: economic, infrastructure, demographic, technological, land use, town planning and policy interventions.

Following on from this first point, the specific urban freight initiatives required in different urban areas will vary as will their specific details (i.e. although there will be some initiatives that show more promise than others, and which are therefore more generally applicable than others, there will be variations in the package of urban freight initiatives implemented in urban areas and their precise details especially in terms of more localised initiatives due to both urban circumstances and political will). There is no single set of urban freight initiatives that will solve the specific issues and problems faced by all European urban areas and even where similar individual freight initiatives are implemented in more than one urban area these are likely to vary due to political, geographical, infrastructural and economic factors.

9.4 The policy challenge

The results in this report indicate the potential scale of the challenge for policy makers aiming to achieve the European Commission's vision for essentially CO_2-free urban logistics by 2030. These policy makers will need to remain open-minded to a wide range of policies and interventions both focusing on behaviour change in the urban area, and behaviour change across all HGV and LGV drivers, as well as wider sector-wide vehicle- and fuel-based solutions. The modelling results also indicate that vehicle kilometres travelled by HGVs and LGVs are likely to be far less susceptible to change as a result of urban freight initiatives and other logistics measures than CO_2 emissions.

Much uncertainty remains in current research about the scale of CO_2 emissions in urban areas in HGV and LGV operations due to current lack of foresight regarding technological, political, regulatory, and financial factors. It will therefore be necessary to revisit this topic in the coming years as insight into the potential benefits of urban freight initiatives and other logistics measures becomes available from experiments and trials. A better understanding of the likely uptake of such initiatives and measures will also become clearer over time as a result of further research into the business case for such solutions. Such business case research will also help in understanding concerning the extent to which urban, national and international governmental authorities will be able to rely on voluntary approaches or will have to implement solutions based on compulsion in order to reach CO_2 emission reduction targets for goods vehicle operations in urban areas.

Appendix I: Standard deviations for survey results

Appendix I provides standard deviations for the main tables of survey results provided in the main body of the report. Each table in the appendix uses the same table numbering as that in the main body of the report with a prefix of the letter ‘A’ and roman numeral ‘I’.

Table A.I.3.3: Change in HGV and LGV vehicle kms in European urban areas by 2030 expected by respondents (compared with now)

Vehicle type	Change in vehicle kilometres (average - %)	Standard Deviation (%)
HGV	+11	16.3
LGV	+24	18.5

Table A.I.4.1: Survey results for freight initiatives expected to reduce HGV vehicle kilometres and CO_2 emissions in European urban areas by 2030

Initiative	Expected % impact of this initiative on reducing total HGV urban freight vehicle kilometres and CO_2 emissions by 2030 (average - %)	Standard Deviation (%)
Urban consolidation centres / mobile depots for retail goods and parcels	2.4	3.7
Collaborative logistics operations between freight companies to improve vehicle loads	1.7	3.9
Use of rail freight	1.6	2.4
Reverse logistics to improve empty running	1.4	2.6
Road user charging for freight vehicles	1.1	1.9
Vehicle routeing and scheduling tools	1.1	1.8
Partnership working in the supply chain operations	1.1	1.7
Use of higher capacity vehicles	0.9	1.8
Logistics land use planning (to make logistics depot land available in urban areas and reduce stem distances to delivery/collection areas)	0.9	2.0
Urban consolidation centres for construction materials	0.8	1.7
Increase price charged for home deliveries of online shopping according to delivery lead time requested	0.7	1.8
Sustainable construction logistics - reducing the number of material suppliers used	0.6	1.5
Sustainable procurement practices - using the same goods suppliers as other neighbouring businesses	0.6	1.4
Charging / booking system for on-street loading bays	0.6	1.0
Use of waterborne freight	0.6	0.8
Sustainable procurement practices - ordering goods less frequently (and holding more stock on site)	0.5	1.1
Sustainable procurement practices - reducing the number of goods suppliers used	0.5	1.1
Use of locker banks (for online shopping)	0.5	1.4
Increase price charged for home deliveries of online shopping according to delivery lead time requested	0.3	0.5
Use of drones for urban freight deliveries and collections	0.2	0.7
Use of click and collect services and other collection points in retail stores (for online shopping)	0.2	0.3
Use of electrically-propelled cargocycles operating from central micro-hubs	0.2	0.2
Increase delivery lead time for home delivery of online shopping (fewer same-day and next-day deliveries)	0.1	0.2
Use of autonomous (driverless) vehicles for urban freight collections and deliveries	0.0	0.1

Table A.I.4.2: Survey results for freight initiatives expected to improve HGV fuel use and CO_2 emissions in European urban areas by 2030

Initiative	Expected % impact of this initiative on reducing total HGV urban fuel use and CO_2 emissions by 2030 (average - %)	Standard Deviation (%)
Better information provision about roadworks and road traffic problems (to reduce vehicle queueing)	0.8	1.6
Retiming of logistics operations (companies accepting deliveries and collections outside the daytime peak)	0.6	1.3
Retiming of logistics operations (companies relaxing existing delivery time windows)	0.6	1.4
Common logistics operations for a major multi-tenanted building or area (staff in loading bay take responsibility for receiving goods and distributing within building (to reduce vehicle dwell time, and queueing)	0.3	0.8
New service in which goods vehicles deliver goods to public staff at the kerbside who make final delivery (so that driver can depart immediately after unloading to reduce queueing and circulating for kerbside space)	0.2	0.6
Companies making off-street parking space available for delivery and collection vehicles (to reduce vehicle queueing and circulating)	0.1	0.4

Table A.I.4.3: Survey results for freight initiatives expected to reduce LGV vehicle kilometres and CO_2 emissions in European urban areas by 2030

Initiative	Expected % impact of this initiative on reducing total LGV urban freight vehicle kilometres and CO_2 emissions by 2030 (average - %)	Standard Deviation (%)
Urban consolidation centres / mobile depots for retail goods and parcels	2.8	3.4
Logistics land use planning (to make logistics depot land available in urban areas and reduce stem distances to delivery/collection areas)	1.9	2.9
Collaborative logistics operations between freight companies to improve vehicle loads	1.8	3.0
Use of electrically-propelled cargocycles operating from central micro-hubs	1.7	2.8
Road user charging for freight vehicles	1.2	2.3
Reverse logistics to improve empty running	1.2	2.1
Partnership working in the supply chain operations	1.0	1.4
Vehicle routeing and scheduling tools	0.9	1.4
Sustainable procurement practices - reducing the number of goods suppliers used	0.8	1.5
Charging / booking system for on-street loading bays	0.8	1.1
Use of higher capacity vehicles	0.8	1.2
Use of rail freight	0.7	1.9
Sustainable procurement practices - ordering goods less frequently (and holding more stock on site)	0.7	1.2
Sustainable procurement practices - using the same goods suppliers as other neighbouring businesses	0.7	1.4
Sustainable construction logistics - reducing the number of material suppliers used	0.6	1.5
Use of click and collect services and other collection points in retail stores (for online shopping)	0.5	0.7
Use of locker banks (for online shopping)	0.5	0.9
Urban consolidation centres for construction materials	0.5	0.9
Increase price charged for home deliveries of online shopping according to delivery lead time requested	0.4	0.6
Increase price charged for home deliveries of online shopping according to delivery lead time requested	0.4	0.7
Use of waterborne freight	0.3	0.5
Increase delivery lead time for home delivery of online shopping (fewer same-day and next-day deliveries)	0.3	0.5
Use of drones for urban freight deliveries and collections	0.3	0.7
Use of autonomous (driverless) vehicles for urban freight collections and deliveries	0.0	0.2

Table A.I.4.4: Survey results for freight initiatives expected to improve LGV fuel use and CO_2 emissions in European urban areas by 2030

Initiative	Expected % impact of this initiative on reducing total LGV urban fuel use and CO_2 emissions by 2030 (average - %)	Standard Deviation (%)
Better information provision about roadworks and road traffic problems (to reduce vehicle queueing)	0.9	2.1
Retiming of logistics operations (companies accepting deliveries and collections outside the daytime peak)	0.5	1.5
Retiming of logistics operations (companies relaxing existing delivery time windows)	0.4	1.6
Common logistics operations for a major multi-tenanted building or area (staff in loading bay take responsibility for receiving goods and distributing within building (to reduce vehicle dwell time, and queueing)	0.4	1.2
New service in which goods vehicles deliver goods to public staff at the kerbside who make final delivery (so that driver can depart immediately after unloading to reduce queueing and circulating for kerbside space)	0.2	0.6
Companies making off-street parking space available for delivery and collection vehicles (to reduce vehicle queueing and circulating)	0.2	0.6

Table A.I.4.5: Survey results for servicing initiatives expected to reduce LGV vehicle kilometres and CO_2 emissions in European urban areas by 2030

Initiative	Expected % impact of this initiative on reducing total LGV urban freight vehicle kilometres and CO_2 emissions by 2030 (average - %)	Standard Deviation (%)
Sustainable procurement practices - using the same service providers as other neighbouring businesses	0.9	1.6
Use of collection points (for spare parts and tools for service engineers)	0.6	0.9
Use of locker banks (for spare parts and tools for service engineers)	0.5	1.1

Table A.I.4.6: Respondents' estimates of the combined impacts of urban freight initiatives to reduce CO_2 emissions from HGV and LGV in European urban areas by 2030

	HGVs		LGVs	
Category of package of urban freight initiatives	**Average (%)**	**Standard Deviation (%)**	**Average (%)**	**Standard Deviation (%)**
Aimed at reducing vehicle kilometres travelled	-11	27	-8	35
Aimed at retiming operations and reducing queueing	-2	13	-4	16
Total impact of all combined measures	-13		-12	

Table A.I.5.1: Respondents' expectations about the extent to which other logistics measures will change CO_2 emissions from HGVs and LGVs in European urban areas by 2030

Logistics measures	**HGVs**		**LGVs**	
	Average (%)	**Standard Deviation (%)**	**Average (%)**	**Standard Deviation (%)**
Use of CO2-free vehicles	-21	18	-41	24
Improvements in fuel efficiency of conventional vehicles	-9	13	-5	10
Greater use of biofuels in diesel	-19	6	-16	5
Retrofitting existing vehicles	-3	3	-3	3
Driver training and performance monitoring	-5	5	-3	4

Table A.I.8.1: Survey results for expected changes in road freight operating variables for European urban freight journeys by 2030

	HGVs		LGVs	
Freight transport operating variables	**Average (%)**	**Standard Deviation (%)**	**Average (%)**	**Standard Deviation (%)**
Average journey length	-9	1.5	-4	1.3
Average vehicle carrying capacity	+6	1.2	+5	1.6
Vehicle utilisation on laden trips	12	1.6	+14	1.8
Empty running	-8	1.1	-13	1.5
Substitution of urban freight activity towards non-road modes	0	1.7	0	2.4
Additional journeys retimed to outside of traffic peak periods	+3	1.3	+4	1.6

Appendix II: Results of applying the framework to HGV operations in selected UK cities

As explained in **section 7.2** the decision was taken to test the validity of the framework and its ability to provide insight into urban freight transport variables and outputs for both heavy and light goods vehicles, as well as to indicate differences in urban freight operations and performance between urban areas.. In order to carry out this test of the validity of the approach data was obtained from the Freight Statistics Team in the UK Department for Transport showing the key freight operating variables for road freight transport journeys to, from and within six British urban areas in 2014. The Freight Statistics Team disaggregated and provided this data from that collected nationally as part of the Continuing Survey of Road Goods Transport (CSRGT – on-going survey of domestic HGV operators).

A spreadsheet model was developed to relate the determinants, key variables and outputs (as shown in **Figure 7.1**) using this CSRGT data. The spreadsheet model was used to analyse these variables and produce freight output statistics from them in terms of the total vehicle kilometres travelled and the related CO_2 emissions in urban areas. Performance indicators for HGV operations in these six urban areas were calculated with the use of population and spatial area statistics. The results of this analysis can be found in **Appendix A.2.**

It is important to mention two key points about this CSRGT data. First, the data in CSRGT is based on the weight of goods carried by HGVs rather than the volume of goods. It does not therefore accurately reflect situations in which vehicles are limited by the volume rather than by weight of products (i.e. when the volume to weight ratio of goods (i.e. the bulk density) is low). Second, the data comprises individual vehicle journeys from origin to destination. It therefore includes vehicle journeys to the urban area from elsewhere, journeys from the urban area to elsewhere, and journeys that take place wholly within the urban area. Therefore, the average journey distance and vehicle kilometres do not refer only to the distances travelled with the urban area but also the distance travelled outside to the urban area to the origin or destination of these journeys, wherever that happens to be.

Table A.II.1 shows the road freight variables and outputs for these six urban areas together with population and spatial area statistics. Vehicle kilometres travelled and CO_2 emissions were calculated using the spreadsheet model, with fuel consumption rates derived from Freight Statistics Team data sources. **Table A.II.1** shows the differences in road freight variables and total freight activity in the six urban areas. Average length of haul (i.e. journey distances) can be seen to vary markedly between urban area. This is related to the nature of the economy in the urban area (with some attracting freight from further away than others – such as the ports in Bristol and Southampton) together with the geographical remoteness of the location. The average vehicle carrying capacity and average weight of load carried can be seen to also vary considerably.

Table A.II.2 shows the transport distance and CO_2 emissions performance measurements expressed on a per tonne lifted, per person and per km^2 basis, calculated from the road freight variables and outputs, together with the population and spatial area data. These results indicate the variation in freight performance between urban areas, with the least variation occurring when expressing vehicle kilometres travelled and CO_2 emissions on a per tonne lifted basis. However, even when using this measure, there are still important differences in performance between locations. Analysis of vehicle kilometres and CO_2 emissions on a per tonne lifted basis reflects the distance over which the goods are transported as well as the efficiency of vehicle use.

From the perspective of a policy maker, the intensity of road freight transport in terms of vehicle kilometres travelled or CO_2 emissions is of great interest as it reflects the distance that goods vehicles are driven on the roads, the fuel they consume or CO_2 emissions per tonne of goods lifted. Reducing the road freight transport intensity would result in less goods vehicle activity per unit of freight handled, thereby alleviating the negative impacts associated with this vehicle activity.

Table A.II.1: Urban area statistics, road freight variables and outputs

	West Midlands	London	Edinburgh	York	Bristol	Southampton
Population (million)	2.83	8.67	0.50	0.21	0.45	0.25
Geographical area (km2)	902	1,572	263	272	110	50
Goods lifted (million tonnes)	72.4	128.8	28.3	27.7	24.3	17.4
Average length of haul (km)	116	73	85	102	143	138
Average carrying capacity by weight (tonnes)	18.2	16.2	16.4	18.8	19.5	21.8
Lading factor	0.56	0.63	0.60	0.61	0.58	0.60
Average load on laden trips (tonnes)	10.2	10.2	9.8	11.5	11.3	13.1
Empty running (%)	29%	31%	26%	30%	24%	31%
Total vehicle kilometres (million)	1,166	1,338	334	351	408	265
Total CO_2e emissions (thousand tonnes)	389	446	111	117	136	88

Table A.II.2: Urban area road freight performance measurements

	West Midlands	London	Edinburgh	York	Bristol	Southampton
Average distance travelled per tonne transported (kms)	16.1	10.4	11.8	12.7	16.8	15.2
Average distance travelled per km^2 (000 kms)	1,293	852	1,268	1,290	3,706	5,302
Average distance travelled per person (kms)	412	154	669	1,696	907	1,062
CO_2e emissions per tonne transported (kg)	5.4	3.5	3.9	4.2	5.6	5.1
CO_2e emissions per km^2 (tonnes)	431	284	423	430	1,236	1,769
CO_2e emissions per person (kg)	137	51	223	566	303	354

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