WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

SUPPLY CHAIN DECARBONIZATION

THE ROLE OF LOGISTICS AND TRANSPORT IN REDUCING SUPPLY CHAIN CARBON EMISSIONS

Report prepared with the support of Accenture

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Executive Summary

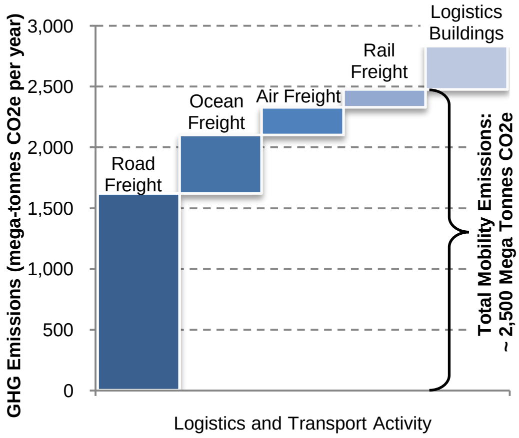
Significant movement is expected towards reduced supply chain carbon intensity. This will create both opportunities and risks for logistics and transport firms, with changes in supply and demand driven by:

- Regulation of carbon emissions
- Higher and more volatile fuel prices
- Evolving consumer and client demand

The sector can play an influential role in decarbonization, both in its own operations and through broader supply chain optimisation. This provides direct benefits through reduced costs, managed risks and business growth.

Findings

Human activity generates annual greenhouse gas emissions of around 50,000 mega-tonnes CO_2e. We estimate that 2,800 mega-tonnes – or 5.5% of the total – are contributed by the logistics and transport sector.



Key to supply-chain-wide decarbonization is an understanding of CO_2 emissions across the system. Corporate-level reporting, guided by the widely-used Greenhouse Gas Protocol, is a spreading reality. Product level foot-printing is an important step towards supply chain carbon rationalisation. It has been given a boost by the agreement of the first standards.

Supply Chain Decarbonization Opportunities

Commercially viable decarbonization opportunities which could be enabled by the logistics and transport industry are of the order of 1,400 mega-tonnes CO_2e in the medium term.

Around 60% of this potential carbon abatement originates from the sector's own emissions. Others come from the broader supply chain and can be achieved through changed logistics and transport configurations:

Supply Chain Decarbonization Opportunities	Potential Abatement Mt CO_2e	Assessed Index of Feasibility
Clean Vehicle Technologies	175	High
Despeeding the Supply Chain	171	High
Enabling Low Carbon Sourcing: Agriculture	178	Medium
Optimised Networks	124	High
Energy Efficient Buildings	93	High
Packaging Design Initiatives	132	High
Enabling Low Carbon Sourcing: Manufacturing	152	Medium
Training and Communication	117	Medium
Modal Switches	115	Medium
Reverse Logistics / Recycling	84	Medium
Nearshoring	5	Medium
Increased Home Delivery	17	Medium
Reducing Congestion	26	Low

Recommendations

Logistics and Transport Providers

- Adopt new technologies industry-wide
- Improve training and communication industry-wide
- Switch modes where possible
- Develop recycling offerings
- Develop home delivery offerings
- Promote carbon offsetting of shipments

Shippers and Buyers

- Understand and reduce carbon impact of manufacturing through alternative sourcing
- Plan to allow slower and better optimised transport
- Reduce packaging materials
- Work on product carbon labelling, standards, auditing tools, and use
- Increase shared loading

Policy Makers

- Reflect cost of carbon in energy tariffs
- Support carbon measurement and labelling standards
- Build open carbon trading systems
- Invest in infrastructure and flow management
- Facilitate recycling along the supply chain
- Encourage retrofitting of buildings to better environmental levels

Contents

Executive Summary **4**
The Need for a Review **5**
Understanding Supply Chain Decarbonization 5
Context of Decarbonization **6**
Regulation of Carbon Emissions 6
Response to Higher and More Volatile Fuel Prices 6
Evolving Consumer and Client Demand 6
Logistics Sector Response 6
Objectives and Approach **7**
Objectives 7
Approach 7
Findings **8**
Logistics and Transport Sector Carbon Footprint 8
Total Supply Chain Carbon Footprint 9
Pressures for a Shift to Decarbonization 10
Supply Chain Decarbonization Framework 12
Main Opportunities for Decarbonization **12**
Summary of the Main Opportunities for Decarbonization 14
Overview of the Scorecards 15
Recommendations **29**
Logistics and Transportation Providers 29
Shippers and Buyers 29
Policy Makers 30
Conclusions **31**
Annexes **32**
Annex 1: Definition of Key Terms 32
Annex 3: Further Reading 40
Annex 4: List of Industry Partners 40
Contact Information **41**

The Need for a Review

To date, logistics and transport companies have mostly taken a tactical and internal view of supply chain decarbonization. This has resulted in important, but nevertheless small scale, responses to climate change. Point solutions have included increased use of battery powered trucks, automated scheduling applications and green building technologies.

The need to look more strategically at the end-to-end supply chain, encompassing all aspects of the product life cycle from raw material to disposal, is now being evidenced. Across sectors, firms and policy makers have spoken of the requirement to consider the total product lifecycle impact of carbon, before optimising across boundaries.

Near-term economic uncertainty has changed the immediate outlook for the logistics and transport sector. Nonetheless, even in this operating environment, the underlying business imperatives for supply chain decarbonization remain valid.

Understanding Supply Chain Decarbonization

This report is constructed from the viewpoint of the world's largest logistics and transport firms, capturing the commitment of the sector to be at the heart of supply chain decarbonization efforts.

We provide both a contextual and an initial quantitative assessment of the supply chain decarbonization challenge. It looks at likely opportunities for abatement, purposefully pushing the boundaries of current knowledge seeking to clarify controversial topics.

Communicating the findings through a series of accessible scorecards, we take a first step towards assessing the scale and feasibility of potential emission abatement options across the supply chain.

Overall, we aim to move the global dialogue forward and to help carriers and buyers alike to:

- Take practical and cost-effective steps towards decarbonization strategies
- Anticipate external drivers for change – which may have significant effects on the long-term demand for freight

Context of Decarbonization

Of humanity's 50,000 mega-tonnes of annual CO_2e greenhouse gas emissions, around 2,800 mega-tonnes can be assigned to logistics and transport activities.

Though there is significant uncertainty in the figures, it seems possible that significant emissions reductions could be achieved in the medium term[1] by implementing change throughout the end-to-end supply chain. This could be primarily achieved through wider adoption of available technologies, leveraging new commercial relationships and developing new business strategies.

The conditions required to enable these changes are being created. We see three developments providing the necessary business environment for implementation.

Those three fundamental drivers of change are:

- Regulation of Carbon Emissions
- Response to Higher and More Volatile Fuel Prices
- Evolving Consumer and Client Demand

Regulation of Carbon Emissions

Supply chain carbon emissions will increasingly be regulated through a variety of legal standards as numerous policy developments are underway. By December 2009, the 192 member countries of the United Nations Framework Convention on Climate Change have agreed to launch a mechanism to achieve "deep cuts" in emissions[2].

Independent targets in developed nations call for significant cuts in emissions – the European Union's Energy Policy calls for a 20% reduction in greenhouse gas emissions by 2020[3] while California's AB 32 'Global Warming Solutions Act' seeks state-wide emissions reductions of 25% by 2020[3]. The UK Climate Change Act mandates an 80% cut in national carbon emissions by 2050[3]. There is increasing convergence in the debate towards a universal price for carbon.

Response to Higher and More Volatile Fuel Prices

A further clear driver of decarbonization is the link between carbon emissions and energy cost. For the most part within supply chains, there is a simple win-win on cost and carbon, with initiatives to decrease fossil fuel to reduce costs.

Less financial risk can also be the result: reduced fossil fuel consumption decreases exposure to volatility in the cost base in an operating environment which has – and will continue to – see significant energy price volatility.

Evolving Consumer and Client Demand

Evolving customer demand for products, in response to changing expectations on sustainability, feeds through the supply chain in two ways:

- Direct consumer response in the form of changing retail purchasing patterns
- Indirect effect as retailers and distributors change sourcing decisions to respond to - and pre-empt - consumer requirements

Logistics Sector Response

The sector has started to make meaningful changes in its own right, targeting substantial reductions in carbon intensity within its demand envelope.

Major levers of change have been seen as being operational efficiency and new technology; green vehicles such as battery powered vans and hybrid or alternative fuel trucks are increasingly considered, while aerodynamic technologies, such as those supported by the US EPA SmartWay programme, are commonly seen across fleets of all types.

In parallel, most large logistics and transport firms publish annual corporate social responsibility reports, detailing their path towards more sustainable operations. Several of these include detailed carbon footprint information, calculated in line with the Greenhouse Gas Protocol - the mostly widely used accounting tool for emissions.

To maximise the carbon abatement potential from their investments, logistics and transport firms are seeking to engage with both policy makers and shippers to make cohesive changes across the entire supply chain. An end-to-end view of the supply chain is a vital step towards achieving the changed behaviours which can bring about efficient change.

1 *Refer to calculations on page 14*
2 *CEO Climate Policy Report to G8 Leaders, WEF, 2008*
3 *With respect to 1990 level*

Objectives and Approach

Objectives

This report examines opportunities for carbon emissions reduction across supply chains.

We provide a quantitative and segmented outline of the size of carbon emissions across product life cycles.

We articulate potential trends in future demand for global supply chain services, in response to external drivers of change.

We outline and indicatively quantify the main opportunities for decarbonization within end-to-end supply chains.

Finally, we identify specific actions logistics and transport executives can take to most effectively decarbonise supply chains: within their business operations, in collaboration with shippers and through engagement with policy makers.

Approach

There is a clear need to move beyond corporate and geographic barriers in addressing supply chain carbon emissions. Tactical approaches (using specific technologies to meet the needs of a particular situation) and even sectoral approaches (whereby initiatives are implemented within the boundaries of the logistics and transport sector) do not meet the requirement to decarbonise end-to-end supply chains as a whole.

In fact, tactical approaches can serve to shift carbon emissions between different parts of the supply chain, rather than boosting overall efficiency.

We have taken a strategic approach to the end-to-end supply chain, looking at opportunities to address carbon emissions across the product lifecycle. The opportunities we outline are intended to be transformational and, in some cases, are unashamedly ambitious. Nevertheless, we have sought to make the outcomes commercially relevant to supply chain organisations and achievable under current circumstances. We have not, for example, assumed the adoption of any technologies which are not already commercially available.

In the development of the report, we have worked closely with the corporate social responsibility (CSR) and strategy leads of major logistics and transport firms. We have also been assisted by representatives from NGOs, particularly the Carbon Trust and World Business Council for Sustainable Development – for which we are very grateful.

The materials presented in this report are therefore built on two forms of data and analysis. Firstly, we have used data from official sources, particularly OECD, IPCC and government statistics organisations to understand and begin to size specific decarbonization opportunities. Secondly, we have put those opportunities into context, outlining which may be viable, through qualitative research and interviews with colleagues from industry and NGOs.

From an initial outline of around 75 potential topics, we have slimmed this down to 13 opportunities which are of most relevance to the supply chain sector. These have been validated with our key stakeholders and advisors. The nature of the topic means that a very substantial degree of uncertainty and estimation remains, although we have sought to validate our assumptions and estimates at each stage.

Findings

Our high level findings are structured as follows:

- Logistics and Transport Sector Carbon Footprint
- Total Supply Chain Carbon Footprint
- Pressures for a Shift to Decarbonization
- Supply Chain Decarbonization

Logistics and Transport Sector Carbon Footprint

Key findings:

- The logistics and Transport Sector has a carbon footprint of around 2,800 mega-tonnes CO_2e
- Road freight is a major element of this footprint
- Minerals and food transportation are the largest contributors by product category

Using OECD emissions data, combined with GHG Protocol emissions factors and other data points, we have estimated the size of the logistics and transport sector's carbon footprint. Using source data for transport emissions, we excluded passenger transport emissions and then sought to build in emissions from warehouses and sortation facilities.

Overall, we estimate that the logistics and transport sector has a carbon footprint of around 2,800 mega-tonnes. In absolute terms, road freight is the greatest part, at around 57% of the total, with ocean freight some way behind at17%.

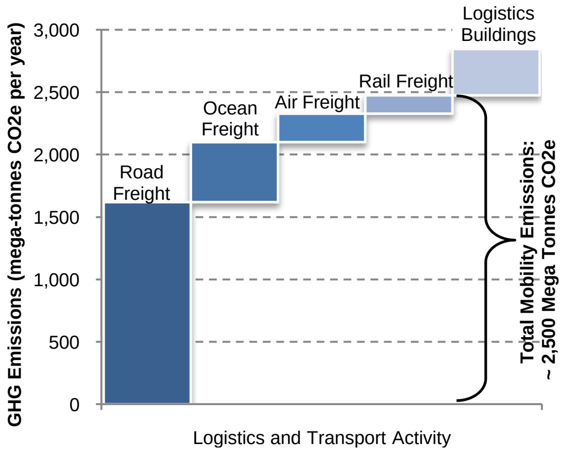


Figure 1: Emissions Share per Logistics Activity

Of course, this does not imply that road transport is the least efficient mode however. Assessed in terms of emissions intensity per tonne-km, air freight is considerably more carbon intensive than road. Overall, the most carbon efficient modes are rail and ocean freight. Carbon intensity of both modes is quoted by UK Defra as being around one sixth of that of road freight – or one hundredth of that of airfreight[4].

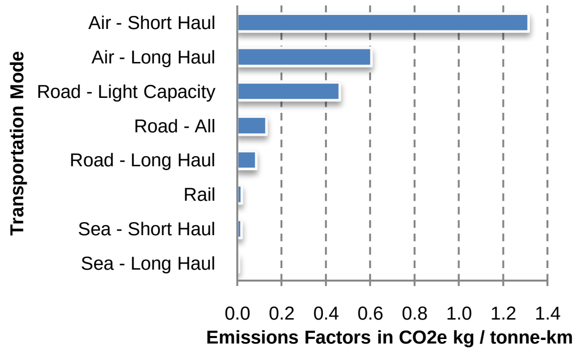


Figure 2: Emission Efficiency per Transport Mode

Eurostat road freight data suggests that across the EU and Norway "crude and manufactured minerals, building materials" make up 17% of all tonne-km moved, with "foodstuff and animal fodder" being a further 16%[5].

In the USA, looking across all modes, coal makes up 17.6% of all ton-miles moved, with cereal grains accounting for a further 8.2% of volumes[6].

Taken together, these calculations allow us to identify the key characteristics of carbon emissions in the freight sector:

- Road freight is the principle contributor to freight transport emissions globally
- Air freight is an highly carbon intensive mode
- Ocean and rail freight are the most carbon efficient modes
- Minerals and food products are major sources of transport emissions

The current trend is for freight transport carbon emissions to grow over coming years. In the OECD countries, freight transport tonne-km grew by an average of 3% per year from 1990 to 2004[7]. The continuing shift to more globalised supply chains, combined with the underlying economic growth is likely to continue – an assumption which is confirmed by the available country-level data after 2004[8].

[4] *Defra emissions factors, April 2008*
[5] *Road Freight Transport by Type of Goods, 2006, Eurostat*
[6] *http://www.bts.gov/programs/freight_transportation/, extracted 9/11/08*
[7] *WEF analysis, using OECD data*
[8] *OECD Environment Data, 2006,2007*

In India, diesel fuel consumption in the transport sector grew by 1.5% per year from 1990 to 2006[9]. In China, the number of tonne-km of freight moved by road increased by a massive 14% per year over the same period[10].

Total Supply Chain Carbon Footprint

Key finding:

- Logistics and transport emissions are 5 to 15% of product lifecycle emissions

There are a number of approaches which look at carbon emissions across the entire supply chain. Methodologies are not yet sufficiently advanced to draw emissions profiles for the entire industry, but we can draw some initial insights.

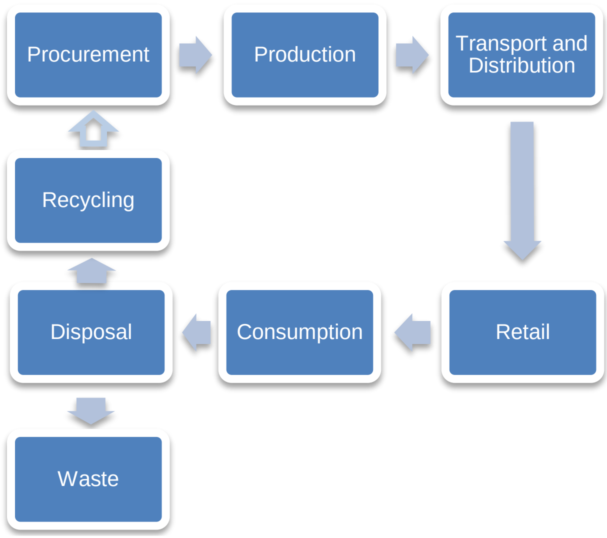


Figure 3: End-to-End Supply Chain Process

Using the product-level carbon emissions calculation methodologies developed by the Carbon Trust, firms have been able to build a meaningful picture of the total product lifecycle emissions of individual products.

An early application of this approach led to the carbon labels on bags of Walkers Crisps[11]. Later projects have looked at other consumer products, including T-shirts, light bulbs, orange juice and potatoes[12]. The number of detailed studies completed at product level remains small. They are, however, likely to prompt more firms to take an initial look at the lifecycle emissions of their products, particularly as major retailers increasingly stipulate carbon reduction targets in their suppliers' contracts.

Economic Input Output Life Cycle Assessment (EIO-LCA) approaches provide an approximate idea of the carbon footprint of more products, with known accuracy limitations. We have used the Carnegie Mellon University Green Design Institute model[13] to look at logistics and transport within the lifecycle emissions of products.

One limitation of the EIO-LCA model is that the use and disposal phases of the product lifecycle are out of scope. Logistics and transport is commonly found to be a 5-15% of the emissions of each product – around 9% for telephone manufacturing and 10% for sugar manufacturing in the following examples.

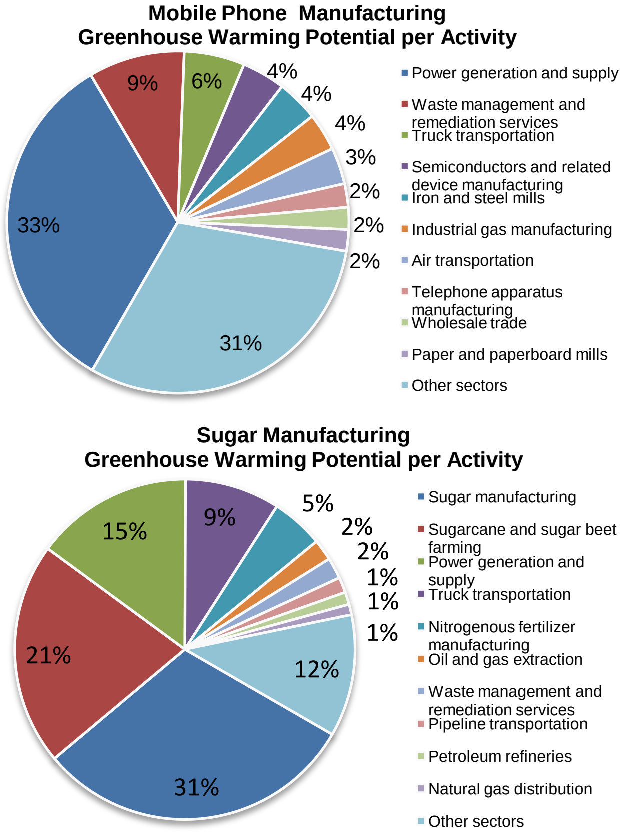


Figure 4: Share of Emission per Product Type

Clearly it is important that the logistics and transport sector works internally to slow and then reverse the rate of growth in its emissions. There is, however, an equally valuable role for the

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[9] *WEF analysis, using Indian Ministry of Petroleum and Gas data*

[10] *WEF analysis, using National Bureau of Statistics of China data*

[11] *http://www.pepsico.co.uk/carbonlabel, extracted 9/11/08*

[12] *http://www.carbon-label.com/product.html, extracted 9/11/08*

[13] *Carnegie Mellon University Green Design Institute. (2008) Economic Input-Output Life Cycle Assessment (EIO-LCA), US 1997 Industry Benchmark model [Internet], Available from :<http://www.eiolca.net> Accessed 12 October, 2008.*

sector to play in enabling emissions reductions in other parts of the product lifecycle.

Pressures for a Shift to Decarbonization

Key findings:
The main commercial determinants of supply chain decarbonization will be:

- Carbon regulation
- Fuel price volatility
- Consumer carbon awareness

Decarbonization pressures from policy makers will not go away during a recession, with the continued development of carbon trading schemes being evidenced. A significant amount of the cost of energy is already tax take for many parts of the supply chain. Further fiscal disincentives to emit carbon – such as limit-based approaches and tariff-based schemes – could introduce markets to address environmental externalities from supply chain activities.

The major precedent has been the introduction of EU ETS to heavily polluting industries in the EU. While the first phase of EU ETS was hit by over-supply, it is expected that this will be addressed in future phases.

EU ETS will be extended to the aviation sector in 2012 and there are some discussions about extension to ocean freight. There is currently little or no discussion about direct extension into the road transportation sector. This is due to pre-existing fuel taxes. However; feed-through effects from changes in manufacturing strategy in energy intensive industries could be expected.

A carbon price applied at the current market rates for EU ETS credits would add a further 5% to 16% to today's prices of crude-based fuels.

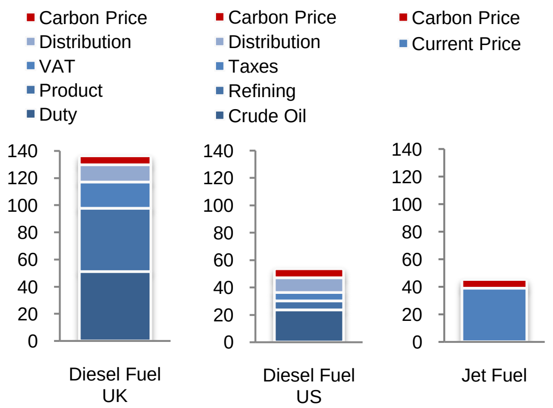


Figure 5: Effect of Potential Carbon Price Addition to Fuel at EU-ETS Market Rates

Reducing fossil fuel consumption in supply chains is the single most important lever to cut carbon emissions. It also substantially reduces operating expenses in a sector where energy purchases can range from 5 to 35% of the total cost base[14].

In the decade from 1991 to 2001, energy markets saw a period of low and stable prices. In the ten years to October 2001, the average price of a barrel of crude was US $ 21. Furthermore, the range from maximum to minimum price was only US $ 27 over the whole period[15].

Implementing decarbonization also reduces business exposure to energy cost volatility, helping to de-risk the cost base. The era of low and stable energy costs ended in 2001, perhaps linked to growing scarcity and uncertainty of supply. Through 2008, businesses experienced the effects of fuel price volatility and exposure. In the two years from October 2006 to October 2008, oil prices averaged US $ 86 / barrel. The lowest spot price of a barrel in that period was US $ 50; the highest was US $ 144 in July 2008[15].

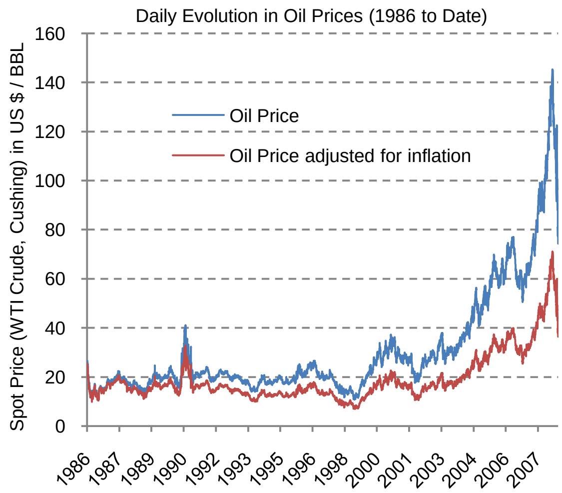


Figure 6: Fuel Price Evolution

Many businesses in the supply chain, both logistics operators and more widely, were seriously impacted when oil prices spiralled up as high as US $144 / barrel in July 2008. Yet others, for example those who hedged at the time of peak prices and were unable to unwind their positions, lost out as prices fell back.

Additional pressure to reduce emissions comes from de facto standards which are not directly legislated. These are driven in large part by NGOs, think tanks and public policy organisations. Attention here is increasingly focussed on the supply chain:

[14] *Accenture analysis*
[15] *Accenture analysis, using US Energy Information Administration data on Cushing, OK spot prices*

- The Carbon Disclosure Project launched a supply chain programme in 2007. Requests for information were sent to over 2,000 firms[16]
- The Greenhouse Gas Protocol created a de facto standard for emissions reporting. Specific supply chain guidance comes from the Logistics and Transport supplement of the Global Reporting Initiative[17]

Recent initiatives have moved towards the calculation of the carbon footprint of a product through its entire lifecycle. Standards here are generally still in development, but the Carbon Trust was instrumental in the October 2008 launch of the PAS 2050 methodology[18], while a similar scheme has been launched in Japan[19]. It seems likely that initial frameworks such as these will form the basis of later ISO standards.

On the demand side, consumers still want to become 'greener', with carbon on top of their minds. 85% of consumers in a recent worldwide survey were either 'extremely' or 'somewhat' concerned by climate change, and 81% thought it would directly impact their lives[20]. And, as Sir Terry Leahy, CEO of Tesco plc, commented, the current economic situation means that "we need to ensure that green products are not luxury items, but can be bought by those on a tight budget"[21], further fuelling pressures to cut both cost and carbon.

In the short term, consumers are hampered in their direct response by the limited availability of information; few products are carbon labelled and there is not yet a global labelling standard.

Consumers instead respond to proxy indicators of carbon emissions, with a degree of inaccuracy. One obvious example has been the dialogue about air miles[22] for supermarket groceries. Consumer awareness campaigns have not, by contrast, focussed on the emissions impact of manufacturing location, though this is likely to have a larger impact on product lifecycle emissions[22].

Nevertheless, consumers have become increasingly carbon-aware: research by the Carbon Trust[23] found that 64% of consumers in the UK are more likely to use a business marketing itself as low-carbon. 67% of consumers in the UK were likely to buy a low-carbon product, and similar trends are seen across much of the EU. In the USA, the data is less compelling, with retailers focussing on price-driven marketing, although the cost-carbon linkage remains relevant[24].

Looking again at analysis from the Carnegie Mellon University's Green Design Institute model, it is evident that the carbon footprint of products varies significantly in dollar value terms. For basic industrial commodities, such as iron and steel, emissions are three to four tonnes of CO_2e per US $ 1,000 of value. For consumer electronics like laptops and phones, the figure is considerably less than half a tonne.

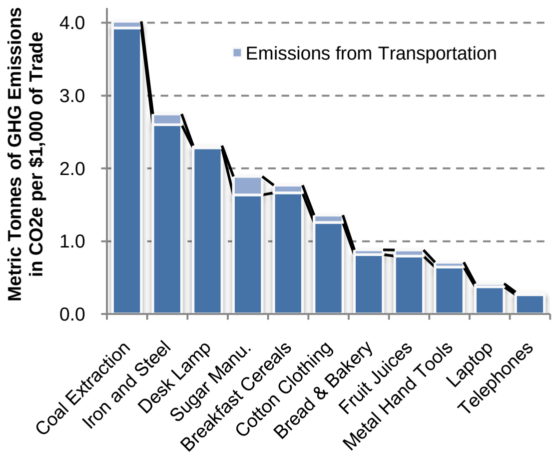


Figure 7: Lifecycle Emissions in Dollar-Value Terms with Transport Highlighted

It is possible that changing consumer awareness around carbon emissions will impact on demand for products in different ways, particularly if carbon calculation and labelling schemes bring footprint information to the fore. The effects of changing consumer demands, combined with a supporting response from the large global retailers, could therefore have a profound effect on supply chains.

Retailers and distributors increasingly see carbon emissions performance as a source of competitive advantage, on the supply side and on the demand side[25]. Carbon management can be a route to lower costs and greater visibility of the cost base. The obligation to reduce emissions will

16 *Carbon Disclosure Project, Supply Chain Brochure 2009*
17 *http://www.globalreporting.org/Reporting Framework/SectorSupplements/LogisticsAnd Transportation/ Dec 2008*
18 *Carbon Trust website, extracted 10/11/08*
19 *AFP, "Japan to label goods' carbon footprints: official", Aug 19, 2008*
20 *Accenture End Consumer Survey on Climate Change, 2007*
21 *Sir Terry Leahy, speech to British Council of Shopping Centres annual conference, 11 Nov 2008*
22 *Review of Food Miles Carbon and African Horticulture: Environmental and Developmental Issues, COLEACP*

23 *Carbon Trust Nov 2006 survey*
24 *Carbon Catalogue Organisation*
25 *Accenture Executive Survey on Climate Change 2008*

be partly borne by the retailer directly, but that responsibility will also pass back up the supply chain.

Already, Wal-Mart has adopted a comprehensive approach to sustainability in its supply chain strategy to realise cost and carbon reduction opportunities across logistics, production and innovation. Through internal initiatives and engagement with its suppliers, the world's largest retailer will make its truck fleet "25 percent more efficient in three years, double in 10 years". It "plans to share [its] innovations throughout the supply chain, which [it] believes will create a ripple effect and magnify these solutions on a global scale"[26].

Supply Chain Decarbonization Framework

In preparing this report, we have worked on a large number of strategic opportunities for supply chain decarbonization. We have identified a set of common characteristics across these opportunities, generating a high-level framework for supply chain decarbonization as a result.

The framework establishes potential for end-to-end supply chain emissions reduction in nine focus areas (Figure 8, page13).

The framework therefore supports businesses seeking to develop more focussed and specific initiatives for decarbonization in supply chains. It outlines the likely target areas for all types of supply chain. It also allows easy development of specific opportunities beneath this, once the emissions in each area have been sized.

Main Opportunities for Decarbonization

Based on the nine-point framework, workshops with the World Economic Forum's members allowed us to identify around 75 individual opportunities which displayed potential to reduce the carbon intensity of supply chains.

In the analysis phase for this report, we have narrowed these down to the top thirteen items which present a real and credible opportunity for cost-effective and attainable decarbonization. These are the thirteen opportunities which are outlined in the scorecards presented on pages 16-28.

Key findings:

- Deploying clean road vehicle technologies, optimising logistics networks and implementing green building programmes all retain significant potential
- Sourcing goods from more efficient production locations can provide carbon abatements which substantially outweigh the additional emissions from more transport
- Nearshoring in many cases is counter-productive in reducing emissions. However, slowing ocean freight vessels in transit would have significant abatement potential
- Increasing recycling and reducing the use of packaging materials provides very meaningful abatement opportunities
- The potential gains from increasing the take-up of home delivery are more limited

[26] *www.walmartstores.com/sustainability, extracted 08-11-08*

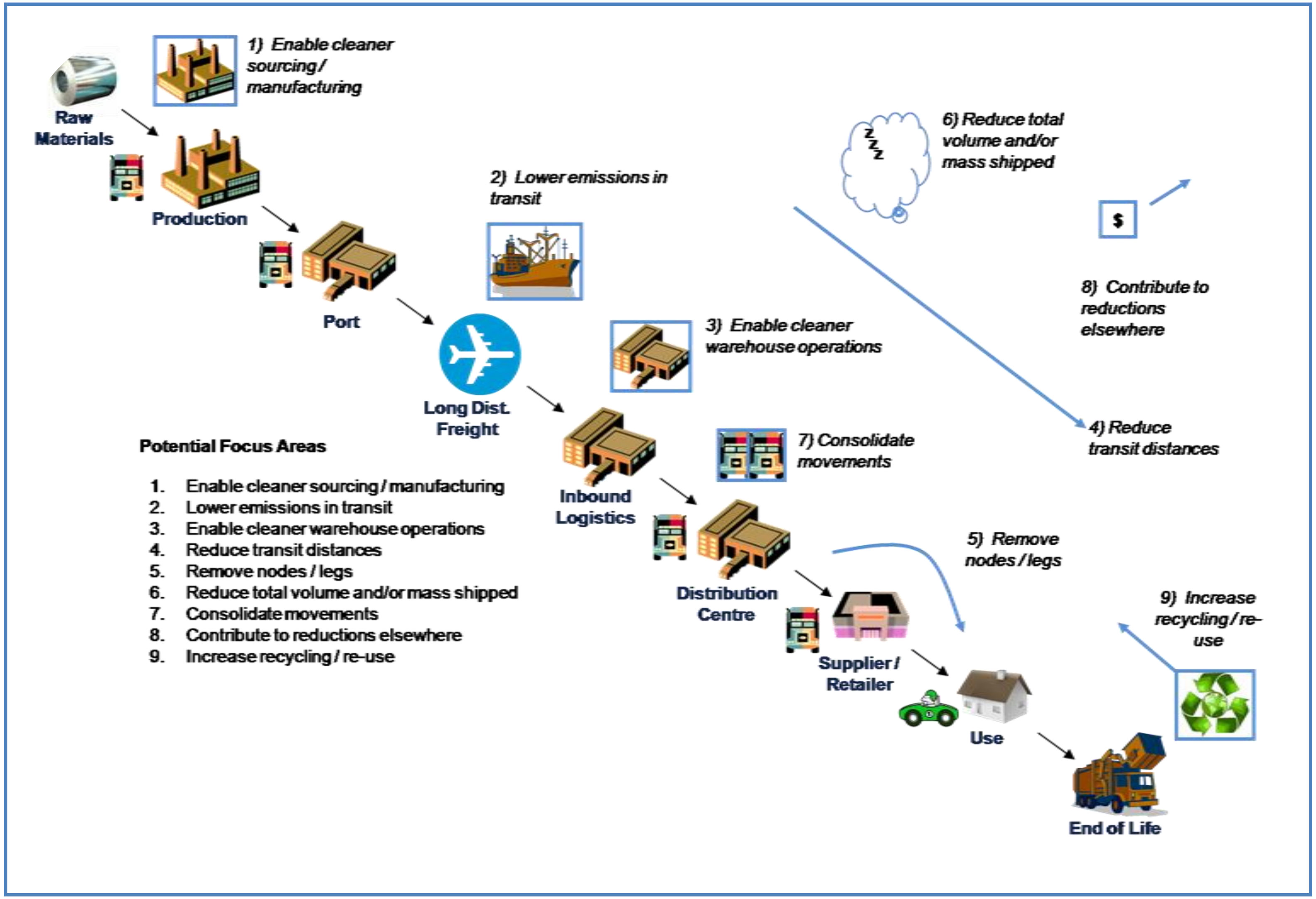


Figure 8: The Nine Focus Areas in Supply Chain for Potential Emissions Reduction

Summary of the Main Opportunities for Decarbonization

Based on the analysis which is shown in the individual Scorecards (pages 16-28), the relative significance of the thirteen supply chain decarbonization opportunities can be plotted, giving consideration to two factors:

- **Emissions abatement potential on the x-axis**: the normalised abatement potential that we have calculated, With respect to the maximum carbon emissions abatement potential from all the opportunities
- **Feasibility on the y-axis**: the indexed, qualitative value that has been placed on the opportunity, considering likely barriers to deployment, and the extent to which the potential to deploy is controlled by the various stakeholders in the supply chain.

The specific value has been determined via a number of workshops with the strategy and CSR leads from the World Economic Forum's Logistics and Transport Industry Partners.

The three opportunities that offer the most potential – in absolute terms – to reduce supply chain carbon emissions within the Logistics and Transport sector are:

Scorecard 1 – Clean Vehicle Technologies
Scorecard 2 – Despeeding the Supply Chain
Scorecard 4 – Optimised Networks

These three opportunities also appear to offer a good balance between carbon abatement potential and the likely feasibility (or ease of implementation) in supply chains.

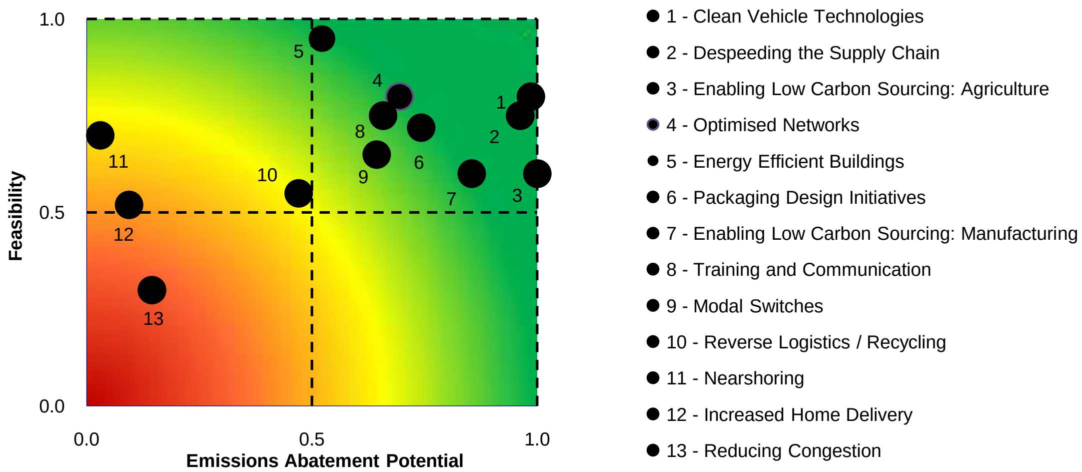


Figure 9: Effectiveness of Each Opportunity

Decarbonization Opportunity	Description	Potential Abatement Mt CO_2e	Assessed Index of Feasibility
Clean Vehicle Technologies	Introduce clean and environmentally efficient technologies	175	0.8
Despeeding the Supply Chain	Decrease transport speed and increase load fill	171	0.8
Enabling Low Carbon Sourcing: Agriculture	Optimise the location of agriculture	178	0.6
Optimised Networks	Improve network planning through transformation projects	124	0.8
Energy Efficient Buildings	Minimise emissions from operating activities	93	0.9
Packaging Design Initiatives	Reduce weight and volume of packaging	132	0.7
Enabling Low Carbon Sourcing: Manufacturing	Optimise manufacturing location	152	0.6
Training and Communication	Provide training to road transport contractors and building operators	117	0.8
Modal Switches	Transfer freight from air and long-haul road freight to ocean, road and rail freight	115	0.7
Reverse Logistics / Recycling	Improve percentage of total supply chain waste which is recycled	84	0.6
Nearshoring	Transfer long-haul air and ocean freight to road and rail freight	5	0.7
Increased Home Delivery	Rely on alternate transport services to deliver goods home	17	0.5
Reducing Congestion	Introduce traffic management techniques	26	0.3

Figure 10: Summary of the Thirteen Opportunities

Overview of the Scorecards

For each decarbonization opportunity presented below, an indicative estimate is given of the carbon abatement potential of that opportunity across the global supply chain.

We have identified carbon reductions which could be reasonably achieved over the medium term, given current technologies and given commercial rates of return on the investments required.

Necessarily, given that the project has deliberately sought to push the current state of knowledge on the topic, there is a degree of estimation and assumption here. Where this has a material impact on the calculations, we have outlined this in detail in the scorecard.

For the purposes of the calculations, the size of the global supply chain is taken 'As-Is', so no assumptions have been made about potential future growth in the sector.

The mechanism of each scorecard is shown below. More details on each calculation and the underlying assumptions can be found in Annex 2.

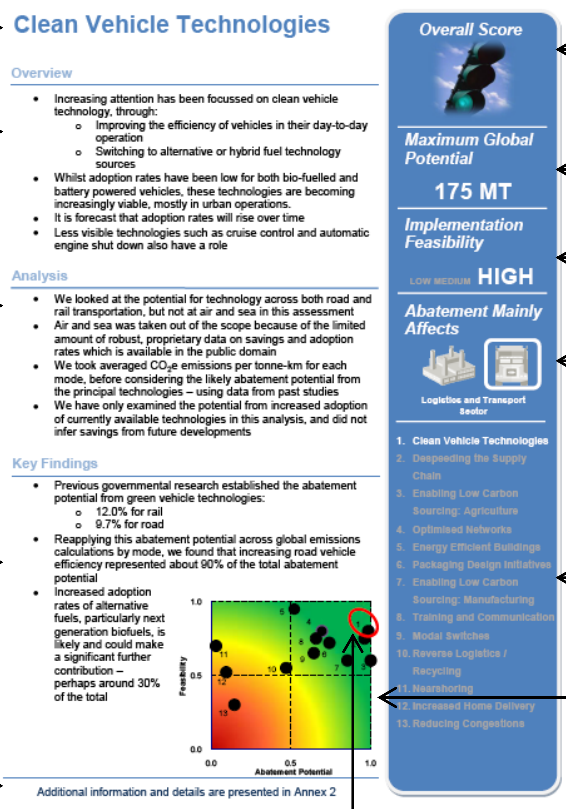
Opportunity Name

Overview
Outlines the specific opportunity and related benefits

Analysis
Giving context on the nature of the opportunity and the likely requirements for successful implementation across supply chains

Key Findings
Based on indicative analysis by the World Economic Forum

Appendix Reference
Links to an appendix containing a full description of the analysis



Overall Opportunity Score
Red / Amber / Green

Maximum Annual Global Abatement Potential as calculated

Implementation Feasibility
Low / Medium / High

Affected Part(s) of the Supply Chain
Logistics and Transport Sector, Wider Supply Chain or End-to-End Supply Chain

List of Opportunities
Opportunity considered in the scorecard is highlighted

Effectiveness Chart
Scoring feasibility against abatement potential

Position of this Opportunity
Circled in red on the chart

Figure 11: Example Scorecard

Clean Vehicle Technologies

Overview

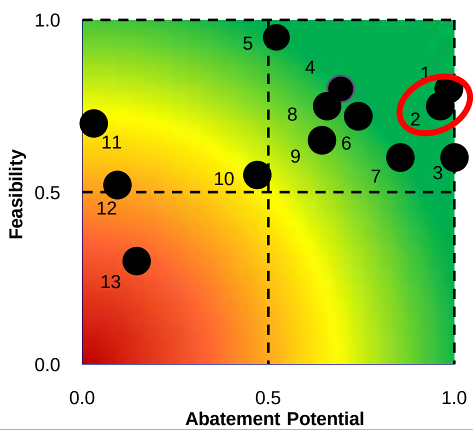
- Increasing attention has been focussed on clean vehicle technology, through:
  - Improving the efficiency of vehicles in their day-to-day operation
  - Switching to alternative or hybrid fuel technology sources
- While adoption rates have been low for both bio-fuelled and battery powered vehicles, these technologies are becoming increasingly viable, mostly in urban operations.
- It is forecast that adoption rates will rise over time
- Less visible technologies such as cruise control and automatic engine shut down also have a role

Analysis

- We looked at the potential for technology across both road and rail transportation, but not at air and sea in this assessment
- Air and sea was taken out of the scope because of the limited amount of robust data on savings and adoption rates which is available in the public domain
- We took averaged CO_2e emissions per tonne-km for each mode, before considering the likely abatement potential from the principal technologies – using data from past studies
- We have only examined the potential from increased adoption of currently available technologies in this analysis, and did not infer savings from future developments

Key Findings

- Previous governmental research established the abatement potential from green vehicle technologies:
  - 12.0% for rail
  - 9.7% for road
- Reapplying this abatement potential across global emissions calculations by mode, we found that increasing road vehicle efficiency represented about 90% of the total abatement potential
- Increased adoption rates of alternative fuels, particularly next generation biofuels, is likely and could make a significant further contribution – perhaps around 30% of the total



Additional information and details are presented in Annex 2

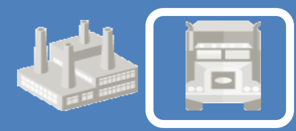
Maximum Global Potential

175 MT

Implementation Feasibility

LOW MEDIUM **HIGH**

Abatement Mainly Affects



Logistics and Transport Sector

1. Clean Vehicle Technologies
2. Despeeding the Supply Chain
3. Enabling Low Carbon Sourcing: Agriculture
4. Optimised Networks
5. Energy Efficient Buildings
6. Packaging Design Initiatives
7. Enabling Low Carbon Sourcing: Manufacturing
8. Training and Communication
9. Modal Switches
10. Reverse Logistics / Recycling
11. Nearshoring
12. Increased Home Delivery
13. Reducing Congestion

Despeeding the Supply Chain

Overview

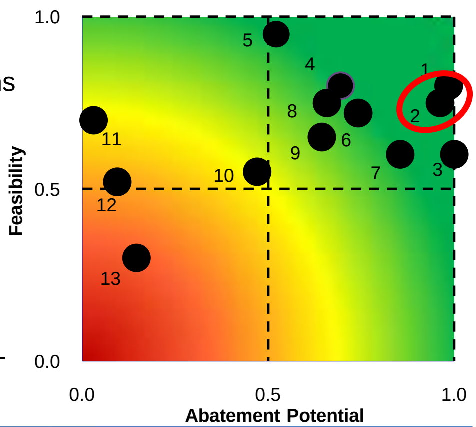
- The high speed of response needed in many supply chain activities means that consumer demand is met effectively, but at a price of increased CO_2e emissions
- Speed in the supply chain is driven by factors such as leadtimes, deadlines and booking windows. This increases emissions – for example through switches to less efficient modes of transport, increases in the number of expedited orders, and increased vehicle and trip speeds
- It is thought that easing leadtimes and delivery stipulations could lead to emissions abatements through ‘despeeding’

Analysis

- We have analysed three different sources of potential abatement forms:
  - Slower road vehicle speed
  - Slower ship speed
  - Potential loadfill improvement with increased time windows
- We looked at the typical savings which have been achieved by firms in slowing down their vehicles – such as Con-Way’s speed reduction from 65 mph to 62 mph in the USA[27]
- We also looked at a similar scenario for ocean freight – where a linear decrease in ship speed brings about a square decrease in carbon emissions
- We calculated the abatement potential from each of the three effects, before combining to give the total opportunity potential

Key Findings

- The single biggest opportunity within this calculation is to reduce the speed at which ships travel as a result of the squared relationship between speed and emissions
- Reducing road vehicle speeds is also a highly effective way to reduce carbon emissions while having only a small impact on operations
- Making reductions in emissions through loadfill improvement is more difficult – the magnitude of any abatement is smaller, partly because emissions rise slightly with the associated increase in vehicle weight



[27] www.con-way.com

Additional information and details are presented in Annex 2

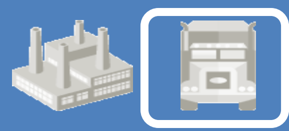
Maximum Global Potential

171 MT

Implementation Feasibility

LOW MEDIUM **HIGH**

Abatement Mainly Affects



Logistics and Transport Sector

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13. Reducing Congestion

Enabling Low Carbon Production:

Through changes in agricultural sourcing

Overview

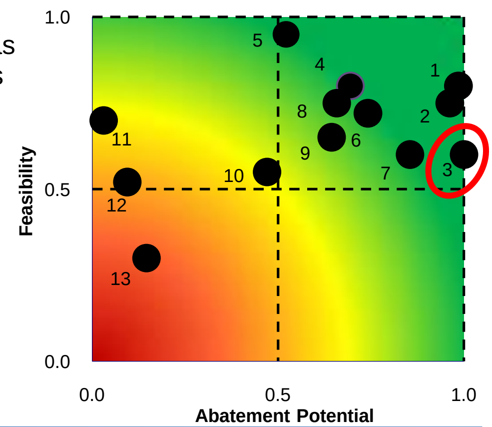
- A number of studies have shown that significant benefits can come from switching production to more carbon efficient sources
- Raw materials represent a large part of the lifecycle carbon footprint of virtually all manufactured products
- These studies have focused primarily on agriculture – for example, Cranfield University examined the impact of different sourcing locations for roses, while Lincoln University made a similar study for lamb
- Key contributors to emissions density are the intensity of agricultural systems and the efficiency of production, driving potential to reduce emissions through changed sourcing location

Analysis

- We have analysed the high-level potential for emissions abatement from:
  - Indicative savings in agricultural sourcing
  - Indicative savings in energy consumption associated with primary production
- The analysis has been based on an assessment of past studies on the topic, then reapplied to calculated agricultural and energy emissions
- These have then been factored down to consider only the portion of production which is traded internationally – i.e. that which could be enabled by the logistics and transport sector in a more limit-based environment
- Finally, the output has been adjusted to assess only the amount of trade which may be able to shift sourcing location

Key Findings

- The ability to switch sourcing locations in agriculture is perceived to be considerably higher than for other primary production
- Analysis of past studies showed that, in individual situations, the savings in agriculture can be significant – averaged across all studies, the typical potential abatement was 61% of As-Is emissions
- Conversely, a relatively low portion of primary production is traded globally, probably around 40%
- Overall, it was estimated that only approximately 10% of agricultural production could be shifted



Additional information and details are presented in Annex 2

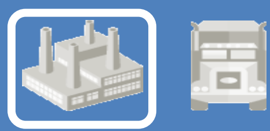
Maximum Global Potential

178 MT

Implementation Feasibility

LOW **MEDIUM** HIGH

Abatement Mainly Affects



Wider Supply Chain

1. Clean Vehicle Technologies
2. Despeeding the Supply Chain
3. **Enabling Low Carbon Sourcing: Agriculture**
4. Optimised Networks
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7. Enabling Low Carbon Sourcing: Manufacturing
8. Training and Communication
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11. Nearshoring
12. Increased Home Delivery
13. Reducing Congestion

Optimised Networks

Overview

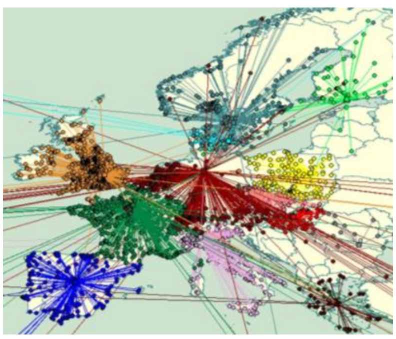
- In network logistics, optimising the network's nodal points, hierarchy and inter-related transport flows can bring significant reductions in both cost and carbon
- Research has shown that many networks remain at least partially inefficient as a result of both inertia to change and lack of durability in supply chain strategy decisions
- Typical studies show that in As-Is networks, restructuring the network gave both an 11% cost reduction and a 10% CO_2e emission abatement[28].

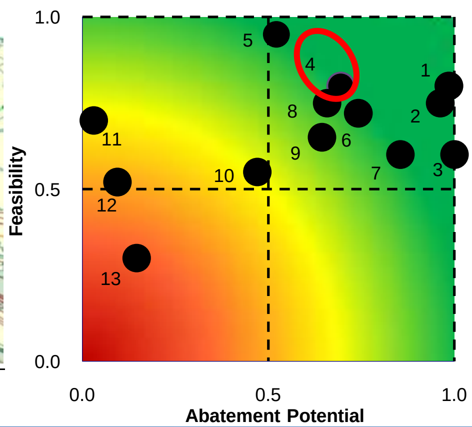
Analysis

- We looked at the extension of that principle across the wider supply chain
- Assessing the high-level potential from network optimisation, we estimated potential flexibility within the:
  - Distribution hierarchy
  - Nodal structure
  - Optimisation of planning decisions
- We studied the typical savings achieved in past transformational projects, before reapplying these savings to relevant sub-sectors of the road transport industry
- The output here is the potential average abatement available from network optimisation at a global, total supply chain level

Key Findings

- Significant abatement through transport network efficiency is still achievable, for example:
  - 24% of goods vehicle kms in the EU are running empty
  - When carrying a load, vehicles are typically only 57% loaded as a percentage of maximum gross weight
- Overall the total abatement potential across the sector globally could be 124 mega-tonnes of CO_2e per year
- Of this, around 30% may be due to the potential to improve economic transaction sizes in freight movements





[28] *Accenture internal research*

Additional information and details are presented in Annex 2

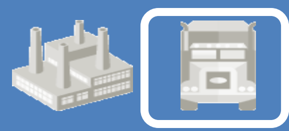
Maximum Global Potential

124 MT

Implementation Feasibility

LOW MEDIUM **HIGH**

Abatement Mainly Affects



Logistics and Transport Sector

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13. Reducing Congestion

Energy Efficient Buildings

Overview

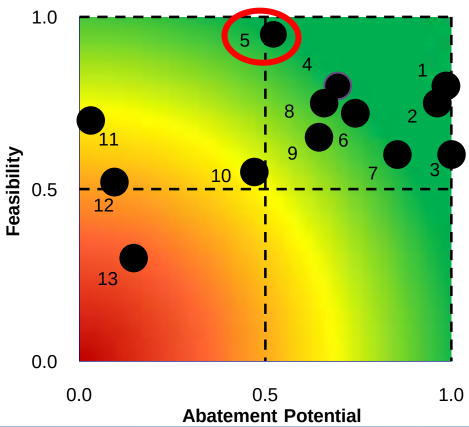
- Energy efficient improvements can be found from:
  - Improved specification of new buildings
  - Making incremental improvements to old facilities
- Significant cost and carbon savings can be made in three principal ways:
  - Through behavioural change (considered separately within Scorecard 8, page 23)
  - Implementing more efficient point technologies, such as new lighting or cooling systems
  - Integrating systems together more effectively, to allow them to collaborate better, and prevent solutions working against each other
- Local energy sourcing can also be a consideration for energy efficient buildings, with the inclusion of energy green sources such as an on-site wind turbine or solar panels

Analysis

- Overall, buildings are calculated to make up approximately 13% of the freight sector's carbon emissions – or around 371 mega-tonnes of CO_2e emissions per year
- By finding average savings across a number of green buildings projects from the public domain, we were able to calculate a high level potential abatement figure across the sector

Key Findings

- Across several studies, green building technologies typically deliver savings in the region of 10% to 15% of energy consumption
- Additional savings are achievable with the inclusion of integrated building management systems – which in their own right have delivered further, similar magnitude savings
- The potential savings from retro-fits are larger than from up-scaling the technologies used in new builds



Additional information and details are presented in Annex 2

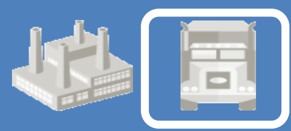
Maximum Global Potential

93 MT

Implementation Feasibility

LOW MEDIUM **HIGH**

Abatement Mainly Affects



Logistics and Transport Sector

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Packaging Design Initiatives

Overview

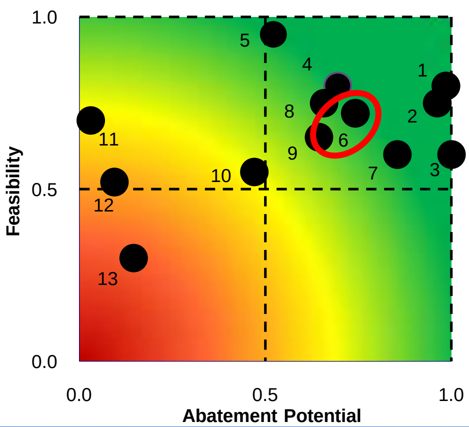
- Sustainable packaging initiatives can make a substantial contribution to carbon abatement across the supply chain
- Packaging initiatives can consider either transit or consumer packaging and should assess the carbon impact of packaging through the entire supply chain
- Techniques such as packaging elimination, light-weighting and the selection of alternative materials are already used by leading firms – in this analysis, we have assessed the potential for further deployment of these techniques

Analysis

- Our initial analysis assesses the total volume of consumer packaging estimated to be linked to consumer goods logistics globally
- We then used figures taken from packaging initiatives such as the Courtauld Commitment to project the size of savings which may be available across the sector
- These potential savings are converted into a carbon abatement potential, in just the production and distribution phases of the product lifecycle
- The waste management potential from less packaging is considered separately in Scorecard 10 on page 25

Key Findings

- There are a variety of estimates available on the weight of consumer packaging, which is typically put at around 5% of the total weight of consumer goods shipments
- The carbon abatement of eliminating packaging is significant in the production phase of the lifecycle – at up to 125 mega-tonnes of CO_2e per year
- Savings in distribution are considerably smaller, in the region of 3 mega-tonnes per year



Additional information and details are presented in Annex 2

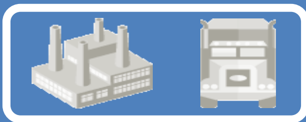
Maximum Global Potential

132 MT

Implementation Feasibility

LOW **MEDIUM** HIGH

Abatement Mainly Affects



End to End Supply Chain

1. Clean Vehicle Technologies
2. Despeeding the Supply Chain
3. Enabling Low Carbon Sourcing: Agriculture
4. Optimised Networks
5. Energy Efficient Buildings
6. **Packaging Design Initiatives**
7. Enabling Low Carbon Sourcing: Manufacturing
8. Training and Communication
9. Modal Switches
10. Reverse Logistics / Recycling
11. Nearshoring
12. Increased Home Delivery
13. Reducing Congestion

Enabling Low Carbon Production:

Through changes in manufacturing sourcing

Overview

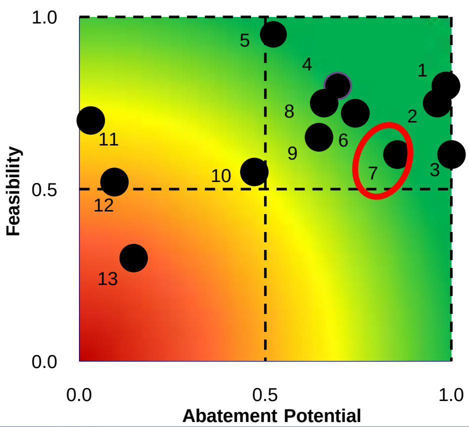
- In lifecycle assessments, the contribution of manufacturing can be around 25% of total emissions, with energy consumption in the manufacturing phases playing a significant role
- Reductions in manufacturing emissions are envisaged to come from two different sources in this analysis:
  - Achieving economies of scale in production
  - Switching to lower carbon energy sources

Analysis

- Based on the IPCC Fourth Synthesis Report emissions for manufacturing, we have assessed the potential abatement from:
  - Optimising manufacturing processes
  - Selecting less carbon intensive energy sources
- We have then adjusted these calculations to take into account:
  - Only the elements of manufactures which are traded globally
  - The limitations of contractual terms and the likely available potential for relocation
- This gives the maximum abatement potential that is reported in this scenario

Key Findings

- The carbon intensity of manufacturing changes significantly across geographies
- the carbon intensity of power generation also changes significantly with geographies: emissions intensity in China is around 175% that of the EU average carbon intensity
- Reviewing a series of factory merger studies, the average cost saving through efficiency was around 11% – which we assessed as being broadly indicative of a CO_2e emission reduction
- Around 70% of total manufactures are traded internationally, creating theoretical potential for these volumes to be switched alternatives sources
- We anticipate that difficulties in achieving change could come from the inertia effects of asset life, contractors' obligations and government policies



Additional information and details are presented in Annex 2

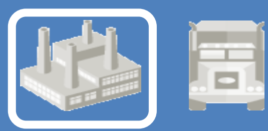
Maximum Global Potential

152 MT

Implementation Feasibility

LOW **MEDIUM** HIGH

Abatement Mainly Affects



Wider Supply Chain

1. Clean Vehicle Technologies
2. Despeeding the Supply Chain
3. Enabling Low Carbon Sourcing: Agriculture
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6. Packaging Design Initiatives
7. **Enabling Low Carbon Sourcing: Manufacturing**
8. Training and Communication
9. Modal Switches
10. Reverse Logistics / Recycling
11. Nearshoring
12. Increased Home Delivery
13. Reducing Congestion

Training and Communication Programmes

Overview

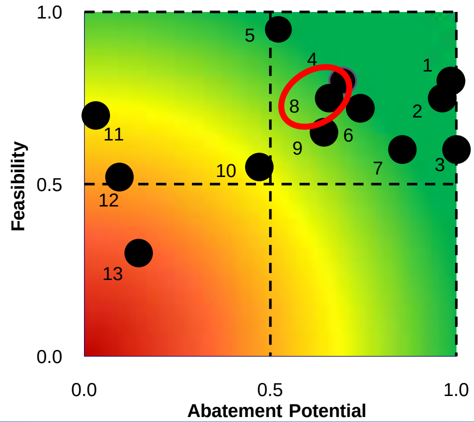
- Increasing attention is being focussed on the behavioural aspects of managing climate change, both for demand side (consumer) activity and supply side (supplier) actions
- In the logistics and transport sector, attention to date has largely focussed on the fuel savings achievable through driver training programs, helped in part by the significance of fuel in the transport cost base, and legislative activities such as the introduction in the EU of mandatory driver training
- There is a wider potential for emissions abatement from training and communication programmes

Analysis

- We have looked at the theoretical potential which comes from training and communication programmes in two areas:
  - Road freight emissions from fuel use
  - Building emissions from energy use
- Due to the limited public research currently available on the subject, we have not looked at the effect in other modes
- However, there may be additional abatement potential in these areas – for example from a switch to continuous descent approach in aviation or changed acceleration and deceleration patterns in rail
- We quantified the total emissions for road freight and warehouse / sortation facilities
- We then considered the typical reported savings from training and communication programmes, before reapplying these to the addressable part of the carbon emissions build-up

Key Findings

- Looking across a number of studies, we found that driver training programmes achieve an average of 9% fuel economy improvement, with smaller savings coming from behavioural building efficiency programmes
- The larger footprint of road emissions relative to buildings means that 95% of the total calculated abatement potential comes from road freight
- Many articles refer to the tail-off of savings in the period after training and communication activities, which is where reinforcing technologies probably have an important role to play



Additional information and details are presented in Annex 2

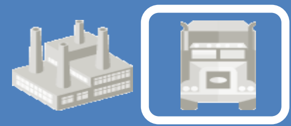
Maximum Global Potential

117 MT

Implementation Feasibility

LOW **MEDIUM** HIGH

Abatement Mainly Affects



Logistics and Transport Sector

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Modal Switches

Overview

- Significant differences exist in CO_2e emissions between different freight transport modes when expressed in terms of emissions per tonne-km shipped
- UK Defra data suggests that shipping emissions are in the region of 1% to 2% of those of airfreight per tonne-km, when comparing long haul air to ocean freight container vessels
- Where absolute emissions from the less efficient modes are significant, switching small volumes of freight in percentage terms to another mode may have a significant impact on emissions

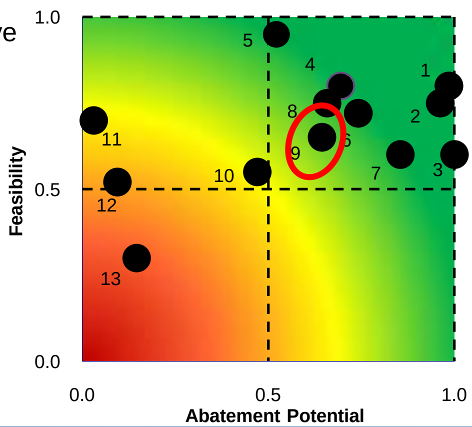
Analysis

- Our initial analysis suggested that three mode switches were worth detailed investigation:
  - Intercontinental air to ocean freight
  - Short haul air to road transport
  - Long distance road freight to rail or waterways
- We discounted other mode switches as being less practical or of significantly lower abatement potential
- For each potential switch, we used a variety of WTO, Eurostat and USA Department of Transportation data to calculate:
  - **Total As-Is Emissions** from the existing modal split
  - **Switchable Emissions** which could realistically be moved to a different mode
  - **Maximum Abatement Potential** that can be achieved

Key Findings

Mode Switch / Emissions [Mt CO_2e]	Total As-Is	Switchable	Abatement Potential
Long Haul Air to Sea Freight	54	10	10
Short Haul Air to Road Freight	95	18	17
Long Haul Road Freight to Rail or Water	340	114	87

- Overall, the largest abatement potential comes from switching long haul road transportation to rail or waterways
- There is an additional benefit from switching out of air freight, although the savings may be harder to achieve and are of a much smaller scale
- The key criteria may therefore be to improve the competitiveness of the modal alternatives to road freight – for example by adding rail spurs, or decongesting long-haul rail flows



Additional information and details are presented in Annex 2

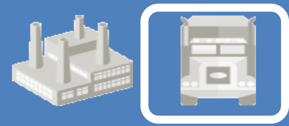
Maximum Global Potential

115 MT

Implementation Feasibility

LOW **MEDIUM** HIGH

Abatement Mainly Affects



Logistics and Transport Sector

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5. Energy Efficient Buildings
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7. Enabling Low Carbon Sourcing: Manufacturing
8. Training and Communication
9. **Modal Switches**
10. Reverse Logistics / Recycling
11. Nearshoring
12. Increased Home Delivery
13. Reducing Congestion

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COMMITTED TO IMPROVING THE STATE OF THE WORLD

Reverse Logistics / Recycling

Overview

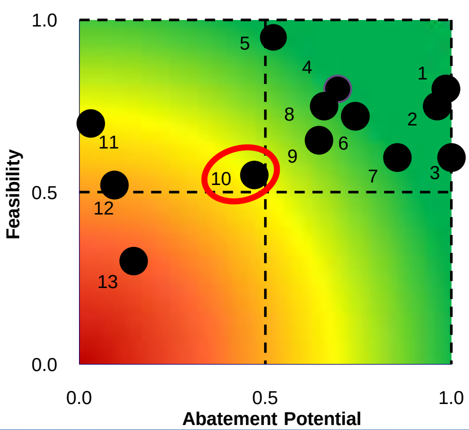
- There is potential to address CO_2e emissions through increases in the take-up of recycling and reverse logistics activities
- These operations divert volume from waste, addressing landfill and incineration carbon emissions
- They also reduce the resource requirement – and therefore associated carbon emissions – from raw material extraction and processing activities
- For nearly all types of waste, recycling operations are more carbon efficient than virgin material procurement and waste disposal operations

Analysis

- Given that the amount of waste recycled globally is highly variable by geography – for example ranging from 10% to 60% just across the EU – there is a significant opportunity in some geographies to promote the growth of recycling solutions
- We have built a dataset which supports modelling of different recycling and reuse combinations for various waste streams
- This allows consideration of the impact of different:
  - Waste processing options, such as landfill compared to incineration
  - Types of waste, for example metals, plastics, papers
  - Recycling and reuse scenarios
- We assessed the amount of carbon abatement achieved with current recycling rates then calculated the abatement potential which would result from all countries moving to best-in-class recycling rates
- This gives an assessment of the global potential from increased waste diversion

Key Findings

- Waste volumes grow in parallel to GDP, suggesting that the opportunities for emissions abatement and associated business revenues will both grow over time
- Materials with the largest environmental benefit from recycling are aluminium, steel and other metals, along with some plastics and paper products
- Overall, the abatement potential from raising recycling rates globally to the best-in-class level is equivalent to around 84 mega-tonnes of CO_2e per annum.



Additional information and details are presented in Annex 2

Maximum Global Potential

84 MT

Implementation Feasibility

LOW **MEDIUM** HIGH

Abatement Mainly Affects

Wider Supply Chain

1. Clean Vehicle Technologies
2. Despeeding the Supply Chain
3. Enabling Low Carbon Sourcing: Agriculture
4. Optimised Networks
5. Energy Efficient Buildings
6. Packaging Design Initiatives
7. Enabling Low Carbon Sourcing: Manufacturing
8. Training and Communication
9. Modal Switches
10. **Reverse Logistics / Recycling**
11. Nearshoring
12. Increased Home Delivery
13. Reducing Congestion

Nearshoring

Overview

- The era of cheap transport and wage arbitrage potential resulted in a large swing to low cost country sourcing
- With rising volatility in fuel prices – plus other effects such as the growing need for flexibility in supply chains – nearshoring may be both a cost-efficient and carbon- friendly choice in manufacturing location decisions
- Discussions across the literature have focused on switches to Mexico for the US and Canadian market, and to Eastern Europe for high tech manufacturing for the European market

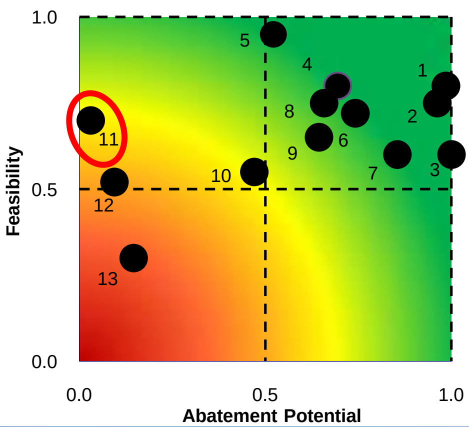
Analysis

- Our assessment looked at the impact of reducing long haul freight volumes by replacing it with shorter nearshore flows
- In our calculations, we used current modal splits for both the long haul freight removed and the short haul freight added
- We used current emissions factor data per tonne-km, assuming no future changes from efficiencies or technologies
- For the long haul volumes removed, only types of freight which could be readily re-directed were considered – for example, raw material shipments from other geographies were not used
- We then reapplied the 'switchable' volume into a new model, which used the As-Is modal split and current average journey lengths for the relevant parts of the EU and USA freight markets

Mode	Abatement from mode switch [Mt]	New emissions from alternative modes [Mt]	Net Abatement [Mt]
Sea	37	-50.2	-13.4
Air	19	-0.3	18.7

Key Findings

- While significant reductions in tonne-km volumes are seen with nearshoring, the impact on emissions remains small
- This is due to the relative carbon inefficiency of road and rail transportation when compared to ocean freight
- The average flow length could fall from over 5,000 km to around 700 km but with an emissions reduction of only approximately 5 mega-tonnes CO_2e
- Considering the effect of switching air freight – and assuming that 25% of volumes may be able to switch their sourcing locations – there may be significant saving in the specific relocation of manufacturing facilities which require fast or expedited orders
- This nearshoring of airfreight opportunity creates savings of around 20 mega-tonnes of CO_2e



Additional information and details are presented in Annex 2

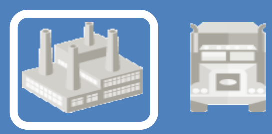
Maximum Global Potential

5 MT

Implementation Feasibility

LOW **MEDIUM** HIGH

Abatement Mainly Affects



Wider Supply Chain

1. Clean Vehicle Technologies
2. Despeeding the Supply Chain
3. Enabling Low Carbon Sourcing: Agriculture
4. Optimised Networks
5. Energy Efficient Buildings
6. Packaging Design Initiatives
7. Enabling Low Carbon Sourcing: Manufacturing
8. Training and Communication
9. Modal Switches
10. Reverse Logistics / Recycling
11. **Nearshoring**
12. Increased Home Delivery
13. Reducing Congestion

Increased Home Delivery

Overview

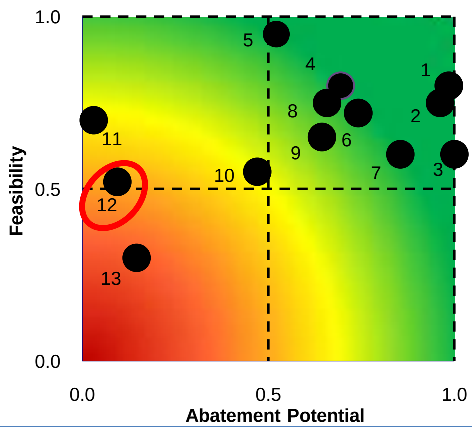
- It is perceived to be more efficient in many cases for retailers to deliver purchases to consumers' homes than to have consumers drive to stores to make purchases
- Home delivery was boosted in certain segments of the retail market in western economies in recent years by the emergence of the internet retail channel
- There remains significant potential in the market for growth, with market volumes growing by around 20% per annum in several Western economies

Analysis

- We have modelled the impact of more home delivery on carbon emissions in selected Western economies
- We were able to use existing studies to establish the number of shipping trips that may be eliminated and the number of additional delivery trips created
- Key considerations have been the relative efficiency of delivery vehicles, the number of drops achieved and some of the direct behavioural implications for consumer activity
- We have not considered indirect consumer behavioural effects in this analysis, such as substitution of shopping time with more leisure activities which emits carbon

Key Findings

- The number of shopping trips and number of kilometres travelled per year by consumers is significant – on average 50 trips per shopper per year, with around 126 billion vehicle km of travel covered for shopping among the larger economies
- In our analysis, home delivery is shown to be around four times more efficient in carbon emissions terms, assuming that the home delivery service is able to eliminate the travel journey entirely
- Although the absolute savings (in global emission terms) may be relatively small here, it is likely that there may be significant commercial opportunities for firms in new service offerings



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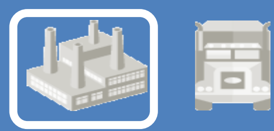
Maximum Global Potential

13 MT

Implementation Feasibility

LOW **MEDIUM** HIGH

Abatement Mainly Affects



Wider Supply Chain

1. Clean Vehicle Technologies
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11. Nearshoring
12. **Increased Home Delivery**
13. Reducing Congestion

Reducing Congestion

Overview

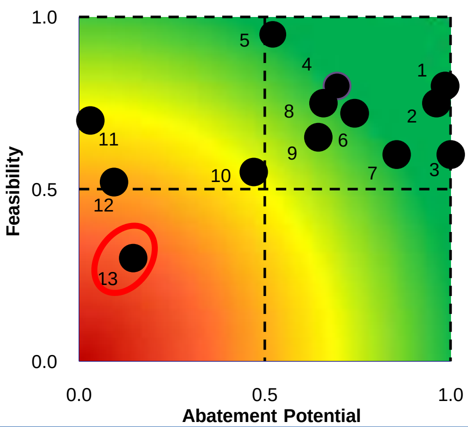
- Transport congestion across all modes has grown in most economies, as a result of traffic volume growth outstripping the supply of new infrastructure
- The cost and carbon impact is significant in road transport:
  - 6% is added to the EU road transport fuel bill by traffic congestion (Eurostat)
  - In the USA, the 1.5% of fuel purchases which are burnt in traffic jams equates to 2.4m gallons of fuel per year (US Bureau of transportation statistics)
- Bottlenecks also cause congestion in other modes, including air and rail:
  - 35% of European flights arrive more than fifteen minutes late due to congestion
  - Up to 20% of freight trains in the USA are delayed arriving at their destination

Analysis

- Congestion is believed to cause increased emissions in two ways:
  - Directly through increased emissions per km when vehicles are not moving at efficient speeds
  - Indirectly through increases in the number of expedited orders and through re-routing of vehicles
- Our analysis focussed on the total amount of road freight carbon emissions which may be associated with congestion
- Based on previous studies, we then approximately identified the global potential from implementing successful congestion reduction strategies such as demand management system

Key Findings

- It is easier to quantify the carbon impacts of congestion in road transport than other modes due to greater data availability
- Illustratively, a 6% fuel bill due to congestion would equate to the global emissions of 90 to 100 mega-tonnes of CO_2e per year
- The savings achieved through demand management schemes are variable – however they may be up to 20 to 25% with congestion charging
- The total abatement potential from reducing congestion could be in the region of 25 Mt of CO_2e per year



Additional information and details are presented in Annex 2

Maximum Global Potential

26 MT

Implementation Feasibility

LOW MEDIUM HIGH

Abatement Mainly Affects

Logistics and Transport Sector

1. Clean Vehicle Technologies
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4. Optimised Networks
5. Energy Efficient Buildings
6. Packaging Design Initiatives
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Recommendations

To successfully decarbonise global supply chains, co-ordinated action is required.

Past tactical or sectoral initiatives have been successful in raising the profile of the carbon emissions challenge and in beginning to foster small-scale actions. However, they have not been successful in reversing the trend towards supply chain emissions growth.

We see carbon abatement remaining relevant in a downturn – and possibly even being more desirable. As much of managing carbon emissions is about reducing energy consumption, supply chain decarbonization often brings with it economic benefits. This makes now the time for the foremost companies to work together to bring about change.

To achieve the substantive change necessary, three main groups must collaborate across geographies and organisations:

- Logistics and transportation providers
- Shippers and buyers
- Policy makers, both governmental and non-governmental

We hope that the recommendations from this review can lay the groundwork for meaningful dialogue between industry, customers and policy makers.

Logistics and Transportation Providers

We see three key responsibilities and opportunities for logistics and transport businesses:

- Reduce emissions using internal solutions
- Encourage external shippers and buyers to change their behaviour
- Actively engage policy makers

Our specific recommendations for the internal actions the logistics and transport sector can take are:

- **Clean vehicles**
  - Speed up the industry wide adoption of new technologies, fuels and associated processes by implementing where there is a positive business case
- **Optimise networks**
  - Deploy network reviews of large ‘closed’ networks to ensure efficient hierarchies and nodal structures
  - Seek to integrate optimisation efforts across multiple networks, for example integrating own and customers’ networks into one model
- **Mode switches**
  - Work on mode switches within own networks where possible, for example in the large ‘closed’ networks operated by postal operators, parcel carriers and pallet networks
- **Co-loading**
  - Enable further collaboration between multiple shippers and/or between carriers to make greater use of co-loading opportunities
- **Green buildings**
  - Encourage wider industry commitment to improve existing facilities through the retro-fitting of green technologies, via individual and/or sector-wide actions
  - Work towards industry-wide commitments to boost investment into new building technologies
- **Training and employee engagement**
  - Set budgets for sustainability training and engagement programmes across the organisation
- **Recycling and waste management**
  - Develop new offerings around recycling and waste management, working collaboratively with customers
- **Home delivery**
  - Develop new home delivery offerings, working collaboratively with customers
- **Carbon offsetting**
  - Develop carbon offsetting solutions for own operations and clients as part of a balance suite of business offerings

Shippers and Buyers

By determining the source of supply, delivery location and many supply chain characteristics for products, shippers and buyers of products 'lock in' much of the carbon emissions associated with supply chains. They determine how much carbon is designed into a product through raw material selection, the carbon intensity of the production process, the length and speed of the supply chain, and (at least partly) the carbon characteristics of the use phase.

Shippers and buyers can take decisions which actively drive positive change up and down the supply chain. For example, if a large retailer changes its buying requirements, its suppliers' supply chains are amended accordingly.

Our specific recommendations are that logistics and transport businesses engage shippers and buyers of products in conversations that support improvements in:

- **Product and packaging design**
    - Agree additional standards and targets around packaging light weighting and elimination
    - Seek cross-industry agreements on modularisation of transit packaging materials
- **Low carbon sourcing**
    - Develop sustainable sourcing policies that consider the carbon impact of primary production, manufacturing and rework activities
- **Tactical nearshoring opportunities**
    - Integrate carbon emissions impact into the business case for nearshoring projects
- **Mode switches**
    - Support efforts to make mode switches across supply chains
    - Begin to despeed the supply chain, allowing economic order quantities to rise and delivery frequencies to fall
- **Carrier incentivisation**
    - Build environmental performance indicators into the contracting process, particularly around carbon emissions
- **Consumer incentivisation**
    - Support better understanding of carbon footprints & labelling where appropriate
    - Work with consumers to make recycling easier and more resource efficient
- **Technologies and techniques to help synchronise supply chains**
    - Encourage collaboration amongst shippers and carriers
    - Invest in data exchanges to increase visibility of co-loading and other collaboration opportunities

Policy Makers

Policy makers have a key role to play in decarbonising supply chains. Substantial intervention by international regulatory bodies, governments and de facto policy making authorities is necessary to support the emissions reduction required across the sector. The policy interventions we envisage will further reduce the extent to which carbon is an externality across supply chains and will create supportive environments to help businesses deal with the scale of change required.

Our specific recommendations for policy makers are:

- **Energy pricing**
    - Ensure that the full cost of carbon is reflected in energy tariffs across all geographies and all modes of transport
- **Carbon reporting**
    - Work with the logistics and transport sector to develop universal carbon measurement and reporting standards
- **Carbon trading**
    - Build an open carbon trading system
    - Review tax regimes to remove counter-productive incentives
- **Congestion**
    - Promote further expansion of integrated flow management schemes for congested roads
    - Make specific, point investments in congested nodes or sections of infrastructure – around congested road junctions, ports and rail junctions
- **Capacity expansion**
    - Actively promote mode switches to rail, short sea and inland waterways
    - Consider re-opening idle rail

lines, waterways and port facilities with government support

- **Carbon labelling**
  - Support efforts to move towards further carbon labelling
- **Recycling and waste management**
  - Address anomalies in incentivisation around recycling – monetarising the potential environmental benefits from recycling
- **Green buildings**
  - Encourage industry to commit to improvements, which consider the boundaries of possibilities with current and future technologies, through individual and sector-wide actions

Conclusions

Through this research, we have identified that legislative and commercial imperatives will continue to support the case for supply chain decarbonization.

Legal and de facto standards, energy cost volatility and evolving consumer expectations created the circumstances for the logistics and transport sector's initial response – and make now the time to move towards more strategic responses.

The types of responses required often transcend firms, sectors and geographical boundaries. Of the three top opportunities for supply chain decarbonization identified, two can only be achieved with a truly multi-sectoral response. The third, speeding up adoption rates of green vehicle technologies, would be greatly benefited by supporting action from policy makers to aid implementation.

We have therefore recommended that three groups (logistics and transport providers, shippers, policy makers) collaborate to achieve decarbonization.

Annexes

Annex 1: Definition of Key Terms

CO_2e
Expression of greenhouse gas emissions in comparative units of carbon dioxide emissions, calculated by multiplying the mass of a given greenhouse gas by its global warming potential

Decarbonization
A reduction in the carbon intensity of a process or set of linked processes, such as a supply chain

EIO-LCA Model
A model developed by the Green Design Institute at Carnegie Mellon University to estimate the overall environmental impacts from producing a certain amount of a commodity

Freight transport
Transportation of goods and products by ship, aircraft, train or road means

Logistics and transport
Activities, resources and means associated with the movement and handling of goods and products

Mega-tonne (Mt)
1,000,000 tonnes

PAS 2050
Publicly Available Specification document giving the specification for the assessment of the lifecycle greenhouse gas emissions of goods and services, created by three UK authorities: BSI, Defra, Carbon Trust

Product lifecycle
Consecutive and linked stages in the creation of a product from raw material acquisition or generation of natural resources to end of life, inclusive of any recycling or recovery activity

Supply chain
The system of organisations, technologies and activities which is involved in the achievement of the product lifecycle

Tonne-km
Standard unit resulting from the multiplication of a payload in tonnes by a distance travelled in km

		Lifecycle Processes					Modes Considered										
Scorecard	Opportunity	Raw Materials	Manufacturing	Distribution	Consumption	End of Life	Ocean	Air (long haul)	Air (short Haul)	Road	Rail	Warehouse	Mt CO_2e Abatement	Steps and key values used to compute the feasible abatement potential	Outputs	Sources	Principal source Assumptions and Notes
1	**Clean Vehicle Technologies**									X	X		175	**1. Abatement in road transport, considering:**			
														Total emissions for road	1620 Mt	OECD 2005 data	
														Savings from road emissions model improvement	6.80%	Department for Transport	
														Savings from road emissions with biofuel	2.90%	Department for Transport	
														2. Abatement in rail transport, considering:			
														Total Emissions for Rail Transport	147 Mt	OECD 2005 data	
														Savings from rail emissions	12%	Department for transport	
2	**Despeeding the Supply Chain**			X			X			X			171	**1. Abatement in road freight with slower speed:**			
														Road freight total emissions	1620 Mt	OECD 2005 data	
														Abatement from achievable with slower speed	3.40%	Columbus Business First	
														Emissions saved from road freight speed	55 Mt		
														2. Abatement in road freight with loadfill increase:			
														Road freight Emissions	1620 Mt	OECD 2005 data	
														Abatement from Load fill improvement target	0.50%	WEF Analysis	
														Resulting increase in emissions from load fill	-0.21%	WEF Analysis derived from DEFRA	
														Emissions saved from road freight load fill	5 Mt		
														3. Abatement in ocean freight with slower speed:			
														Ocean freight emissions	481 Mt	OECD 2005 data	
														Abatement from achievable slower speed	36%	WEF Analysis	based on a 20% speed reduction
														Resulting increase in emissions from additional ships	-20%	WEF Analysis	
														Updated ships consumption with slower speed	73%		
														Emissions saved from ships	112 Mt		
3	**Enabling Low Carbon Sourcing:**	X											178	**1. Abatement in agriculture, considering:**			
														Total emissions from agricultural activities	6620 Mt	IPCC	

		Lifecycle Processes					Modes Considered										
Scorecard	Opportunity	Raw Materials	Manufacturing	Distribution	Consumption	End of Life	Ocean	Air (long haul)	Air (short Haul)	Road	Rail	Warehouse	Mt CO_2e Abatement	Steps and key values used to compute the feasible abatement potential	Outputs	Sources	Principal source Assumptions and Notes
	Agriculture													Saving which can be made by relocating agriculture	61%	WEF analysis derived from: Cranfield, Lincoln	
														Portion of goods traded internationally	44%	WEF Calculations	
														Likely applicability across all agricultural activities	10%	WEF analysis	
4	**Optimised Networks**									X			124	**1. Abatement in road transport, considering:**			
														Road transport total emissions	1620 Mt	OECD 2005 data	
														Potential savings based on network transformation	13%	Accenture Internal	
														Portion of the sector only affected by the transformation	57%	WEF Analysis	
5	**Energy Efficient Buildings**											X	93	**1. Abatement in road transport, considering:**			
														Emissions from all considered operating activities	371 Mt	OECD 2005 data	
														Potential savings on operating activities	16%	WEF Analysis based on Royal Mail, Vattenfall, DHL	
6	**Packaging Design Initiatives**			X								X	132	**1. Abatement in logistics operations, considering:**			
														Total emissions from logistics operations	2847 Mt	OECD 2005 data	
														Percentage of total weight reduction achievable	5%	UK Local Government Association - 2007	
														Percentage of logistics operations associated to consumer goods	14%	International Chamber of Shipping	
														Average maximum abatement from logistics operations	19%	IGD Packaging Reduction fact sheet, 2007	
														Achievable abatement target	80%	WEF Analysis	
														Potential abatement	3.09 Mt		
														2. Abatement in paper packaging, considering:			
														Total packaging volume globally	253 Mt	Research Market Ltd.	
														Paper percentage	51.30%	Research Market Ltd.	
														Emissions associated with paper packaging	0.83 kg /(kg recycled paper)	timetochange.org	
														Achievable abatement target	15%	WEF Analysis	

		Lifecycle Processes					Modes Considered										
Scorecard	Opportunity	Raw Materials	Manufacturing	Distribution	Consumption	End of Life	Ocean	Air (long haul)	Air (short Haul)	Road	Rail	Warehouse	Mt CO_2e Abatement	Steps and key values used to compute the feasible abatement potential	Outputs	Sources	Principal source Assumptions and Notes
														Potential abatement	16 Mt		
														3. Abatement in plastic packaging, considering:			
														Total packaging volume globally	253 Mt	Research & Markets Ltd,	
														Plastic percentage	48.70%	Research & Markets Ltd,	
														Emissions associated with plastic packaging	6 kg /(kg recycled paper)	timetochange.org	
														Achievable abatement target	15%	WEF Analysis	
														Potential abatement	113 Mt		
7	**Enabling Low Carbon Sourcing: Manufacturing**		X										152	**1. Abatement in manufacturing, considering:**			
														Total emissions from manufacturing	9506 Mt	OECD 2005 data	
														Potential efficiency gain from combining production facilities	11%	WEF analysis derived from: Cranfield, Lincoln, Accenture	
														2. Abatement in associated energy productions, considering:			
														Total emissions in associated energy production	3323 Mt	OECD 2005 data	
														Benefit to be gained from using greener energy source locations	10%	WEF Analysis	
														3. Apply restriction on the total abatement			
														The proportion of manufactures which are traded globally	70%	WEF Analysis derived from UNIDO & WTO	
														The percentage of manufacturing contracts that are likely to be negotiable within the next 5 years	80%	WEF Analysis	
														The percentage that may have locational flexibility	20%	WEF Analysis	
8	**Training and Communication**									X		X	117	**1. Abatement in buildings, considering:**			
														Total emissions from buildings	371 Mt	OECD 2005 data	
														Portion of considered building emissions	50%	WEF Analysis	
														Total abatement potential from building programmes	16%	WEF Analysis derived from Royal Mail, Vattenfall, DHL	

		Lifecycle Processes					Modes Considered										
Scorecard	Opportunity	Raw Materials	Manufacturing	Distribution	Consumption	End of Life	Ocean	Air (long haul)	Air (short Haul)	Road	Rail	Warehouse	Mt CO_2e Abatement	Steps and key values used to compute the feasible abatement potential	Outputs	Sources	Principal source Assumptions and Notes
														Abatement from programmes which can be addressed by training	20%	WEF analysis	
														Emissions saved for Buildings	6 Mt		
														2. Abatement from road transport, considering:			
														Total emissions from road freight	1620 Mt	OECD 2005 data	
														Portion of considered road freight emissions	75%	WEF Analysis	
														Abatement from driving training	9%	Vincanton, Carbon Trust, DHL	
														Emissions saved from road freight	111 Mt		
9	**Modal Switches**						X	X	X	X	X		115	**1. General considerations for air freight:**			
														Total International air freight emissions	130 Mt	Airbus Air Cargo Forecast	80% of the world's air freight is international
														2. Abatement in long haul air freight by switching to sea freight, considering:			
														Estimated long haul percentage of international of flights	68%		Estimate from regional tourism ratios
														Total long haul freight	88b. Tonne-km		
														Air freight emissions rate	0.606 kg/Tonne-km	DEFRA	
														Estimated emissions associated with long haul flights	54 Mt		
														Abatement from freight that might switch to ocean freight	19%	WEF Analysis	
														Emissions associated to switch to ocean freight	-0.14 Mt		
														3. Abatement in short haul air freight by switching to road freight, considering:			
														Total domestic air freight emissions	30b. Tonne-km		
														Estimated short haul percentage of international freight	32%		
														Total short haul freight	72b. Tonne-km		
														Air freight emissions rate	1.32 kg/Tonne-km	DEFRA	
														Estimated emissions associated with short haul flights	94.75 Mt		

		Lifecycle Processes					Modes Considered										
Scorecard	Opportunity	Raw Materials	Manufacturing	Distribution	Consumption	End of Life	Ocean	Air (long haul)	Air (short Haul)	Road	Rail	Warehouse	Mt CO_2e Abatement	Steps and key values used to compute the feasible abatement potential	Outputs	Sources	Principal source Assumptions and Notes
														Abatement from freight that might switch to road freight	19%		
														Emissions associated to switch to road freight	-1.21 Mt		
														4. Abatement in road freight by switching to rail/waterway freight, considering:			
														Total emissions from road transport	1620 Mt	OECD 2005	
														Percentage of long distance road freight	21%	WEF Analysis	Using EU data
														Estimated emissions associated with road freight	340 Mt		
														Abatement from freight that might switch to rail/waterway freight	42%		
														Estimated overlap percentage between different considered modes	80%	WEF Analysis	
														Emissions associated to switch to rail/waterway freight	-27 Mt		
10	**Reverse Logistics / Recycling**	X	X	X	X	X							84	**1. General considerations for recycling principles**			
														Total waste worldwide	11 000 Mt	WEF Analysis based on GDP from considered countries	the GDP was assumed to be proportional to the waste generated by the considered country
														Panel distribution of different waste categories		DEFRA	
														Panel of recycling efficiency of different materials		DEFRA	
														Emissions associated with materials/production/distribution of each material		EPA	
														Emissions associated with disposal/waste method of each material		EPA	
														Average landfill use	70%	DEFRA	
														Average incinerator use	30%	DEFRA	
														2. Abatement in recycling, considering:			
														Panel of difference in emissions from recycled product to non recycled product for each materials			Computed using above data
														Abatement from current waste recycled	20%	DEFRA	
														Emissions savings associated with total waste currently	56 Mt		

		Lifecycle Processes					Modes Considered										
Scorecard	Opportunity	Raw Materials	Manufacturing	Distribution	Consumption	End of Life	Ocean	Air (long haul)	Air (short Haul)	Road	Rail	Warehouse	Mt CO_2e Abatement	Steps and key values used to compute the feasible abatement potential	Outputs	Sources	Principal source Assumptions and Notes
														recycled			
														Abatement from target waste recycled	50%	WEF Analysis based on DEFRA and BBC	
														Emissions savings associated with total waste target	139 Mt		
11	**Nearshoring**						X	X		X	X		5	**1. Abatement in shipping from nearshoring**			
														Total cargo sea freight	51,200b. tonne-km	International Chamber of Shipping	
														Sea freight considered	17600b. tonne-km	International Chamber of Shipping	
														Shipping emissions rate	0.008 kg/tonne-km	DEFRA 2007	
														Abatement from sea freight reduction from nearshoring	20%	WEF Analysis based on International Chamber of Commerce	
														Sea freight emissions reduction	28 Mt		
														2. Abatement in air freight from nearshoring			
														Total air freight	150 tonne-km	Airbus Air Cargo Forecast	
														Air freight considered	125 tonne-km	Airbus Air Cargo Forecast	
														Air freight emissions rate	0.606 kg/tonne-km	DEFRA 2007	
														Abatement from air freight reduction from nearshoring	25%	WEF Analysis based on Airbus data	
														Air freight emissions reduction	19 Mt		
														3. Abatement from intermediate road operations			
														Total weight of freight diverted	836b. tonne	WEF Calculation	
														Average distance between port and production location	150 km		Estimate
														Portion of road transport	69%		
														Road freight emissions rate	0.17 kg/tonne-km	DEFRA 2007	
														Portion of rail transport	31%		
														Rail freight emissions rate	0.03 kg/tonne-km	DEFRA 2007	

		Lifecycle Processes					Modes Considered										
Scorecard	**Opportunity**	**Raw Materials**	**Manufacturing**	**Distribution**	**Consumption**	**End of Life**	**Ocean**	**Air (long haul)**	**Air (short Haul)**	**Road**	**Rail**	**Warehouse**	**Mt CO_2e Abatement**	**Steps and key values used to compute the feasible abatement potential**	**Outputs**	**Sources**	**Principal source Assumptions and Notes**
														Intermediate operations emissions reductions	9 Mt		
														4. Additional emissions created from near-shore operations	-50 Mt		
12	**Increased Home Delivery**			X						X			17	**1. Abatement potential in road transport from shopping trips, considering:**			
														Combined kilometres travelled for shopping per year per household	345 km	WEF Analysis based on Siikavirta et al. 2003	
														Total number of household considered	367 millions		
														Averaged emissions per car	0.26 kg/km	Eurostat - EPA	
														Portion of shopping trips that can be replaced by home deliveries	63%	Siikavirta et al., 2003	
														Potential abatement using home deliveries	21 Mt		
														2. Increase in emissions from substitute delivery modes, considering:			
														Home delivery emissions per drop	0.87 kg		
														Number of new substituted trips from increase in home deliveries	4.77b. Trips		
														Total increase in emissions due to home delivery	4 Mt		
13	**Reducing Congestion**									X			26	**1. Abatement in road transport, considering:**			
														Total road transport emissions	1620 Mt	VEF Calculations	
														Percentage of emissions caused by congestion	6%	Eurostat	
														Potential to reduce congestion	27%	WEF Analysis	

Annex 3: Further Reading

World Economic Forum: Logistics and Transport Industry Partnership
www.weforum.org/en/ip/LogisticsandTransport/

Accenture Sustainability Practice
www.accenture.com/sustainability/

Carbon Trust
www.carbontrust.co.uk

World Business Council for Sustainable Development
www.wbcsd.org

Greenhouse Gas Protocol
www.ghgprotocol.org

WRAP
www.wrap.org.uk

PAS 2050 mini-site at BSI
www.bsi-global.com

UK Department for Environment, Food and Rural Affairs, carbon emission factors
www.defra.gov.uk/environment/business/envrp/conversion-factors.htm

Institute for Grocery Distribution, consolidated distribution pages
www.igd.com

United Nations Framework Convention on Climate Change
www.unfccc.int

The Carbon Disclosure Project
www.cdproject.net

US Environmental Protection Agency, SmartWay pages
www.epa.gov/smartway/

Global Reporting Initiative
www.globalreporting.org

US Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics
www.bts.gov/programs/freight_transportation/html/ton_miles.html

Carnegie Mellon University, Green Design Institute, EIO-LCA Model
www.eiolca.net

Point Carbon, carbon market analysis and carbon price data
www.pointcarbon.com

Annex 4: List of Industry Partners

Industry Partners within The World Economic Forum Logistics and Transport group

- Agility
- DP World
- Deutsche Post World Net
- FedEx Corp.
- GeoPost Intercontinental
- ProLogis
- Stena AB
- TNT
- UPS

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