

M) Freight Transport

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1. Introduction

This section covers the transport of any kind and quantity of goods, on land or water and over any distance (although it focuses on domestic freight). It includes, for example:

- freight transported by road, rail or ship
- facilities enabling freight to be switched from one mode to another
- trucks and vans delivering to local warehouses and businesses
- small boats taking rice or other farm produce to market
- goods tricycles selling textiles or food in an urban neighbourhood.

The section provides information about how governments and national leaders can implement policies to ensure that the nation's goods can be transported effectively, promptly, and between any two locations while reducing greenhouse gas emissions generated by freight. Seven objectives are offered here to achieve this. A number of measures are suggested to achieve each objective. Some measures are quite distinct and can be effective even if implemented on their own, while others need to be introduced in conjunction with other measures in order to be effective. This will be explained. The seven suggested objectives are as follows:

- more freight carried by rail, and increased efficiency of rail freight
- more freight conveyed on water, and greater efficiency of water-based freight
- effective linkages that enable multimodal freight transport to happen efficiently
- less freight moved by road, but improved efficiency of road freight
- better logistics and driving practices to reduce road trips and fuel used
- the use of appropriate small-scale and non-motorised vehicles and vessels to transport goods
- reducing demand for freight transport through urban planning and production processes.

2. Benefits from these measures

Economic benefits

These measures will result in less use of energy and reduce vulnerability to depleting supplies of fossil fuels. They will result in greater energy efficiency, reductions in unnecessary freight transport, and reductions in road-building and repairs. Finally, they will reduce pollution and accidents and the health and other costs these impose.

Social benefits

People will benefit from fewer accidents, less pollution, less noise and visual intrusion, better health and better quality of life.

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Environmental benefits

As a result of the measures described here there will be less local pollution, fewer greenhouse gas emissions, less use of non-renewable fossil fuels, and less land used for freight transport.

3. Greenhouse gas emissions reduction potential

Table 3.2 sets out energy use and emissions figures for different transport modes. The figures are from a developed country (Australia), but it serves to illustrate the stark differences between modes when the technologies are relatively modern and well-maintained, as they would be in this case. Such differences highlight the importance of switching freight transport modes, and of setting up freight centres and terminals that make this process more efficient and competitive. Other measures here focus on reducing the amount of freight transported and the distance transported, and in these cases the greenhouse gas reductions will be directly proportional to these reductions in distance and amount. Yet other measures cover the use of non-motorised transport, or transport with very small motors, and here emissions will be zero or very minimal. Lastly, there are measures to reduce greenhouse emissions through better technology and maintenance, and in many of these cases specific emissions reduction figures are included in the text.

Table 3.2 Energy and emissions intensity for road, rail and shipping transport of freight for Australia in 2005

| Mode | Energy Intensity (MJ-FFC/tkm) ^a | Emission Intensity (g CO ₂ -e/tkm) ^b |
|---------------------------|--|--|
| Road Transport | | |
| Light Commercial Vehicles | 21.07 | 1532 |
| Rigid Trucks | 2.95 | 209 |
| Articulated Trucks | 0.98 | 71 |
| Rail | | |
| Hire and Reward | 0.32 | 24 |
| Ancillary | 0.09 | 6 |
| Coastal Shipping | 0.17 | 15 |

^a Megajoule per ton km (MJ/tkm) on a Full Fuel Cycle (FFC) basis. A 'full fuel cycle' includes feedstock production, extraction, fuel production, distribution, transport, storage, and vehicle operation, including refuelling, combustion, conversion, permeation, and evaporation.

^b Grams of carbon dioxide equivalent (g CO₂-e) per ton km.

Source: Data drawn from Ernst von Weizsäcker, Karlson 'Charlie' Hargroves, Michael H. Smith, Cheryl Desha & Peter Stasinopoulos, *Factor Five: Transforming the Global Economy through 80% Improvements in Resource Productivity*, Earthscan, London, 2009.

4. The seven objectives and the measures that can help to realise them

A greater proportion of freight carried by rail, and increased efficiency of rail freight

As Table 3.2 shows, there can be large energy and emission reductions when goods are transported by rail – or by water, which is considered in the next part – rather than by road. In general terms, rail can be very competitive with road on price and delivery time over long distances. A German food company reported saving 40% of its energy consumption by switching to rail for long-distance transport.¹ Multimodal trips (those combining two or more transport modes) can also be cost effective and reliable, as well as reducing greenhouse gas emissions. The aim should be to have as great a proportion of medium to long distance freight as possible transported by rail or water, leaving road freight to handle just the local pick-up and delivery legs of the total freight journey.

In order to shift a greater volume of freight to rail, a range of measures may need to be taken, including improvements to rail routes, improvements to train technology, the establishment or upgrading of multimodal freight terminals, and the proper pricing of both rail and road freight – so that rail is advantaged, instead of disadvantaged as it is now.

Improvements to rail routes include the separation of freight and passenger rail tracks – especially in urban areas – and the straightening and strengthening of freight tracks. These measures enhance freight speed, which is important if rail is to compete with the speed of road freight.² Grade separations to eliminate level crossings – again, particularly in cities – also enhance rail speed and competitiveness and reduce accidents.

On the matter of train technology, hybrid diesel-electric motors that power many freight trains today are very efficient and exemplify improvements in rail efficiency over the past few decades. US rail freight company CSX claims to have improved fuel efficiency 80% since 1980, while Swiss railways – already one of the most efficient in the world – predicts further improvements of up to 60% in their rolling-stock, flowing from better engine efficiency, energy recovery from dynamic braking, more light-weight materials, and reduced drag and friction.³

If freight rail services are government-owned, then governments can invest in these efficiency improvements themselves, provided they can raise the funds. If governments contract the services out to private operators, they can stipulate that greenhouse gas emission levels or fuel efficiency standards will be taken into account in the competitive tendering process, or set minimum acceptable standards.

There is a strong argument for subsidising both passenger and freight rail because of the many benefits they generate,⁴ but governments have to decide what, if any, level of subsidy is financially feasible. For more on rail services, see also the Mass transit section.

Figure 3.52 Rail is normally a highly efficient mode for freight transport



Picture Credit: Jamie Cox.

A greater proportion conveyed on water, and more efficient water-based freight

Water freight generally is more energy efficient than road freight, as has already been noted. The factors that can make it more competitive with road freight are the same as those that advantage rail freight: improved routes, improved technology, better freight terminals or centres, and more favourable pricing arrangements in relation to road freight. On the matter of routes, domestic water transport services can travel along coasts, rivers or canals, across lakes or between islands. In countries that have water transport routes, it is important that they are integrated, well-maintained and free of obstructions in the form of low bridges, and weirs or irrigation devices without locks. Water transport routes are described in more detail in the Water transport section.

Water freight requires multimodal terminals so that freight can be transferred to or from rail or road, and such terminals are discussed in the next part. Containerisation offers big advantages, and an efficient centre will have gantries or cranes to shift loads, whether containerised or not. The technology that is going to do this fastest and easiest is also likely to be more expensive and energy consuming. One large gantry, for example, can use as much energy as three buses,⁵ so it is preferable if the power source is low or zero carbon.

On the question of technological improvements, major improvements identified in one report included anti-fouling coatings to reduce drag, improved hull design, air floatation, propeller design, wind propulsion and the use of renewable energy in port.⁶ The report was mainly considering larger freight vessels, but they would be relevant for medium sized vessels as well.

The UN Economic and Social Commission for Asia and the Pacific (UNESCAP) has produced a *Manual on Modernization of Inland Water Transport within a Multimodal Transport System*, which provides much

Figure 3.53 Water-based freight is also highly efficient, especially if containerised and using loading technology



Picture Credit: Dana Smillie, World Bank Photo Collection.

practical information on water-based freight transport,⁷ some of which is described in the Water transport section. This manual also highlights the importance of water-based freight transport in Europe, and increasingly in China.

Over many routes, particularly those on inland waterways, water freight competes with road freight, and so it is important that it is not disadvantaged because of road transport subsidies, and that road transport is priced as discussed later. Water transport is generally slower than road, though not always so. This is one reason that it produces less greenhouse gas, in that boat emissions are proportional to the speed of the vessel squared. However, if the time required for water-based freight is planned for, delays can be avoided. In areas such as eastern Peru and the deltas of Bangladesh and Vietnam, water transport has an advantage in that roads are poor or non-existent, but this lack of competition can also be a disadvantage for passengers and those sending or receiving freight, as it is in eastern Peru, where the state of the vessels and the docks leave much room for improvement.⁸

Freight centres and linkages that enable multimodal freight transport to happen efficiently

Rail and water transport cannot take freight from point of origin to destination, and so must rely on road transport for these first and last legs. Moreover, there may be one or more transitions from water to rail transport, or vice versa, in a freight journey. For this reason, and particularly in the context of competition with road transport that may not need these linkages, it is vital that there are efficient multimodal freight centres or terminals at which freight can be transferred from one mode to another quickly and smoothly. As noted earlier, the technology at such centres can be expensive, energy consuming and potentially greenhouse gas producing, but this has to be balanced against the economic, social and environmental costs of relying on road freight alone, and, as just noted, there is always the possibility of the energy coming from low or zero carbon sources.

Such centres need to be carefully located so that road traffic to and from them does not constitute a social or environmental problem, as it would, for example, in a dense urban area.⁹ Even if a freight trip is entirely by road, freight centres located outside a city centre are needed to allow freight to be transferred from large long-haul trucks to smaller trucks for city or other local distribution. If properly planned – especially through the use of logistics technology - this means reduced emissions, noise and congestion in city centres, better health and safety, and less fuel use and cost for the companies.¹⁰ Moreover, consolidation of freight deliveries within a limited number of centres increases the amount of freight that has the same origin and destination, and thus increases the chance of return loads and of different consignments in the one load, thereby reducing the number of vehicles used.¹¹

There is also an argument for locating freight centres and production facilities near each other. In Japan, freight centres also function as wholesale markets, especially for food, from which the food is distributed to smaller wholesalers and retailers.¹²

Freight centres can benefit from both public and private investment,¹³ but experience indicates that they are much less likely to be viable if their development and location do not take into account market factors.¹⁴

Less freight moved by road, but improved efficiency of road freight

In order to reduce the proportion of road freight, and increase the proportions conveyed by rail and water, pricing issues have to be addressed. Road freight usually enjoys public subsidies because fees and taxes

do not cover its full public costs, with trucks responsible for much more wear and tear on roads than are cars and other small vehicles. This needs to be reversed. Road freight should pay the full cost it imposes on society, the economy and the environment, or at least a much greater share of this. Pricing will also deter trucks from using certain roads, although simply banning trucks from these roads is an alternative. Pricing will also make road freight less competitive in relation to rail and water, and thus lead a greater proportion of it to be carried by these alternative modes – if the modes are available and if the balance of their benefits and costs make them at least as attractive as road transport.

On the question of how road freight can be priced, the options are:

- registration charges
- fuel taxes
- tolls on particular freeways, roads or bridges
- congestion taxes in selected urban areas.

Tolls and congestion taxes (and bans on freight transport on particular roads) can be for all times or just for some times of the day or week, or there can be higher charges in busier periods. If tolls are to be imposed, electronic toll collection can avoid the generation of additional emissions that would otherwise result from stop-start traffic and vehicle idling when traffic banks up before manual toll collection points, and such technology can be financed out of the tolls. Fuel taxes will encourage better vehicle maintenance and use of more fuel efficient vehicles, and there can also be subsidies or tax concessions for electric or hybrid vehicles.

Governments can also give preference to lower carbon freight modes and technologies through its own procurement policies, directly generating business for these modes and technologies and setting an example for the private sector to follow.

Differential pricing for larger and smaller trucks, or bans on larger trucks in certain areas, will deter or prevent larger truck pick-ups and deliveries in busy city centres, and instead encourage large trucks to

Figure 3.54 Local urban streets are not the place for road freight



Picture Credit: Megananne.

deliver to or pick-up from freight centres further out, with smaller trucks undertaking the first or last leg. These extra stages also remove the door-to-door advantage that road freight can have over other modes.

The trend for businesses to keep reduced volumes of stock in storage, and to have more just-in-time delivery, unfortunately results in more freight deliveries with smaller loads. If road freight companies have higher costs for delivering these small loads – costs that they can pass on to the businesses – then these businesses can be encouraged to order in larger quantities, and to thus enable road freight to be more efficient.

Trucks also need to be more fuel efficient and thus less greenhouse gas generating and this leads to the question of vehicle maintenance and the adoption of better technologies and fuels. On the matter of vehicle maintenance, there is another section on this, Improving private vehicle operating standards, which applies to trucks as well as other private vehicles and therefore can be consulted. Governments need to look at ways of encouraging or requiring vehicle owners to maintain their vehicles, and a range of measures are covered in that section, specifically:

- setting standards for vehicle fuel economy
- setting standards for vehicle emissions
- vehicle inspections
- mandatory adoption of particular technologies in extreme cases
- taxation and pricing measures relating to emissions, vehicle age and fuel economy
- requiring the inclusion of emissions standards in vehicle warranties
- schemes to get older vehicles off the roads
- standards for fuel quality
- driver or owner education about vehicle maintenance.

On the matter of better truck technologies, many improvements can increase fuel efficiency, including improvements to truck shapes to reduce aerodynamic drag, reduction in truck weight, alterations to tyre tread and tyre configuration, and a range of improvements to engines, transmissions, cooling systems, and other components and systems, as well as alternative fuels and engine technologies. Further reading on these possibilities is available and recommended,¹⁵ and another section in this guidebook, Vehicle and fuel technologies, has extensive information on this.

The Green Trucks Pilot Project in Guangzhou, China, sought to improve fuel efficiency and reduce greenhouse gases emissions and local pollutants through the retrofitting of new technologies and driver training. Adoption of particular tyre and aerodynamic technologies alone paid for itself in 1.8 years through improved fuel efficiency, and, if adopted by all of the 826,000 heavy trucks in Guangdong Province, this would save 8.6 billion litres of fuel a year and reduce CO₂ emissions by 22.3 million tons a year, equal to the emissions of a large city.¹⁶

Better logistics and driving practices to reduce road trips and fuel use

A range of technologies can help to plan the shortest, quickest and least congested routes, match up the supply of and demand for freight carrying capacity so that loads are fullest (including on return journeys), keep track of and manage vehicles, and improve driving.

In China, Japan and the Philippines, 30-40% of truck trips are empty.¹⁷ Reducing the numbers of empty or only partially full loads has a significant impact on greenhouse gas emissions. And research has shown that mixing light and heavy products in a load can maximise the load's efficiency. If the heavy products alone are packed, they soon reach maximum load weight while leaving empty space in the trailer, while the light products take up available space before reaching the most efficient load weight. But a blend of the two can align volume and weight capacity.¹⁸

A transport company in Thailand is using a traffic flow database called Road Net Program, which calculates the fastest, most cost-effective route by processing traffic volumes, route restrictions, and other data.¹⁹ One analyst, writing in the context of Korea, has suggested subsidies and loans to switch to green logistics, the establishment of an integrated national information centre for logistics, and a green logistics certification plan.²⁰

Driving practices that increase fuel efficiency can be achieved through information provision, driver training and real-time performance monitoring technology.²¹ 'Eco-driving' schemes in Japan have resulted in 12% savings in fuel consumption, through things like proper use of gears, switching off the engine when the vehicle is stationary, and avoiding heavy acceleration.²² Owner drivers have a material incentive to improve their driving in these ways; companies can consider offering efficiency bonuses for employed drivers so they too can have such an incentive.

Overall, the main incentive for road transport companies to adopt better driving practices, better logistics, newer, more efficient technology and improved maintenance practices are that these measures will save a lot of money, and the importance of such savings can be sharpened if road freight becomes more expensive through pricing mechanisms. But it can also be useful if governments make this industry more aware of these potential savings, and offer further information, training programs, and subsidies and loans to adopt the necessary measures. Moreover, it has to be recognised that increasing the pricing of road freight, while leading some operators to become more efficient and low carbon, will also drive other less efficient and sustainable operators out of business in the overall shift to increased proportions of rail and water freight. For this reason it is important to have plans in place to re-deploy truck-drivers and others working in the trucking industry into other, more sustainable forms of employment in transport or elsewhere.

The availability of appropriate small-scale and non-motorised goods vehicles and vessels

The transport of smaller volumes of goods over shorter distances on land or water can be done effectively in small, often non-motorised vehicles and vessels. This is particularly the case where there is little space, as in dense, crowded urban areas with narrow roads, lanes or canals. Such transport can be especially suitable for small producers and traders, most of whom have little capital for more expensive vehicles or vessels.

Non-motorised vehicles are sometimes seen as 'backward', which is unfortunate as they often are the most greenhouse efficient as well as playing a vital role in the total transport system. Modern, efficient solutions to transport needs are those that achieve the greatest benefits for the least costs (both private and public) and sometimes this means simple, traditional technologies. Handcarts, goods bicycles and tricycles, animal drawn vehicles, and boats propelled by paddles, oars, poles and sails can have a range of advantages for either the owner or the community. They can be cheap to buy and run, easy to maintain and repair, quiet, compact, not dangerous to other vehicles or pedestrians, flexible in limited spaces or if frequent stops are required, non-polluting and non-greenhouse gas producing. Compare this environmental record with that of light commercial vehicles in Table 3.2 earlier, which produce CO₂ emissions per unit of

weight carried that are more than 250 times those of a freight train.²³ Non-motorised vehicles and vessels can double as a 'stall' from which goods can be sold. And draught animals can be sources of milk, and of fertiliser and building material from dung.

Examples of non-motorised vehicle use can be found all over the world: handcarts in Africa transporting goods to and from markets,²⁴ adapted bicycle rickshaws in Bangladesh carrying bolts of cloth,²⁵ couriers delivering business parcels in inner-city Australia, goods bikes in New York City or Amsterdam,²⁶ and sellers in floating markets in Bangkok or on the Mekong River. A tricycle (Figure 3.55) can transport up to one tonne of goods on flat terrain without the aid of an engine.²⁷ When a bakery in Colombia was unable to fund the replacement of its 135 ageing trucks, a non-motorised transport option seemed impossible given the distance of the bakery from retail outlets. However, its solution was to buy 50 trucks to take the products to satellite warehouses, from where 904 cargo-tricycles took them to stores. Distribution costs fell from 27 to 8% of total costs, and employment increased substantially.²⁸

Governments and non-government organisations can help small producers and traders to purchase such vehicles and vessels through loan schemes, and loans, information and business advice can support businesses to manufacture them. Designs can be updated with attention to lightweight, sturdy materials and specially adapted cargo areas for particular kinds of goods. Attention can be paid to parking needs for such vehicles.²⁹ And goods bicycles and tricycles can incorporate auxiliary electric motors. There should be a much bigger future for non-motorised goods transport.

Figure 3.55 Urban cargo tricycle, Hangzhou, China



Picture Credit: Karl Fjellstrom, itdp-china.org.

Reducing demand for freight transport through urban planning, production processes and product design

As described in the *Reducing the need to travel* section, if urban areas are denser, have more mixed land use and greater self-sufficiency, then there will be less need for people to travel, and the same is true for freight. Self-sufficiency means more local production and this can be increased in both urban and rural areas, but the efficiency of the production process also needs to be considered. Economic orthodoxy argues that larger scale production is more efficient, but this is increasingly being challenged in the age of decentralised, networked businesses and ICT. It may also be less relevant in developing countries where labour is more plentiful and capital is scarcer.

In developed countries, the notion of buying locally has become popular, particularly in relation to food, and talk of ‘food miles’ is common. However, it cannot be assumed that the use of locally produced goods generates fewer greenhouse gases because of the shorter distance transported. With reference to Table 3.2 again, it is not clear if the figures in the table are based on average loads or maximum capacity, but either way, a kilogram of oats taken to a farmers’ market in a partly full van may be producing 50-100 times the CO₂ per kilometre travelled of a kilogram of oats on a full goods train. So attention has to be paid to the distance freight travels, the loadings, the energy efficiency of the mode of travel, and the carbon intensity of any fuel used.

Even if products are to be sold further afield, increasing the proportion of processing or production that occurs locally can produce large emissions savings by reducing the volume and weight to be transported. This particularly applies to agricultural, mining and timber industries. For example, if milk is to be turned into powdered milk, extracting the water at the individual dairy or dairy cooperative will result in dramatic reductions in the weight and volume of the product to be transported, and this also increases business and employment in regional areas.

The volume of goods to be transported is also reduced if products are designed to be more durable, if packaging is minimised, and if attention is paid to what has been called ‘reverse logistics’, that is, the process of planning and implementing the efficient re-use or disposal of products and packaging once they have ceased to be used for their original purposes.³⁰ We tend to focus on the transport of goods to producers, retailers and consumers, but an almost equal volume of matter then has to be re-transported once it has been ‘used’.

5. Costs and sources of funds

The costs of freight are a major driver in infrastructure decisions as productivity gains can be very large once good freight access is provided. Sources of funds can often be found from the private sector in both road and rail, as freight transport is much more able to fully pay its way than is passenger transport. Thus Public Private Partnerships are preferred when freight projects are put to governments. As the economic flow-ons are so good, the extra benefits of reducing greenhouse are likely to be only a small part of the benefit-cost ratio. Nevertheless, it may make the difference between being funded or not, especially when targeted greenhouse funds can be found.

6. Conclusion

According to Mehrick,³¹ governments can influence freight practices in four different ways. They can:

- **Regulate:** setting vehicle standards, making planning laws, and limiting vehicle access for various purposes
- **Incentivise:** through taxes, pricing, grants and subsidies
- **Persuade:** through information provision and social marketing
- **Facilitate:** through infrastructure development, education and training, promotion of intelligent transport systems, and research and development support.

Through these means, governments and national leaders can assist large and small businesses to adopt more low carbon freight transport: to switch to lower carbon freight modes, to maintain vehicles and vessels better, to invest in lower carbon technology, to use logistics technologies, to eliminate unnecessary trips, and to drive efficiently. In this way they can reduce both their transport bills and their greenhouse gas emissions.

Endnotes

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