Freight Transport and Aircraft Emissions - Implications for Australia

J Sherlock
World Wide Fund for Nature

R.C. Nias
World Wide Fund for Nature

M Rae
World Wide Fund for Nature

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Policies will be required that promote the development or an ecologically sustainable transport sector Changes in the modes of freight transport will be important components of this strategy

Contact Author:

J Sherlock
World Wide Fund
For Nature
GPO Box 528
SYDNEY NSW 2001

Telephone: (02) 247 6300
Fax: (02) 247 8778

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J. Sherlock, R. C. Nias & M. Rae

World Wide Fund for Nature (WWF) Australia, G.P.O. Box 528, Sydney, New South Wales, 2001.

Abstract

It is well recognised that the emissions of CO2 and NOx from road freight vehicles are significant contributors to atmospheric pollution. Reduction in these emissions will be required in order to meet global greenhouse gas reduction targets by the year 2005.

Recent research by the World Wide Fund for Nature into the impacts of atmospheric emissions from road freight in the European Community suggests that we cannot simply rely upon technological advances or more stringent emission standards to generate the reductions necessary to meet greenhouse gas targets as these will be completely nullified by growth in traffic volume in this sector.

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Introduction

Transport and greenhouse emissions in Australia - the policy context.

As part of the Commonwealth Government's Ecologically Sustainable Development Process (ESD) in 1990/91 the Transport Working Group examined issues relating to the environmental impacts of transport under three broad headings: vehicle exhaust emissions, especially of greenhouse gases; urban form and design; and interurban (long distance) freight and passenger movement (ESD Working Group, 1991).

The transport working group reported that the overall CO2 emissions attributable to the transport sector in Australia (28%) is about the average for all International Energy Agency member countries. It was noted that the transport sector is a major contributor to CO and NOx emissions with road transport the major polluter. Of the estimated 78 megatonnes of carbon dioxide emitted from domestic transport, trucks contributed some 17% with light commercial vehicles a further 10% of the total. Aircraft contributed 6% of the total which indicates that combined road freight and air travel contributed one-third of the total carbon dioxide emitted.

In terms of energy efficiency, measured as megajoules per tonne-km, light commercial vehicles (LCVs) and aircraft were inefficient compared with large truck, rail and sea transport. LCVs were estimated to require 20.2 Mjoules/tonne-km and aircraft 44.5 Mjoules/tonne-km; two orders of magnitude greater than bulk rail (0.4 Mjoules/tonne-km) or bulk sea transport (0.2 Mjoules/tonne-km).

Although the report showed the overwhelming importance of urban car based transport in the total (54% of the total), if Australia is to achieve Greenhouse Targets by the year 2005 then it is likely that both road and air transport will also need to be considerably improved. The report suggested that "....it would be desirable to explore the implications of options which, taken together, offer an expectation of reducing by at least 40 per cent the emissions which would be generated in the transport sector in the projected business-as-usual scenario for 2004-05".

The report highlighted that demand management strategies offer scope for improving transport. Present relative costs of all transport services do not fully reflect the ecological, social and economic impacts of providing these services. Ensuring transport prices adequately match transport costs, a more sustainable mix and level of transport activity can occur within existing urban structures.

Finally the working group acknowledged the need to achieve modal shifts from the car to lower impact modes in urban transport and `selected' modal shifts should occur from road to rail for freight transport. Recommendations were also made about improving average fuel efficiency of the Australian air fleet, although little detail was provided about this sector.

In all forty recommendations were tabled which provided a starting point from which to address the issues. Following the ESD reports a draft National Greenhouse Response Strategy (NGRS) was developed in 1992 in order to "contribute towards effective global action to limit greenhouse gas emissions; to prepare for potential impacts of climate change in Australia; and to improve knowledge and understanding of the enhanced greenhouse effect" (NGSC 1992).

The draft NGRS considered the recommendations arising from the Ecologically Sustainable Development Working Groups Final Reports and ESD Chair's Intersectoral Issues Report and Greenhouse Report (1992a,b) as well as the Industry Commissions's analysis in the 1991 report Costs and Benefits of Reducing Greenhouse Gas Emissions (1991).

The draft NGRS adopted as its starting point the interim planning target as included in Schedule 5 of the Intergovernmental Agreement on the Environment, viz;

"to stabilise greenhouse gas emissions (not controlled by the Montreal Protocol on Substances that Deplete the Ozone Layer) based on 1988 levels, by the year 2000 and reducing these emissions by 20 per cent by the year 2005....subject to Australia not implementing measures that would have net adverse economic impacts nationally or on Australia's trade competitiveness, in the absence of similar action by major greenhouse gas producing countries".

A final report was produced in December 1992. The strategy recommends that Governments should aim to;

* improve the technical and economic efficiency of urban and non-urban transportation;

* increase fuel efficiency in motorised transport and encourage fuel switching; and

* optimise the modal mix of transport to achieve greater economic, environmental and social benefits.

Atmospheric emissions from road freight in the European Community.

In a recent WWF report, Taylor and Fergusson (1993) conducted an analysis of the road freight sector in the European Community. Given the large distances involved in transporting goods across Europe, this study may provide some timely warnings about possible trends in Australia and their likely impact on Greenhouse emission control strategies.

In the European Community road freight accounts for around 23% of the total NOx emissions from all sources and 5% of the total CO2 emissions. A significant increase in the EC road network (by 5% over the period from 1978 to 1988), together with a similar decrease (3.6%) in the rail network over the same period suggest that this contribution is likely to increase.

Growth within the freight industry has been more or less confined to the road subsector. Road services are relatively cheap and flexible, and road infrastructure has improved while other modes have been neglected. Light goods traffic has been growing more rapidly than heavy duty truck traffic.

Growth in these sectors is expected to continue with the increasing dependence of industry on the "Just in Time" (JIT) philosophy methods which focus on providing the right part or product in the quantity required at the time required. This places emphasis upon the service attributes which road can provide more readily than other modes. Inventory reductions of 40 to 60% are typical and productivity improvements can be as large as 150%.

Road transport can also generally offer lower prices than the other modes largely due to the simplicity and flexibility inherent in road haulage operations. Not only are labour and terminal costs higher for rail and water but greater competition within road transport keeps the rates low.

The fact that currently road freight may not actually pay the costs they incur is referenced as an element in maintaining its competitive edge over other transport modes.

The study found as one would expect from the mode with the dominant market share that road is also responsible for most of the air pollution from freight transport. However its role in air pollution was disproportionately large in relation to the quantity of goods moved. Taking all pollutants together road has much greater emission rates than rail or inland waterways. Concerning the two pollutants of particular concern in this study NOx and CO_2 roads emission rates were found to be roughly two to three times rail, which where in turn some three to four times that of inland waterways. Furthermore it was noted that the relative efficiency of road freight transport may actually be decreasing, although the precise reasons for this are not clear.

In examining the options to reduce vehicle emission rates there are many trade offs to be considered. Many of the technical measures aimed at reducing NOx emissions from vehicles lead to increased fuel consumption and CO_2 emissions. The trade off between NOx and particulate is also becoming increasingly important in drafting legislation.

Vehicle age is also a major factor with emission rates from some older trucks alarmingly high when compared with modern, regulated vehicles. This results from a combination of less stringent (or non-existent) vehicle standards at the time of manufacture, and infrequent and inadequate maintenance of many older vehicles.

The options available for reducing emissions from road freight are more limited overall than those for passenger cars. They are also much less comprehensive in their scope and often involve complex trade-offs between the different pollutants. High costs and poor reliability remain formidable obstacles to the use of many techniques. In short, since there is no technical panacea for emissions from road-freight vehicles, a comprehensive assessment of the EC's freight-transport industry is essential.

The researchers then modelled projections of CO_2 and NOx emissions in the EC up to the year 2010 under two different demand scenarios.

Scenario A; the "Conventional Wisdom" was based on steady but unspectacular economic growth. Essentially a "business as usual" scenario for the EC with rather conservative demand projections. Almost all the growth in freight is taken by road.

Scenario B; "Sustaining High Economic Growth" envisaged much higher economic growth than A. It also foresaw a more energy efficient economy through technological innovation, and improved consumer behaviour in such areas as traffic management. Road again taking most growth in freight until 2000 but then dips with rail taking an increasing share of the market. By 2010, road and rail have a roughly equal share.

Results from both scenarios indicate CO2 emissions from road freight grow rapidly until the year 2000 (B +25%, A+18%). However in B emissions show a far more promising long term outlook as much freight is transferred away from road (decline back to current levels by 2010).

NOx emissions are expected to peak at about current levels in both scenarios and then fall by about 25% in the early 2000's as legislation is tightened over the next few years.

In Scenario A around 2005 emissions start to rise again which indicates the fundamental problem: unless further technical improvements can be made , increases in freight demand will more than offset the achievements of technical approach to reducing pollution.

In Scenario B the decline is stronger and more sustained than in A. This is a result of the tighter emission standards accompanied by road's falling share of total freight transport.

In conclusion, freight transport's contribution to air pollution and energy consumption within the EC is considerable. Current and predicted trends in economic structure look set to increase these problems. Even with cleaner vehicles, the increase in demand for transport will soon overshadow any improvements.

On the other hand reductions in total demand and/or alterations of modal split would produce significant reductions in CO2 and NOx emissions in the medium term. Intermodal transport could be encouraged to accelerate the trend, thereby combining the flexibility of road with the environmental desirability of rail.

If such changes are to occur without direct regulation, the correct signals must be given to the market. Road pricing for freight would help achieve this. A more representative distribution of costs within, and between, freight modes would improve efficiency, increase modal competition and make transport pricing more realistic. Taxation based on the distance travelled and vehicle load capacity would be the simplest form of road-freight pricing.

In the short term, vehicle taxation could help to introduce technical measures. Vehicle tax can form a considerable portion of an operator's expense. The system could be designed to encourage the purchase of a "cleaner" vehicle at the normal replacement time and to encourage the earlier purchase of a "cleaner" vehicle.

Ultimately if lasting reductions in CO2 and NOx emissions are to be achieved, freight demand will have to be reduced or restructured.

Whilst research in the document refers to trends and statistics emanating out of Europe there is little doubt we are experiencing similar developments in Australia. The findings and recommendation may well be applicable in the Australian context.

Atmospheric emissions from air transport

One of the few attempts to quantify the environmental impacts of air transport was made by Barrett (1991) for WWF. The results of this study, although tentative in a number of respects also have important implications for Australia.

Air transport is one of the fastest growing energy sectors around the world, as well as in Australia. The great majority of international travel is by air and its use for domestic travel in developed and developing countries is expanding rapidly.

Apart from the noise, the environmental impact of air travel has so far attracted little attention. This is because it constitutes a relatively small proportion of global energy use and pollution, and because pollution from aviation has often been excluded from the responsibilities of sovereign states and the consideration of international bodies.

Most of the pollution from aircraft is injected directly into the atmosphere at high altitudes, above 10km. At this altitude pollution can have a far more serious effect than at ground level. At high altitude the air is thin and the emissions from aircraft increase the concentrations of pollutants significantly. Pollutants remain for much longer periods because precipitation, which washes them out at lower altitudes, is minimal or absent. Aircraft pollution may contribute directly to high altitude clouds that increase global warming, and to ozone destruction.

For these reasons the significance of air transport as compared to other energy uses will grow in the coming decades, particularly for global warming and direct impact in the upper atmosphere. Estimates indicate that aircraft may be responsible for a much as 30% of global warming over the next few decades, although further information is required before the environment impacts of aircraft can be confidently and accurately predicted.

The quantities of pollution emitted from aircraft over the next decades depend on the demand for air transport, the way aircraft are used, and changes in aircraft technology.

More people are flying, and they are flying further. This growth is due to a number of factors, but perhaps the single most important is the relative decline in the real cost of flying. Projections by ABARE (1991) suggest that under the business-as-usual scenario, aircraft would contribute some 9% of the total CO2 emissions from domestic transport.

The way aircraft are used can effect the pollution they produce. The number of people abroad, the height and speed the aircraft flies at, and the time wasted through inefficient air control are all important factors.

Perhaps most significant factor is loading. Typically 90% of seats on chartered aircraft are occupied, but less than 70% on scheduled services. The pollution from an aircraft increases only slightly with the number of people on board. The charter flight causes less than 75% of the pollution per person as compared to the scheduled flight.

There are no radically new air technologies in sight offering negligible pollution, however improvements can be made to the design of the body or airframe, and to the engines of the aircraft.

The airframe can made lighter and to offer less air resistance. In so doing the effort needed to propel the aircraft can be reduced by up to 40%, with 10 - 30% being commercially practical. Aeroengines can be made up to 50% more efficient by a range of improvements to turbines, gearboxes and combustion chambers, and through new designs such as propfan.

The improvements to engines reduce fuel consumption, but the concomitant control of nitrogen oxides is very difficult to achieve.

Such improvements to airframe and engine might ultimately increase the fuel efficiency of aircraft by a factor of three. However, to realise this improvement will take a long time because of the research and development needed, and because the turnover of aircraft stock is quite slow. The average age of civil airliners is more than ten years.

Ultimately it may be necessary to phase out bulk freight on aircraft, especially within continents where rail transport or large trucks might provide a more energy efficient alternative.

Developing an ecologically sustainable transport system.

Both studies on road freight and aircraft indicate a limited scope for reliance on technological improvements to meet greenhouse planning targets. Considerable efforts will be need to make modal shifts in freight transport and inter-urban passenger transport, as are already apparent in the case of passenger car use.

Unfortunately the rather limited progress observable since the completion of the ESD reports indicates an apparent unwillingness to tackle these issues.

A large number of recommendations have been made as a result of the studies mentioned in this paper. The following recommendations are just some of those, often reported in relation to road freight and air transport, that might improve the scope for meeting greenhouse planning targets:

* Increased fuel efficiency of vehicles through engineering measures.

* Making a modal shift from the most energy-intensive (e.g road and air) to the more efficient (e.g. rail and sea).

* Substituting petrol and diesel fuel for road transport with renewable fuels or those which produce CO_2 at lower rates such as natural gas.

* Reducing demand by use of planning controls and fiscal incentives.

* Forward planning so as to minimise the distances flown.

* Increasing the real cost of flying to reflect the environmental damage caused.

* Ensuring aircraft are as fully loaded as possible by using advanced internationally integrated booking.

* Minimising the flight length of a given journey by integrating airline operations and stopping environmentally damaging competition.

* Altering cruise speeds and altitudes and flight paths so as to minimise the amounts and impacts of pollutants.

* Improving flight control so as to reduce time spent taxiing and stacking and thereby minimise fuel consumption.

* Instigating technological change and improvements in fuel efficiency in aircraft.

Summary

Recent evidence and trends relating to long-range transport by road and air indicate that greenhouse planning targets may be difficult to achieve without substantial changes to this sector of the transport industry. Of particular note is the conclusion that reductions will probably be required in the amount of freight travelling by road, particularly ,by light commercial vehicles, and by air. These sectors are likely to grow significantly, but are also among the most energy inefficient means of mass transport. Increased development and use of rail and sea as a means of mass transport of goods needs to be considered in the implementation of ecologically sustainable development in Australia.

References

Australian Bureau of Agricultural and Resource Economics (ABARE) (1991). *Projections of Energy Demand and Supply: Australia 1990-91 to 2004-05*. ABARE, Canberra.

Barrett, M (1991). *Aircraft Pollution. Environmental Impacts and Future Solutions*. WWF International, Gland, Switzerland.

Ecologically Sustainable Development Working Groups (1991) *Final Report - Transport*. AGPS, Canberra.

Ecologically Sustainable Development Working Group Chairs (1992a). *Intersectoral Issues Report*. AGPS, Canberra.

Ecologically Sustainable Development Working Group Chairs (1992b). *Greenhouse Report*. AGPS, Canberra.

Industry Commission (1991) *Costs and Benefits of Reducing Greenhouse Gas Emissions*. AGPS, Canberra.

National Greenhouse Steering Committee (1992). *National Greenhouse Response Strategy*. AGPS, Canberra.

Taylor, D. & M. Fergusson (1993). *Atmospheric Emissions from Road Freight in the EC*. WWF International, Gland, Switzerland.