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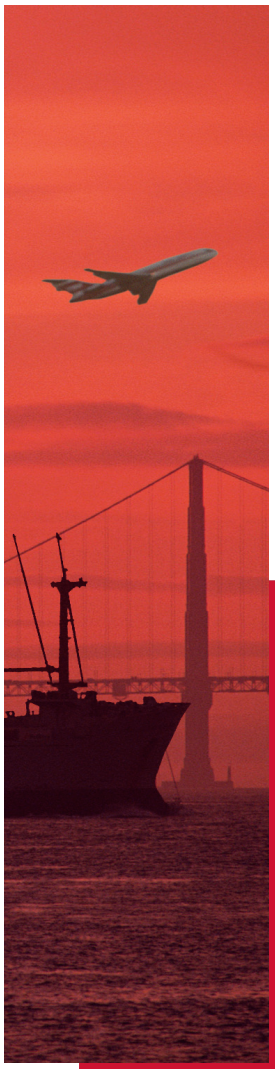

Agriculture and Rural Development

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THE FUTURE OF SUSTAINABLE FREIGHT TRANSPORT AND LOGISTICS

NOTE

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POLICY DEPARTMENT B: STRUCTURAL AND COHESION POLICIES

TRANSPORT AND TOURISM

WORKSHOP
'THE FUTURE OF TRANSPORT'

THE FUTURE OF SUSTAINABLE FREIGHT TRANSPORT AND LOGISTICS

NOTE

This document was requested by the European Parliament's Committee on Transport and Tourism.

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Abstract

This note reviews recent trends in EU freight transport and evaluates the current EU approach to the development of a sustainable freight transport system. It then considers the likely impact of existing and potential initiatives to promote sustainability. For various reasons it will be more difficult to achieve sustainability for freight than for personal transport. Existing technologies and policies will only go part-way towards a full solution and new more radical initiatives will be required in the future.
The issues covered by this note were presented and discussed in the framework of the workshop on 'The Future of Transport' held in the European Parliament on 2 December 2009.

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CONTENTS

LIST OF ABBREVIATIONS

EC	European Commission
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gas
ICT	Information and Communication Technologies
ISA	Intelligent Speed Adaptation
ITS	Intelligent Transport Systems

EXECUTIVE SUMMARY

This note covers issues that were presented and discussed in a workshop on 'The Future of Transport' held in the European Parliament on 2 December 2009.

Economic activity depends on effective logistics to supply materials to industry and to move products along the supply chain and eventually to the final consumer. Whilst logistics encompasses a range of activities, the most visible and environmentally damaging element is the extensive use of freight transport. If the EU is to develop and implement future transport systems that are sustainable, we need to understand how such sustainability can become a key feature of freight transport and to devise policies that will facilitate this.

Current EU thinking identifies greenhouse gas emissions and congestion as the most serious environmental and sustainability issues relating to freight transport and logistics. These are already serious problems, and they will get worse with future growth in population, incomes and consumption.

Sustainability in freight transport use may well be harder to achieve than for passenger transport. There are many reasons for this, including the long time horizons on achieving major technological change in freight vehicles, factors relating to the nature of goods that are moved, the need for significant price changes to induce modal shift and the lack of innovation in more sustainable freight transport modes.

In recent years, freight volumes in Europe have grown broadly in line with economic growth. This means that it will be difficult to achieve targets such as those for carbon reduction. In future, it may be possible to uncouple the relationship with economic growth but it will still be a major challenge to achieve sustainability. Whilst more sustainable modes of transport such as rail have held on to their overall market share in recent years, this masks a variable performance in different regions.

The current EU approach towards sustainability in freight and logistics has significant strengths, most notably the focus on intermodality and recognition of the need for incentives through pricing and the need to encourage wider and more effective use of ICT in freight transport. But there are also areas where more consideration of strategy is required, for instance in the development of sustainable urban freight transport systems.

There are many options, and hence considerable scope, for improving the sustainability of freight transport and logistics. The more conventional options can be considered under the headings of modal pricing, alternative fuels, promoting modal change, improving the efficiency and environmental performance of existing modes, promoting intermodality, exploiting opportunities provided by ICT and ITS, finding innovative urban freight solutions, and integrating outbound and reverse logistics. To maximise the potential offered by such options, the current considerable levels of investment in technological research and development will need to be sustained, and there will be a need to incentivise behaviour change in areas such as modal choice, most notably through the price mechanism.

In the longer term, radically different freight transport modes may be available, though their research, development and implementation costs will be very considerable. Implementation of alternative, more sustainable economic and business models, such as a retreat from globalisation, may also occur, though this is considered unlikely.

1. INTRODUCTION

KEY FINDINGS

- The EU economy requires efficient logistics systems that are also sustainable.
- The scope of logistics is wide-ranging, but freight transport is a large element and is the least sustainable aspect of logistics systems at present.
- We need to understand how far we can make freight transport and logistics more sustainable and how this can be achieved.

As stated in the Action Plan for Freight Transport Logistics (EC, 2007d), logistics is 'the oil in the EU's economic machine'. Economic activity depends on effective logistics to supply materials to industry and to move products along the supply chain and eventually to the final consumer. In addition, for environmental reasons we increasingly require 'reverse logistics' to allow us to manage our waste materials in a responsible way. Whilst logistics encompasses a wide array of activities such as packaging, stockholding and inventory management, the most visible and environmentally damaging element is the extensive use of freight transport. If the EU is to develop and implement future transport systems that are sustainable, it is vital to understand how such sustainability can become a key feature of freight transport and to devise policies that will facilitate this.

2. THE MAJOR ISSUES

KEY FINDINGS

- There are many sustainability issues relating to freight transport and logistics.
- The current view that greenhouse gas emissions and congestion are the most serious issues is confirmed.
- These issues will become more serious unless they are addressed successfully.

Whilst there are many environmental and sustainability issues, such as atmospheric pollution, safety, noise, visual intrusion and community severance, associated with the use of transport (including freight transport), the two problem areas that are singled out for particular attention in the EU document 'A Sustainable Future for Transport' (European Commission, 2009a) are greenhouse gas (GHG) emissions and congestion. In the freight transport and logistics arena, this would appear to be a reasonable assessment. Firstly, we have made enormous strides in recent years to mitigate many of the other problem areas. In terms of atmospheric pollutant emissions and safety, for example, the EU record of improvement is already impressive and further improvements seem assured. Secondly, GHG emissions, through the well-known link with global warming, pose arguably the greatest threat to society in the medium to long term, yet progress towards GHG reduction in freight transport is not encouraging at the present time. Congestion is a major problem not just because of its environmental effects but also due to its detrimental effects on economic performance. Freight transport contributes to congestion but it is also a victim of it, and already suffers from congestion at ports and other transport nodes and terminals, at bottlenecks on key transport corridors and in urban areas where much of freight activity must take place. As population and incomes (and hence total consumption) continue to grow and trade continues to expand, such congestion is likely to get worse unless effective solutions can be found, and it will have its most noticeable impact in major urban areas, which are forecast to be increasingly prevalent in the EU of the future.

3. RECENT TRENDS

KEY FINDINGS

- Recent growth in freight transport and the failure to uncouple freight growth from GDP growth has led to freight contributing a growing share of GHG emissions.
- Many current business practices contribute to a growing demand for freight movement and the dominance of road freight.
- The more sustainable modes (rail and water) are not increasing their market share.
- Growth in the use of sustainable modes in some parts of Europe is being offset by continued decline in such modes elsewhere.

When examining recent trends in the use of freight transport we need to consider the trend not only in the total use of transport but also in the use of individual transport modes. To help in projecting trends into the future, it is also instructive to examine the relationship between economic growth and freight transport use. Some division according to geographical area is also helpful in order to understand whether trends are consistent everywhere, or whether there are divergent experiences.

The use of freight transport has remained relatively closely coupled to economic growth (unlike passenger transport, which has recently been growing less slowly). Whilst the total tonnage of freight grows relatively slowly, distance-weighted tonnages ('tonne-kilometres') have tended to grow more quickly as average distances have increased, partly because of trends towards industrial concentration and the centralisation of stockholding. Moreover, 'just-in-time' strategies, whereby inventories are minimised and goods are moved closely in line with when they are required, tend to reduce consignment size and hence can increase the number of vehicle movements. Such trends are not inevitable, however – in recent years road freight average distances in the UK have been falling back again (Department for Transport (UK), 2009a).

These trends mean that the use of freight transport has increased over the last decade at a rate faster than GDP and transport as a whole. Hence freight is contributing an increasing proportion of GHG (European Commission, 2009a).

Analysis by mode of transport shows that overall there has been little movement in modal shares, so that road transport has remained dominant (European Commission, 2009b). In fact, this masks variation between regions. In some countries, such as the UK, rail has marginally increased its modal share (Office of Rail Regulation (UK), 2009), whereas in much of Eastern Europe the previously very high rail freight tonnages have declined substantially and there is a continuing trend to road, which will be need to be addressed as the EU continues to expand (European Commission, 2009b).

4. WHY MIGHT SUSTAINABILITY BE HARDER TO ACHIEVE FOR FREIGHT THAN FOR OTHER TRANSPORT?

KEY FINDINGS

- Sustainability in freight transport use may well be harder to achieve than for passenger transport.
- There are many reasons for this, including the long time horizons on achieving more sustainable propulsion systems, factors relating to the nature of goods that are moved, the need for significant price changes to induce modal shift and the lack of innovation in more sustainable freight transport modes.

There are various reasons to believe that sustainability in freight transport use may well be harder to achieve than for passenger transport or personal mobility.

- Commercial deployment of radically more sustainable technology is further into the future (see for example the TOSCA project (TOSCA, 2009))
- Decisions regarding freight transport may be more price sensitive for freight (particularly the 'cross elasticities' reflecting the likelihood of modal shift in response to price changes), especially for time-sensitive and higher value freight (Graham and Glaister, 2004). Hence as long as road freight remains cheaper to use than rail, it will remain the dominant mode
- The tendency away from bulks towards consumer products is continuing, so freight volumes continue to rise causing more movement for a given tonnage
- There are fewer opportunities for 'e-substitution' (European Commission, 2009a) for freight (people may well be able to work from home, but goods still have to be moved). The main exceptions to this are the electronic distribution of published media and the reduction in the need to post documents for signature
- There are fewer decision-makers for freight – hence decisions are 'lumpy', and smooth transitions in response to policy changes are less likely
- For rail in particular, freight has typically received less priority on the network compared to passenger traffic
- Also on rail, there has been far less innovation for freight than for passenger traffic. For example, whilst high-speed rail is now well established in the EU rail passenger market, with more such investments on the way, rail freight has not yet seen transformation on any such scale
- There is a growing need for 'reverse logistics' (transport movements connected with recycling, re-use, dismantling, use of waste for heat and energy production) instead of local dumping, leading to increased demand for freight transport, especially as such movements are generally not well integrated with existing freight traffic.

5. CRITICAL APPRAISAL OF THE EU APPROACH TO FREIGHT TRANSPORT AND LOGISTICS

KEY FINDINGS

- In general, the current EU approach is an appropriate way to address the key issues.
- Particular strengths include the focus on intermodality as well as recognition of the need for incentives through pricing and the need to encourage wider and more effective use of ICT in freight transport.
- There are also areas where more consideration is required in terms of strategy and methods of implementation, for instance in the development of sustainable urban freight transport systems.

The current EU approach and thinking regarding freight transport and logistics is set out in various documents but most notably the 'Freight Transport Logistics Action Plan' (EC, 2007b). It also permeates the more recent development of the broader document 'A Sustainable Future for Transport' (European Commission, 2009a). In general, these documents present a relevant and realistic approach to the future development of freight transport and logistics, at least as far ahead as the medium term.

5.1. Strengths

First of all, as stated above in this paper, the focus on the key issues relating to GHG and congestion is appropriate in the case of freight.

A further strength is that significant emphasis is placed on exploiting the relative strengths of each transport mode through intermodality, as, for example, in the encouragement of intermodal terminal development and the solution of congestion and capacity problems at such terminals.

Furthermore, there is emphasis on pricing mechanisms to work towards charging transport users in line with their associated marginal social costs, which would mean higher prices for the least sustainable modes and possibly lower prices for greener alternatives. Such pricing realignment seems justified in the light of the importance of price to freight transport decision-makers, although any such pricing systems would have to ensure that the overall supply chain cost of using more sustainable transport modes is competitive (and not just the transport element in isolation).

In addition, the current approach very commendably identifies Information and Communication Technologies (ICT) as having a major role to play in developing the more sustainable use of freight transport in the future, through more efficient scheduling, tracking and tracing, and a range of other measures aimed at the more seamless use of transport in supply chains.

5.2. Potential weaknesses

It is, however, possible to identify various elements of the plans where additional consideration might be worthwhile.

Firstly, whilst it is acknowledged that population growth and substantial further urbanisation are inevitable and that there will be significant impacts on the need for freight movement, especially in urban areas, the nature of such effects are not clearly set out. The need for more freight transport, with its associated environmental problems, are possibly underestimated, especially if there is to be significant income growth in the future that will drive increased consumption. Greater consideration is therefore needed as to how to improve sustainability in urban freight but, as the documents acknowledge, whilst the EU can identify best practice in this area, it is difficult for such a supranational organisation to ensure that such best practice is encouraged, promoted and implemented appropriately within individual national boundaries.

The current approach places considerable emphasis on the further development of TEN-T corridors (EC, 2007c), potentially converting them into 'green corridors' where intermodality for both passenger and freight is encouraged and the use of more sustainable transport becomes the norm. Whilst this is undoubtedly important, and will deliver worthwhile environmental benefits, a significant amount of freight travels beyond individual corridors, or needs to connect between them. Hence it is also important that Europe starts to place emphasis not only on the TEN-Ts as key individual corridors, but also as the basis for an integrated intermodal 'green strategic network'. This entails the development not just of the corridors as individual routes, but of the ways in which they are inter-connected.

In presenting and discussing the *average* performance of sustainable modes of freight transport (and especially rail) in recent years, the current approach possibly hides inter-regional differences and may play down the difficulties of ensuring sustainability of freight in recent accession countries and likely new entrants, where transport networks are less well developed and where the benefits of future investment and the positive impact of market liberalisation may take considerable time to come to fruition.

For inter-continental freight, the EU has made significant progress in developing a coherent strategy towards seaports, although it is recognised that significant challenges remain, for example in connecting such ports to their hinterlands in a sustainable way (EC, 2007a). It is much less clear that there has been adequate consideration of how to address the environmental issues related to the substantial growth in long-distance air freight.

Considerable scope for ICT within freight transport has been identified, but whilst it is recognised that the freight sector seems to be a laggard in such applications, it is not clearly spelled out how the use of such technologies will become widespread in the future. The view of the range of potential future applications appears somewhat limited, focusing on the promotion of transport efficiency in quite a narrow sense. There is little, for example, on the development and promotion of electronic freight exchanges that could encourage intermodality by offering spare capacity across different transport modes. In addition, there is considerable evidence that the much broader use of ICT, linking up all partners along a supply chain, can result in potentially much greater transport improvements than can be gained from more directly transport-related ICT applications alone. A good example would be where much smarter demand forecasting systems allow large reductions in unnecessary transport capacity (Rodrigues et al, 2008).

Finally, the current approach focuses very largely on achieving significant improvements in the sustainability of existing freight transport modes, as one would probably expect. However, if we wish to look further into the future, there may be opportunities for the development and use of radically different, much more sustainable modes. Some of these are discussed briefly towards the end of this note. It must be stressed, however, that none of these is remotely close to market at the present time.

6. OPTIONS FOR PROMOTING GREATER SUSTAINABILITY IN FREIGHT TRANSPORT AND LOGISTICS

KEY FINDINGS

- There are many options, and hence considerable scope, for improving the sustainability of freight transport and logistics.
- Considerable investment in technological research and development must be sustained.
- There will be a need to incentivise behavioural change in areas such as modal choice, for instance through the price mechanism.
- ICT and ITS offer opportunities to improve the use and sustainability of freight transport in supply chains.
- Longer term, radically different freight transport modes may be available, though their research, development and implementation costs will be very considerable.

6.1. Pricing

Given that we have identified that freight transport decision-makers are essentially cost-driven, pricing is an appropriate mechanism by which to try to change behaviour. The first point to note is that freight transport prices are likely to rise towards the medium term due to rising energy prices. Whilst rising transport costs due to energy prices generally may not be desirable, as they will reduce the benefits of international trade and the single market, they do have the major benefit of promoting the more energy-efficient and more sustainable rail and water transport modes to the detriment of less sustainable road and air freight. Rail prices may also fall relatively as the benefits of rail liberalisation, interoperability and competition are increasingly realised.

It is not likely to be sufficient to rely on such market-led price changes. Hence it is also likely that politicians and policy-makers will have to implement other ways of influencing the prices paid by transport users. The most obvious examples are more direct user charging – such as electronic road pricing – and carbon taxes, both of which would promote more use of sustainable modes, possibly coupled with financial aid to such modes. A further advantage of road pricing, particularly when implemented in urban areas, is that exemptions could be given for greener vehicles such as electric vehicles, as is the case with the London Congestion Charge at present (Transport for London, 2009), which would encourage their use.

6.2. Alternative fuels

Considerable effort still needs to be expended to solve the many problems associated with alternative fuels, including the cost, weight, effective range and battery life of electric vehicles and the multitude of issues relating to biofuels. Nevertheless, such fuels seem likely to play a significant role in freight transport in the future, particularly for urban

distribution. The fundamental issue for road-based freight transport is that whilst such fuels offer scope for relatively marginal benefit, there is little prospect of a step change in fuel technology, say to a hydrogen-powered lorry, on a commercially viable basis for many years to come.

6.3. Mode shift

Given the high share of road freight, modal shift is clearly one of the major opportunities but has historically proved difficult. Continued development of the TEN-T corridors but with a greater focus on sustainable modes such as rail and water will help in this process, as will greater service quality, flexibility and more competitive pricing as rail freight interoperability and liberalisation progresses. Greater capacity and the elimination of congestion bottlenecks on rail and water modes will be required if sufficient volumes are to be transferred to achieve a significant change in modal shares.

EU research and development is starting to focus on technical improvements to allow a long-needed step change in rail freight performance. If technical solutions and the required investment can be found to address the problems of operating significantly longer freight trains, at significantly higher speeds and with higher axle loads, then many of the performance and capacity problems linked to the need to mix passenger and freight trains on the same routes can be solved. Alternatives, which may be more advantageous in some circumstances, are to refocus existing routes on freight after the opening of new high-speed passenger lines or develop dedicated rail freight routes.

Higher freight train speeds would allow rail to penetrate the air freight market, both within Europe and beyond. The Trans-Siberian Railway is already being used on a modest basis for the movement of containers between China and Europe, despite interoperability issues along the route. This route offers a ‘half-way’ solution in terms of transit times between sea and air, and its use is likely to increase considerably. Other routes between Europe and Asia (such as Pakistan to Europe via Iran and Turkey) also offer significant potential.

6.4. Improved efficiency and environmental performance of existing modes

Many governments encourage and promote the more efficient use of existing modes. For road freight, for example, the UK ‘Freight Best Practice’ programme provides information and support for measures such as driver training and aerodynamics, and more effective loading, routing and scheduling in order to improve fuel economy, hence providing simultaneous economic and environmental benefits (Department for Transport (UK), 2009b). However, such measures are largely predicated on removing existing inefficiencies, which will be exhausted long before targets such as those for carbon reduction are reached. Hence this is only a very partial solution.

It may be advantageous to consider changes in road vehicle size and capacity. For example, a slightly longer trailer to carry longer containers may help to promote intermodality. Relaxation of height limits would allow widespread adoption of double-deck trailers, with benefits for the transport of high-volume, low weight goods (McKinnon and Campbell, 1997). Some marginal increase in the EU international standard for maximum gross lorry weight, with adequate environmental safeguards, would reduce the number of lorries needed to transport a given tonnage. More controversially, various types of ‘road train’ or multi-trailer lorry might be evaluated, though several EU Member States, including

the UK, have decided against this (Knight et al, 2008). All such initiatives may well make road transport itself more sustainable. The issue really lies in the impact on the competitive balance between modes, which would seem to be undesirable.

There is likely to be further technical progress in reducing atmospheric pollution caused by lorries, though significant improvement in fuel consumption for heavier vehicles seems less easy to achieve. There is also scope for the use of cleaner technologies for rail and water freight, such as cleaner diesel fuels and less polluting engines. For rail, this is especially true in those Member States that rely heavily on diesel traction for freight haulage. Increased use of electric traction would be beneficial for the environment.

6.5. Intermodality

Intermodality, whereby freight can be transferred relatively seamlessly between modes due to standard loading units, such as containers, is already an important element of freight transport in Europe and its use is set to increase, particularly if initiatives such as the 'Green Corridors' and 'Motorways of the Sea' achieve their potential. Its success will depend on investment to solve bottlenecks at key loading and transfer terminals. It is acknowledged by the EU that there is a need to establish and agree what the future standards will be in terms of unit sizes and compatibilities (European Commission, 2009a). These standards need to be agreed quickly to allow the relevant investment decisions to be made.

6.6. ICT

ICT is expected to play an important role in ensuring the future efficiency and sustainability of freight (EC, 2007b). More effective provision of information will match loads to capacity more efficiently and will reduce empty and part-full movements. Its role could, however, be enhanced significantly. At present, 'electronic freight exchanges', whereby capacities are matched to loads, tend to operate on a single-mode basis. If they were multi-modal, intermodality could be further encouraged. Moreover, better integrated ICT linkages between organisations along an entire supply chain would allow much improved forecasting of volumes to be moved, avoiding a great deal of unnecessary travel. The world of ICT is fast-moving, and we can be reasonably confident that new applications will emerge to address these and other opportunities.

6.7. Intelligent Transport Systems (ITS)

We can be similarly optimistic that ITS will start to offer opportunities for improved sustainability. Examples include smart road pricing, encouraging movement away from the most congested routes and the peak times. In the longer term, we are likely to see Intelligent Speed Adaptation, which could improve both safety and fuel consumption, and perhaps computerised vehicle control that would allow close platooning of lorry convoys and hence improve the utilisation of road capacity.

6.8. The urban logistics problem

Despite a great deal of research over a long period and some practical demonstrations and experiments (see, for example, BESTUFS, 2009), it is disappointing that we are still some way from finding good solutions to the problems of urban freight collection and delivery. There has been overdependence on concepts such as urban consolidation and

transhipment, where experiments have met with little success apart from in very special circumstances because freight operators and users perceive that there are additional costs but no commercial added value. Nevertheless, such initiatives are persisted with: see, for example, the CIVITAS project (CIVITAS, 2009). It is possible that in the longer term, solutions involving a coordinated package of measures, linked to road pricing and urban congestion charging schemes with appropriate incentives for more sustainable vehicles, will lead to greater success. Marginally, in the future there may be more use of innovative solutions such as 'freight trams', as trialled in various cities in recent years (EUKN, 2009). Other possibilities in the longer term might include underground urban delivery networks, (Taniguchi et al, 2001), though these would be very difficult and expensive to retrofit into existing urban areas.

6.9. Integrated outbound and reverse logistics

At present, outbound logistics and the removal of unwanted materials ('reverse logistics') are almost invariably conducted separately. Recent research in a range of urban environments in the UK (Cherrett et al, 2008) suggests that there is considerable scope for integrating elements of outbound and reverse logistics flows, which could reduce the overall need for freight vehicle movement. This will grow in relevance as the need for reverse logistics continues to increase.

6.10. Towards the longer term – potential new freight transport modes

Over the years, various suggestions and proposals have been made for more radical methods of freight transport. Some of these more long-term speculative possibilities are discussed briefly below. None are remotely close to market at the present time, and most would require major investment in research, development and implementation before they were available for use on a commercial scale. Some would also be incompatible with existing freight transport modes and hence would not easily fit into the European vision of greater intermodality.

One proposed technology, currently at a very early stage, is to develop high-speed Maglev (magnetic levitation) freight transport routes. Experiments are currently underway in China for short-distance Maglev transport of bulk commodities. Development of a network of long-distance routes – to fully exploit the speed potential for more general cargoes – would prove very expensive and take considerable time.

Another vision is that in the future there may be greater use of pipelines. Whilst conventional pipelines cater for liquids or gases, there may be opportunities for pneumatic capsule pipes, which could be used to propel non-liquid freight in an energy-efficient manner (Liu, 2000).

A further possibility is the use of dirigibles or airships, which could be used for energy-efficient transport of relatively large loads over long distances (Windischbauer and Richardson, 2005).

These are included in this note for completeness and to convey a picture of what a radically different freight future could look like. It is very difficult to estimate what practical impact any of these possibilities could offer in the longer term. Nevertheless, if we are to achieve sustainability in the longer term, they should not be discounted at this stage.

6.11. Potential new economic and business models – localisation?

In recent decades, Europe has become a single market and has also played a major role in an increasingly global world economy. A more sustainable future could possibly involve alternative business models involving a retreat from just-in-time business practices and/or a return to more localised production and consumption. Such changes would radically alter the demand for freight transport, potentially making it more sustainable through, for example, less use of air freight (see, for example, Beecroft et al, 2003). Such models will not be discussed in any detail here, partly because a major reversal of recent trends towards a global economy seems unlikely and partly because localisation sits rather uneasily with the vision of a liberalised European economy thriving on extensive trade between Member States.

7. CONCLUSIONS

KEY FINDINGS

- Europe is not on track to achieve sustainability targets in terms of its freight transport and logistics.
- The large amount of existing and planned EU research will lead to significant improvements in many aspects of freight transport sustainability, but it will take considerable time to bring new technologies to commercial fruition.
- Incentivisation through appropriate price signals, such as urban road pricing and a fully-implemented Eurovignette reflecting the marginal social costs of road use, will be required to induce behavioural change on the part of freight transport providers and users.

When considered against some of humankind's greatest achievements, such as space exploration and the enormous advances in healthcare and medicine, finding a way to make freight transport much more sustainable would not seem to be so difficult. At present in Europe we are not on schedule to achieve this within the next 40 years. Nevertheless, the range of measures outlined and discussed in this note – if implemented and combined successfully – would bring about major technological and behavioural changes that could get us a long way towards the targets.

In order to achieve established targets, in particular for carbon reduction, the following are recommended;

- Urban road pricing or congestion charging and a fully-implemented Eurovignette to recover the marginal social costs of road use for longer distance freight in order to induce behavioural change on the part of freight transport providers and users.
- Existing and planned levels of research and development into sustainable transport should be maintained into the future, but with increasing emphasis on the development of more sustainable technologies for freight transport and bringing such technologies to the market place.
- Continued research and implementation in order to improve the performance and competitiveness of rail freight through greater efficiency, market liberalisation and better interoperability.
- Continued development and encouragement of intermodal technologies and systems for freight.
- Continued research, development and implementation of ICT in the freight transport sector.

The essential problems relate to the need to galvanise a very large number of stakeholders to make the research and development breakthroughs that are required and to devise and implement appropriate policies that will encourage, incentivise and legislate where necessary to ensure that more sustainable systems are used in the future.

The particular difficulties in achieving sustainability in freight transport, outlined in this note, are essentially difficulties due to the lack of suitable technology available at an acceptable cost to industry and the lack of appropriate pricing signals to encourage users to change their behaviour. In a more positive sense, these are great opportunities for the future, because the underlying economics suggest that the freight market can be expected to react very favourably once the technologies and incentives suggested above are in place.

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