Chapter 9

ALTERNATIVE FUELS AND THE CARBON FOOTPRINT OF RAIL

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INTRODUCTION

The concept of sustainable transport has been around for a long time, but it is only relatively recently that it has started to excite widescale public interest particularly in the context of global warming and potential climate change. Sustainability is not, however, just about environmental issues but part of something widely known as the 'triple bottom-line' of social, economic and environmental factors. Good business, in transport as elsewhere, will recognise that meeting market needs is not just about delivering the right products in the right place at the right time, but doing so in a way that recognises the wider needs of society, economic factors well beyond the immediate production costs, and the best use of scarce resources in a sensible way.

Rail Safety and Standards Board (RSSB) managed a scoping piece of research for its stakeholders and its report 'The rail industry - a way forward on sustainable development' (RSSB 2006) is available on the RSSB website.

The rail industry has been working with government and key stakeholders to develop *'The Case for Rail 2007 – the first sustainable development review of the mainline railways of Great Britain'* (RSSB 2007 1) which was published in June 2007. This chapter is based on that work, and also on the wider research programme which is being managed by for the rail industry by RSSB. The charts included are also taken from the report. RSSB builds industry-wide consensus and facilitates the resolution of difficult cross-industry issues. It provides knowledge, analysis, a substantial

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level of technical expertise, powerful information and risk management tools. This delivers a unique mix to the industry across a whole range of subject areas.

This chapter summarises the key issues for rail and its relationship to other modes. Beginning with a strategic overview, the chapter outlines the separate but related subjects of climate change and air quality before concluding with a brief description of the bodies involved in turning the plans into reality.

It is important to note - and the point has been well made by the Chartered Institute of Transport in its evidence to the Eddington Committee, (CILT 2006) - that improving transport can only work in the context of the wider strategic planning of housing, industry, retailing and major services such as health and education and supplies such as electricity, gas and water. Transport cannot lead in these areas: it can only facilitate once the basic building blocks of where people and goods need to travel from and to have been put in place. Of course, the process should be iterative but any purely transport-led approach will probably fail.

A STRATEGY FOR RAIL

We must start with the demand for, and use of, rail services for the movement of people and freight. Rail has some key strengths and these are primarily for the movement of people over longer inter-urban distances; the peak movement of commuters between home and place of work and return; and the movement of bulk freight to and from major objectives such as ports and the traditional industrial and distribution centres. One of the basic premises must be that rail transport is well-regarded by users and that trains are well patronised, punctual and modern. Key metrics which can be noted are that, in Great Britain, train punctuality is on an improving trajectory, the train fleet is one of the youngest in Europe at an average age of 13 years, and attention is being paid to issues such as physical accessibility at stations, with Department for Transport funding of £370 million.

Wider links with the high speed long distance rail network are being progressively improved, with the route to main European hubs by Eurostar being upgraded in November this year with the opening of the final section of High Speed Line 1 and St Pancras International. Where rail can deliver people to their final destinations in city centres in an efficient and effective manner the demand for modes such as aviation can be reduced. However, there are challenges for rail, which needs to improve its performance by continuing to provide more capacity in a cost-effective way, and by reducing the level of carbon emissions although rail is already a good performer in this area.

A sustainable railway will display most or all of the following characteristics:

- ❒ A strong safety performance
- ❒ Value for money
- ❒ Reliable and efficient mobility
- ❒ Integration with other transport modes

- ❒ Strategic investment in capacity and optimal utilisation
- ❒ Low carbon emissions
- ❒ Efficient use of energy generally
- ❒ Use of clean technologies
- ❒ Strong noise control
- ❒ High levels of accessibility
- ❒ Provision of affordable travel

It should be noted that only a small proportion of these, if any, are solely 'environmental' factors as there is a strong element of social and economic drivers which must also be recognised and met.

Drilling down further into the more strictly environmental factors requires consideration of the effects of rail on, and its relationship to, issues which include:

- ❒ Climate change
- ❒ Energy use
- ❒ Noise and vibration
- ❒ Air quality
- ❒ Land take and severance
- ❒ Waste and pollution
- ❒ Biodiversity
- ❒ Heritage and visual intrusion
- ❒ Water and material use

It is not the author's purpose in this chapter to make unflattering references to the existing and potential record of other modes in comparison to rail. Yet rail has some very strong points in most of these areas and considerable potential for improvement in many. The industry is committed to continued improvement in its sustainability performance by:

1. Developing a 30-year rail sustainable development strategy.
2. Working with the Department for Transport to define a voluntary industry-led agreement to reduce carbon emissions.
3. Continuing the implementation of regenerative braking to reduce the energy used by electric trains.
4. Making reductions in local air pollutants on a per passenger kilometre basis.
5. Reaching a train punctuality target of 89.5% by March 2008.
6. Reducing freight delays by approximately 20% over the next two years.

7. Completing the development of Route Utilisation Strategies by 2010.

8. Investing £10.6 billion to maintain and renew the network infrastructure and to deliver increased capacity throughout the remainder of Control Period 3 (until 2009).

9. Completing noise mapping to prioritise noise-reduction measures where necessary.

10. Continuing to implement programmes to improve accessibility.

11. Continuing to make significant improvements in passenger information provision.

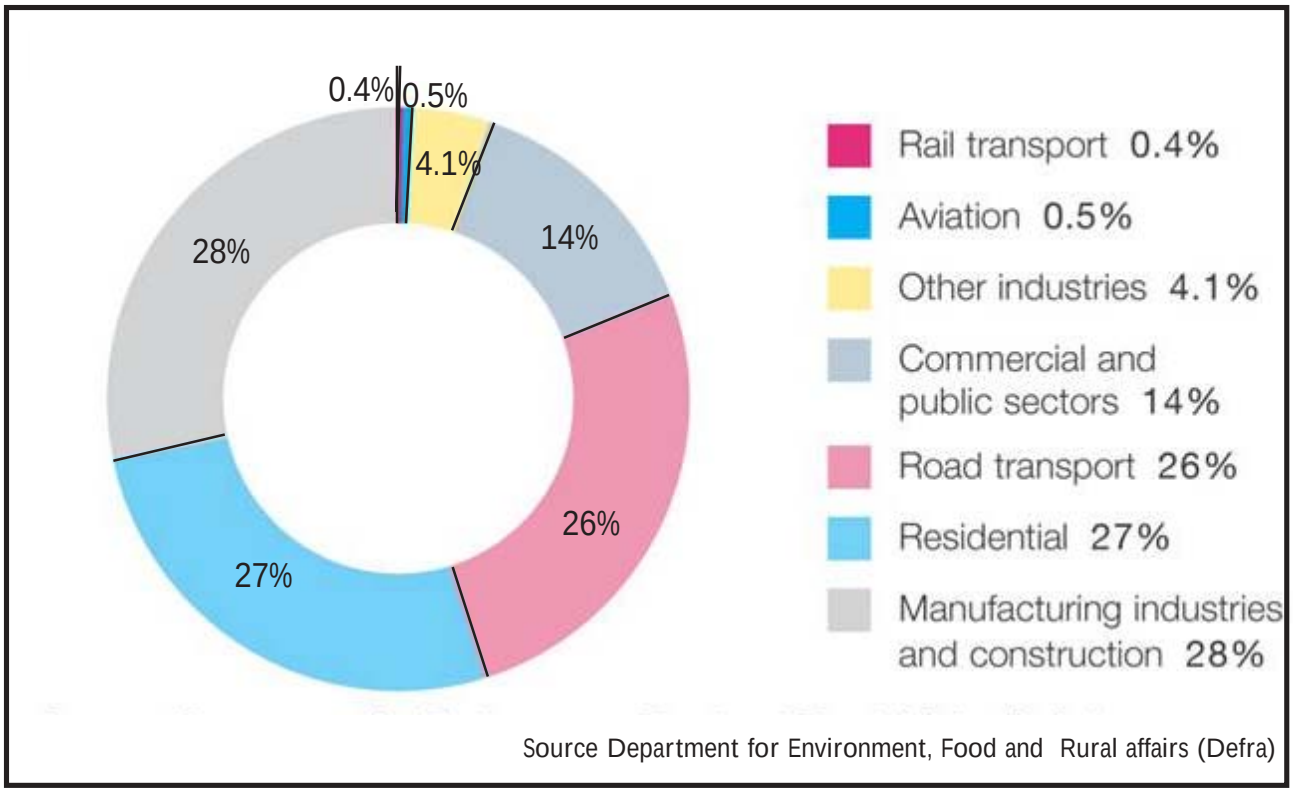
12. Maintaining the strong safety performance and improving where reasonably practicable.

13. Delivering a measurable reduction in the rate of workforce accidents.

This commitment to action is, again, far wider than the related issues of energy consumption and reducing carbon emissions; it is important to understand the wider context and the relationships between the different activities. The important issue is that there is a programme and a significant number of workstreams, including research, designed to support it.

CLIMATE CHANGE

The principal greenhouse gas contributing to climate change is carbon dioxide (CO_2). Transport is a significant contributor and the fastest-growing source of CO_2 emissions in Great Britain. However, rail contributes only some 0.4% to Britain's CO_2 emissions overall although there are slightly different figures around depending on the source material.



Source Department for Environment, Food and Rural affairs (Defra)

Figure 9.1 Breakdown of CO_2 Emissions by Sector

Based upon current performance, the rail industry has a significant role to play in delivering sustainable transport, particularly through a modal shift to rail from less-sustainable transport modes. The average CO_2 emission for the same passenger rail journey is about half that of an equivalent car journey and about one-quarter of an equivalent journey by air. (The average CO_2 emission for rail freight is currently being analysed.) While the railway currently contracts a significant portion of electricity from nuclear sources, the industry has taken the grid energy mix as the basis for calculating the carbon footprint of electric trains because the current contracting arrangements could change. A significant proportion of the reduction in carbon emissions achieved by the rail sector has been through favourable increases in the load factor.

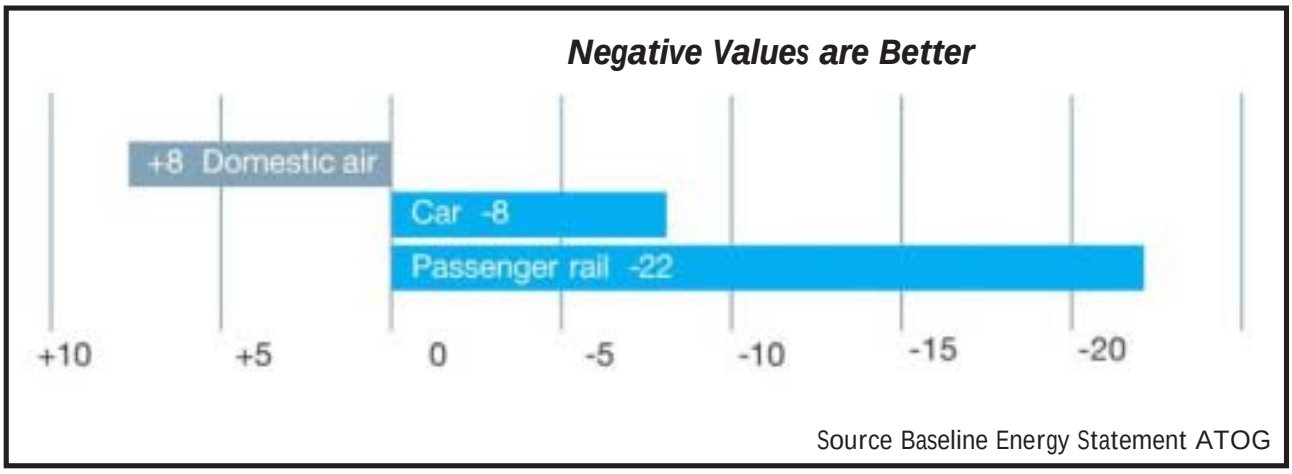


Figure 9.2 Percentage Change in CO_2 Emissions of Different Transport Modes in the last Ten Years

The industry is pursuing improvements through the following activities:

- Typically, a 15–20% reduction in the energy required to move electric passenger trains is being achieved through regenerative braking on the overhead ac electrified network.
- A number of infrastructure system upgrades, which will allow the use of regenerative braking across the entire overhead ac electrified network, are forecast to be complete by the end of 2008. The industry regenerative braking working group is carrying out regenerative braking tests and trials on the dc electrified network with a view to its future implementation across that network.
- Re-engining the current high-speed train (HST) fleet with modern engines has reduced fuel consumption by 17%.
- Diesel-battery hybrid technology is being demonstrated on one of the industry's HSTs. In Japan, this technology has demonstrated fuel savings of 20%.
- Operators of diesel freight locomotives have achieved a 3–5% reduction in fuel consumption by shutting down engines when stationary for more than 15 minutes.
- Other initiatives to reduce fuel consumption are being pursued, including an automatic shutdown device and re-engineering of fuel injection systems.
- Freight train lengthening and higher, constant and passenger train-compatible running speeds are also being considered.

Energy storage and fuel conversion technologies for portable fuels on board trains, such as fuel cells, are being investigated and could potentially deliver substantial reductions in CO_2 emissions. The industry is participating in fuel cell research and its application to rail.

A strategy to reduce carbon emissions from energy use (including setting targets and a reporting mechanism) is being developed. In addition, carbon footprinting by each rail company is being encouraged.

Non-traction energy is also being reduced by individual companies, with reductions in depot consumption of up to 17%. The industry is currently assessing how it uses non-traction energy to identify options for efficiency improvements.

Extensive research and development is being carried out by RSSB including research on mitigating the effects of climate change and adapting to a changing climate. This includes collaboration with the Union Internationale Chemin de Fer (UIC) [International Union of Railways]. A 10% reduction in traction energy demand is considered to be achievable in the short term by initiatives such as reducing the stabling load of electric trains and energy-efficient driving, along with energy metering and optimisation of off-peak train lengths. (RSSB 2007 2) The industry has completed research into the effects of climate change on the railway infrastructure (RSSB 2007 3). The industry is committed to developing a tool to assess the viability of further electrification, which considers effects upon CO_2 emissions (RSSB 2007 4). The industry has also commenced in-service trials of biofuel for the passenger and freight train fleets (RSSB 2007 5).

AIR QUALITY

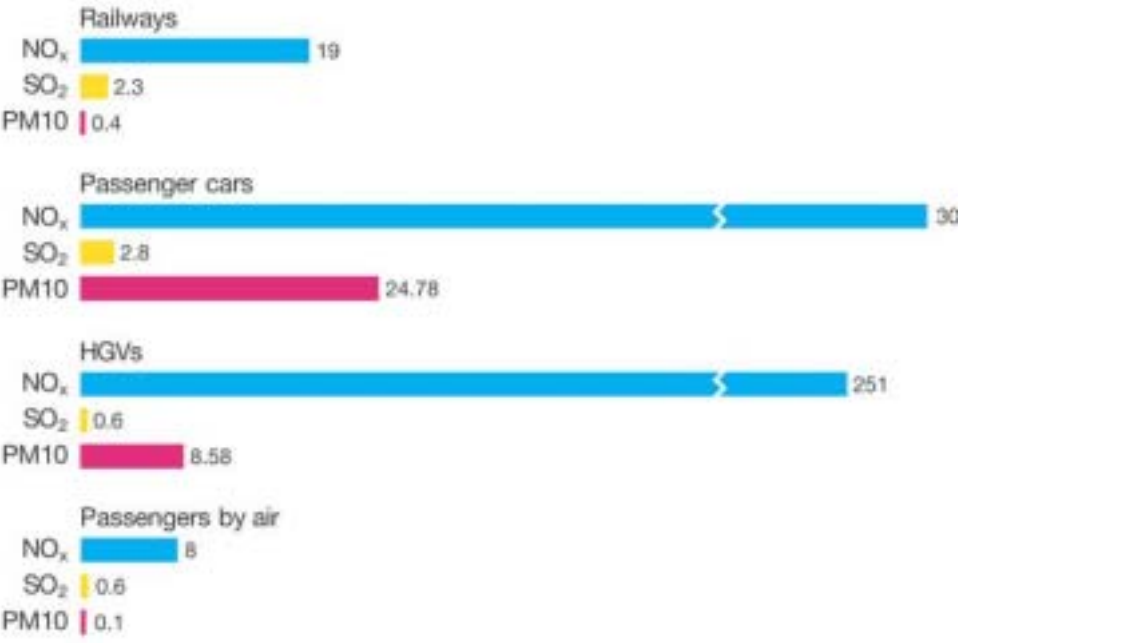
Poor air quality has negative implications for human health and biodiversity. As a user of internal combustion engines, the rail industry contributes to air pollution. Improvements from the transport sectors are being encouraged through the following European Union (EU) Directives:

- ❒ Use of biofuels or other renewable fuels for transport [2003/30/EC]
- ❒ Sulphur Content of Certain Liquid Fuels [1999/32/EC]
- ❒ Non-road Mobile Machinery [2004/26/EC]
- ❒ Fuel Quality [2003/17/EC].

During January 2007, amendments to the Fuel Quality Directive proposed a reduction in emissions limits of sulphur dioxide (SO2). These are now being considered. It is vitally important to note that actions to reduce emissions of local air pollutants can however result in increases in CO_2, energy use and cost. Therefore, reduction strategies need to be analysed with consideration to potential trade-offs.

As has already been mentioned, in terms of current performance, rail's total contribution to air pollution is relatively small when compared to the total for all transport.

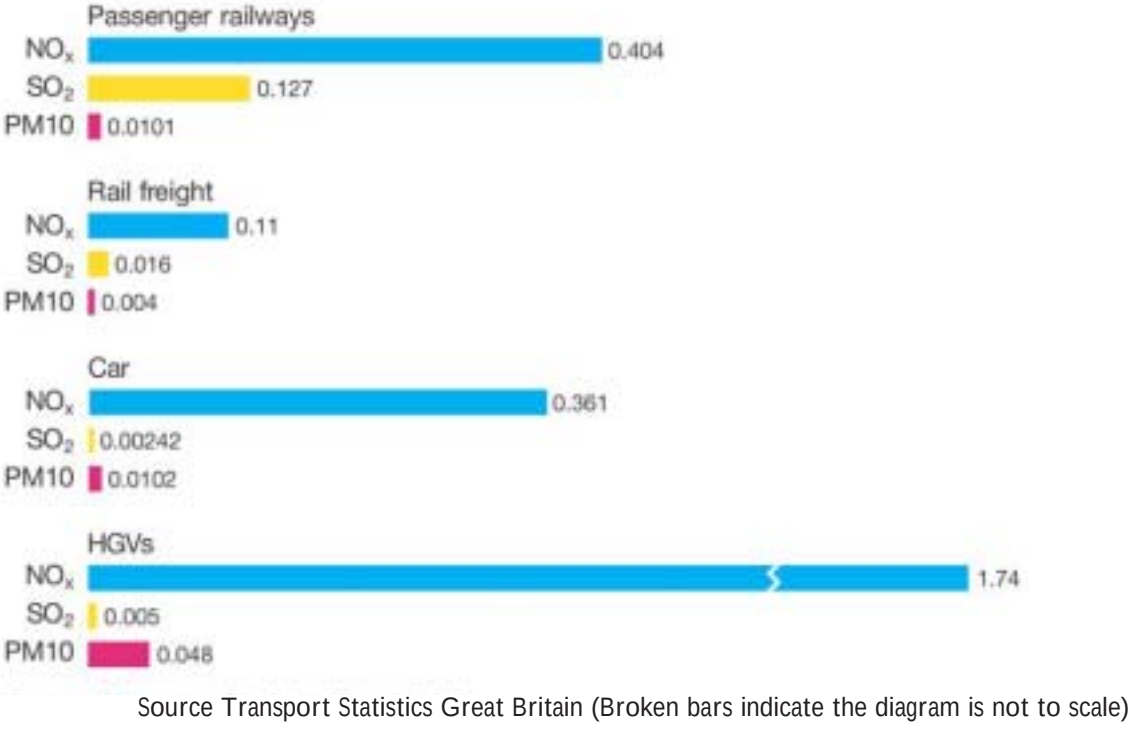
The total pollutant emissions of different transport modes (measured in kilotonnes) is illustrated in Figure 9.3



Source Transport Statistics Great Britain (Broken bars indicate the diagram is not to scale)

Figure 9.3 Total Air Polution Emissions from Diesel-powered vehicles by Transport Mode

The pollutant emissions measured in grams per passenger kilometre or freight tonne kilometre of different transport modes are illustrated in Figure 9.4.



Source Transport Statistics Great Britain (Broken bars indicate the diagram is not to scale)

Figure 9.4 Specific Air Emissions from Diesel-powered vehicles by Mode for GB Transport

This illustrates that:

- Passenger trains are comparable to cars on emissions of particulates (PM10) but under-perform on SO2 and nitrogen oxides (NOx) on a normalised per passenger kilometre basis.
- Rail freight outperforms HGVs on emissions of NOx and PM10 but under-performs on SO2 on a normalised per freight kilometre basis.

Based upon current performance, the industry has a significant role to play in delivering sustainable transport, particularly through modal shift to rail from less sustainable transport modes.

The industry is pursuing improvements through a number of important activities:

Fuel trials have been carried out to determine the feasibility of using Sulphur Free Diesel (road diesel) on the current diesel train fleet instead of gas oil. This project was awarded the Bombardier Transportation Award for innovation in Sustainable Development (RSSB 2007 6).

The industry short-term fuel strategy to cover the next five to ten years is being developed. As well as technical complexities, there are important financial implications to consider including fuel commodity price, quantity required, taxation and the value of environmental benefits.

The industry is committed to ensuring a coordinated approach to reduce traction SO2, PM10 and NOx emissions. Trade offs such as increases in CO_2, energy use and cost will be considered.

The role of electrification continues to be the subject of debate. The key determinant of the level of local air pollutants is the choice of diesel or electric traction. Currently, 40% of the mainline network in Great Britain is electrified (3,062 miles or 4,928 kilometres) and 62% of all passenger journeys are by electric traction (RSSB 2007 5). The industry is committed to developing a tool to assess the viability of further electrification. In the future, rail should be aiming to maximise the number of electrically powered services on the electrified network by using fewer diesel-powered trains on these routes.

Future fuels technology is also being evaluated. Energy storage and fuel conversion technologies on-board trains, eg fuel cells, are being considered. These could potentially deliver substantial improvements in local air quality. The industry is participating in fuel cells research and its application to rail.

Terminal stations can contribute to increased concentrations of air pollutants due to engine idling of diesel-powered trains. Further work has been recommended to quantify more accurately the contribution of idling at stations and yards to pollutant concentrations. The industry is committed to minimising the impact of diesel engine idling. Measures have been taken to alter operational procedures to reduce air emissions from idling engines at enclosed stations.

NEXT STEPS

This chapter has only touched on some of the key initiatives which the rail industry is working on in two of the more important areas of sustainability. Clearly the issues of contributing to solving the problems of climate change and improving air quality are among the most important but rail organisations from within the industry in partnership with the Office of Rail Regulation and DfT are co-operating in many areas and seeking to ensure that good progress is made. It has not been possible in the space available to go into the detailed technical issues which are explained in some depth in the various research reports mentioned: the reader is invited to start with *'The Case for Rail 2007 – the first sustainable development review of the mainline railways of Great Britain'* (RSSB 2007 1) and drill down from there. Further reading would include the Rail White Paper, *'Delivering a Sustainable Railway'* which was published in July 2007 and its related documents (DfT 2007).

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