International Transport Forum
28-30 May 2008, Leipzig

Environmental and Social Sustainability of Transport Intermodal Choices

K. L. Thapar
Asian Institute of Transport Development
India

Sinning to Survive and Prosper

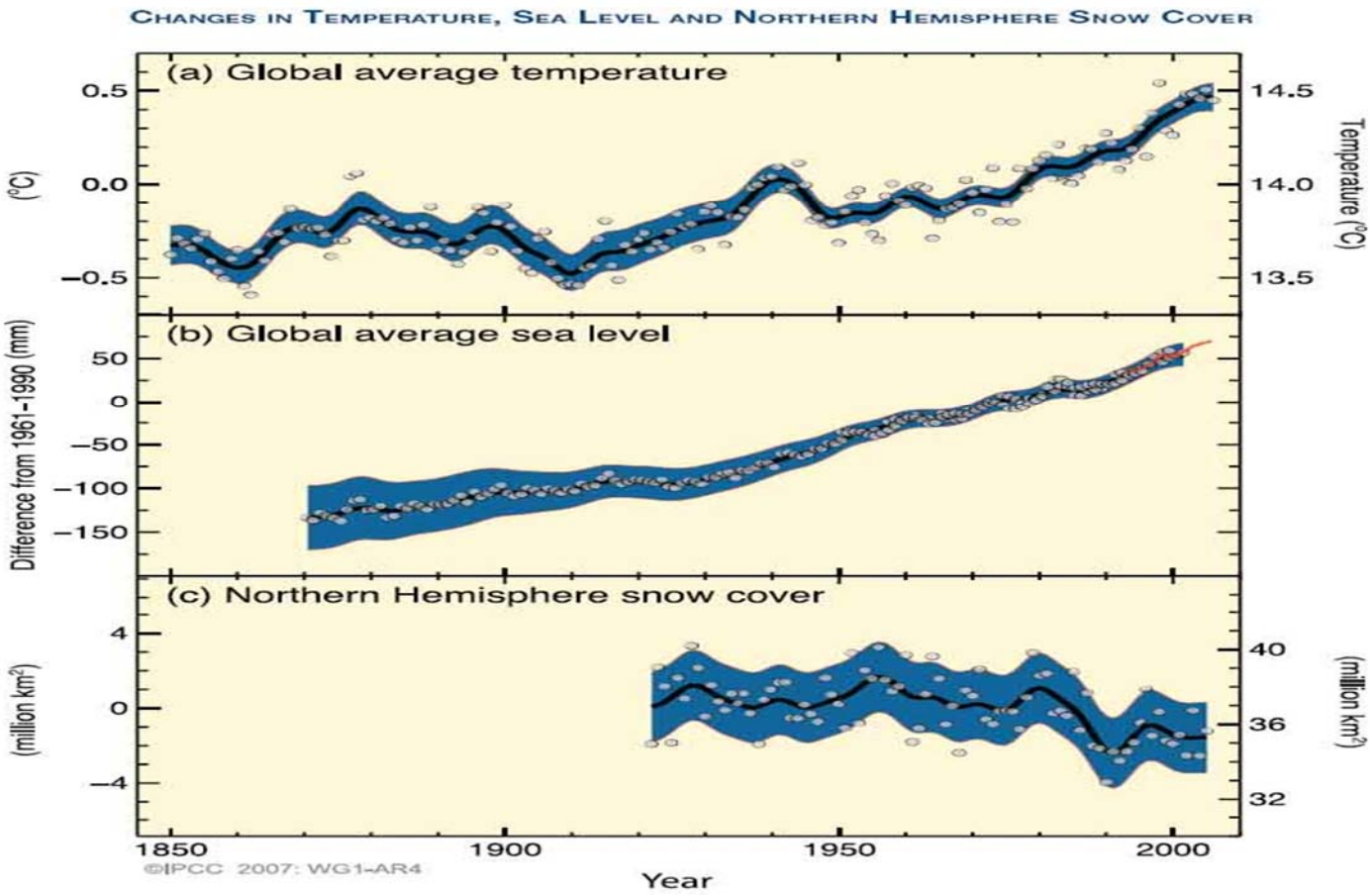
Ever since man's emergence on earth, the conditions under which he lives have been largely shaped by the ease and speed with which he is able to transport himself and his goods. However, if invention of the wheel was the precursor of civilization, environmental pollution is civilization's original sin.

The Looming Disaster

- **Climate change threatens the basic elements of life for people around the world – access to water, food production, health and use of land and the environment.**
- **The impacts of climate change are not evenly distributed – the poorest countries and people will suffer earlier and most.**
- **Increasing risks of serious, irreversible impacts from climate change associated with business-as-usual paths.**

The Evidence

- **There is overwhelming scientific evidence that the global climate is changing. The world is getting warmer.**

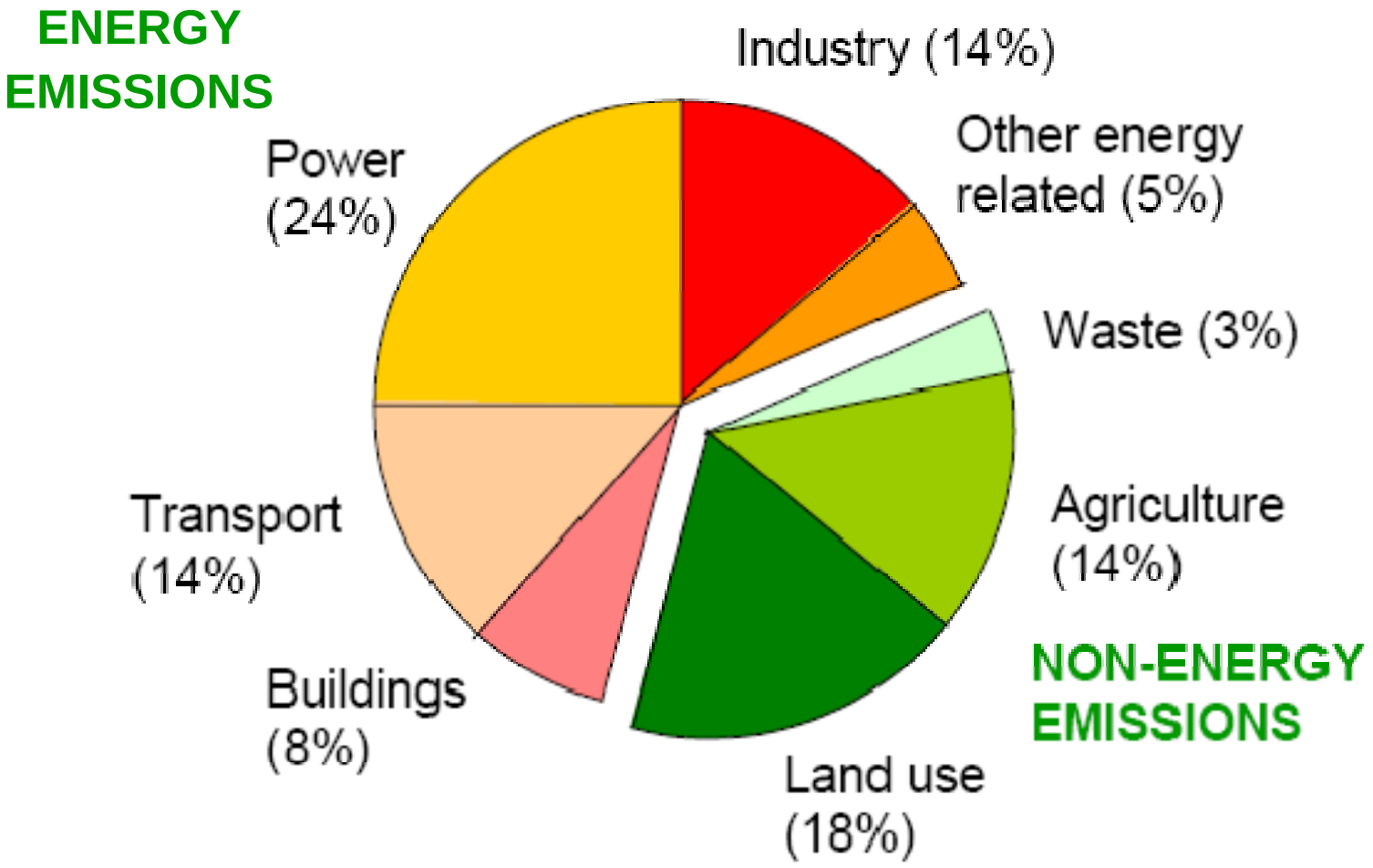


Source: World Bank, Global Monitoring Report, 2008.

Transport and the Environment

- **Transport is not wholly a benign activity. It stresses nature in multiple ways – consuming scarce resources, emitting pollutants and generating harmful wastes.**
- **Transport sector is a major consumer of fossil fuels. In 2004, it used 23 percent of the worldwide total energy.**
- **Greenhouse gas emissions mainly arise from increasing use of carbon-based energy.**
- **Atmospheric carbon dioxide concentration has increased by as much as 31 percent since 1750. In 2006, the share of transport in greenhouse gases was in the range of 14-15 percent.**

Sources of Greenhouse Gases



Source: Stern Review on Economics of Climate Change, 2006, UK.

Individual Choice Vs Social Welfare

- **All human endeavour involves making a choice. Individual choices while maximizing personal welfare, may not maximize social welfare. Nowhere is this more true than in the transport sector.**
- **The intermodal choice of transport has been a matter of concern. Different modes of transport use different forms of energy with varying efficiency and intensity and consequential environmental damage.**
- **There is a growing recognition that the transport systems and modal choices should factor in the cost of environmental degradation and social damage, as it would promote overall sustainability and sustainable transport.**

Environmental Costs & Modal Choices

- **AITD carried out an empirical study exploring the economics of environmental and social costs for the two modes of rail and road transport and monetized them in a manner relevant to Indian conditions.**
- **An important objective of the study was to find out if there was an optimum modal choice and, if so, how to induce the transport user to move towards such optimal modes.**
- **The valuation of environmental service has to be in the context of ecological, social and institutional perceptions and relevance.**
- **Poorer countries have low social preference for environmental effects like noise pollution.**

AITD Study: Methodology

- **This study analyses only those factors which are of greater damage value in developing economies, such as air pollution, congestion and accidents.**
- **Essentially, the empirical model simulates the substitution of a fixed volume of traffic of one mode for an equivalent volume of traffic of the other mode throughout the given time horizon of the analysis and assesses the implications of such substitution in terms of variables of costs and environmental externalities.**
- **The selected rail and road sections broadly represent characteristics of transport situation in the country. The rail sample matches the road service closest in terms of transport output.**

AITD Study: Methodology

- **The simulation relates to the effect of additional given traffic of 10,000 passengers per day or 10440 tonnes of freight per day for long sections and half of these volumes of traffic for shorter sections.**
- **Estimates of road traffic flows and their composition are based on road census data. Road capacity has been normatively chosen and traffic volumes in excess of this capacity represent congestion levels.**
- **Estimates of energy consumption relate to requirements of hydrocarbons and electricity. In case of roads, these are based on road user cost data and economic evaluation of highway projects in India.**

Fuel Choices

- **In case of rail, a special software has been used for simulating train runs to determine diesel fuel consumption, while published data has been used to estimate electricity consumption.**
- **Fuel consumption takes into account variables of speed, gradients, roughness of surface and power-to-weight ratio of engines.**
- **For comparative analysis, energy consumption on both the modes is inclusive of the energy used at thermal power plants and oil refineries in the generation of electrical energy and production of fuel used for locomotion.**

Technical Coefficients

- **Most emission coefficients have been derived from the studies of Intergovernmental Panel for Climate Change (IPCC).**
- **The transfer effect of the emissions at the thermal power plants for generation of electricity used in electric rail traction has been duly accounted for.**
- **The transfer effect of energy use and emissions at oil refineries and steel plants has also been considered.**
- **Health cost estimated on the basis of transfer of benefit method from other country studies and adjustments made for variations in population density, per capita income and purchasing power of currency and exchange rate.**

Results - I

- **Rail consumes much less energy than road and has maximum advantage in respect of freight traffic – 75 to 90 percent less energy for freight and 5 to 21 percent for passenger traffic.**
- **Diesel bus emerges as a close energy-efficient option in comparison to rail. Proportionately higher tare weight of rail passenger coaches as compared to road vehicles results in higher energy consumption.**
- **CO_2 emissions attributable to freight traffic on rail are invariably less as compared to road transport. CO_2 emissions attributable to passenger traffic on rail present a mixed picture.**
- **CO_2 emission in case of rail are negligible. NOX emissions are lower on rail than on road. NMVOC emissions are almost negligible on rail.**

Results - II

- **TSP emission are lower on rail with diesel traction than on road. The position reverses in case of electric traction. Diesel bus emits much higher levels of SO_2 and TSP as compared to petrol-driven car.**
- **Comparison of diesel and electric traction shows that electric traction accounts for higher CO_2, SO_2/SOX and TSP emissions if the polluting effect of the use of coal for power generation at thermal plants located in urban areas is transferred to the transport sector.**
- **This effect gets neutralised if gas is used as fuel for generating power. The electric traction is, however, much cleaner than diesel traction when other noxious pollutants, such as CO and NOX are considered.**

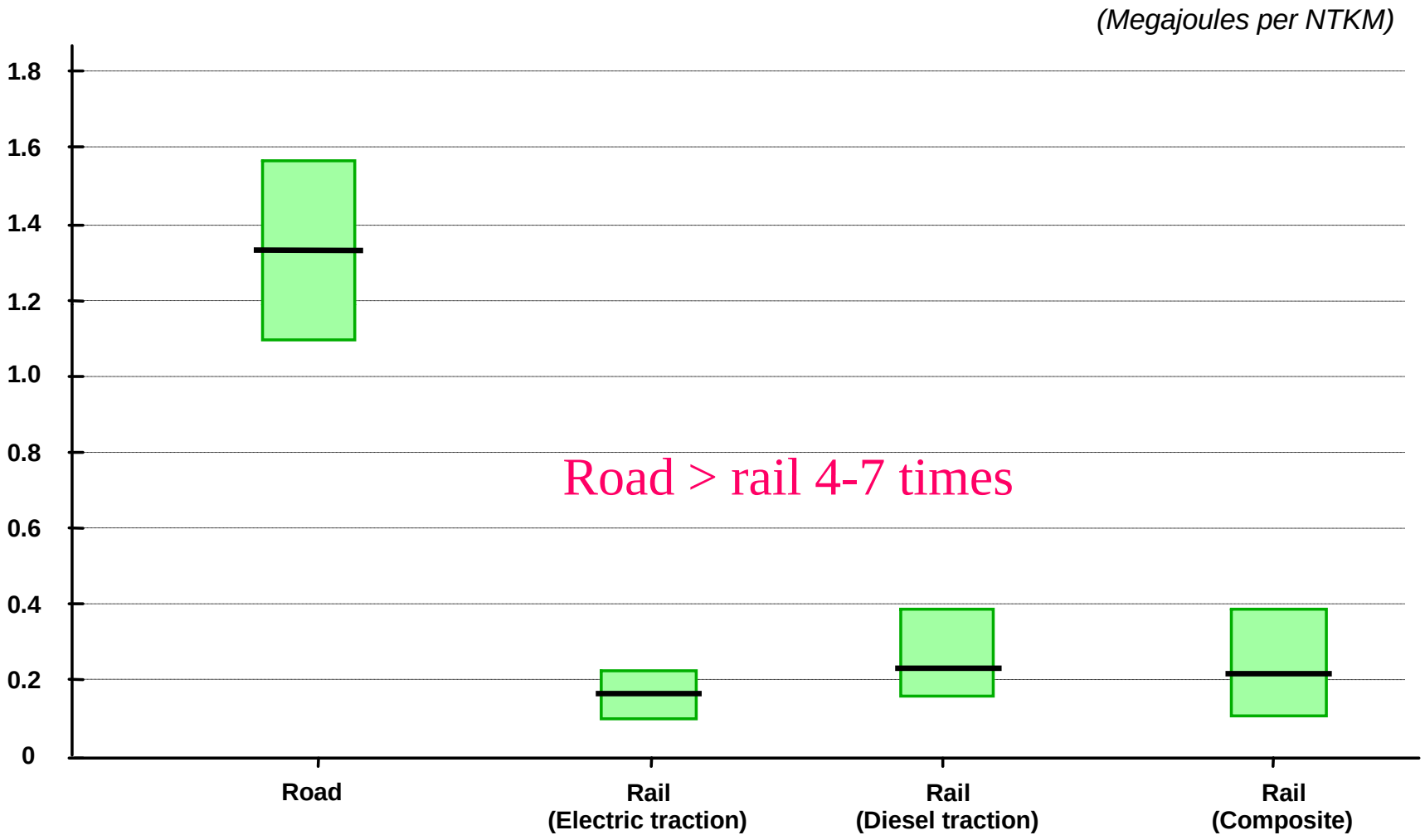
Results - III

- **Diesel bus scores over car in respect of CO_2 and CO emissions, but suffers a disadvantage in regard to NOX, SO_2 and TSP emissions. This clearly brings out the need for providing alternative cleaner fuels for buses, which are the mainstay of public transport system in the country.**
- **Substitution of 10,000 tonnes of road freight traffic results in huge savings in energy consumption amounting to 614522 litres of diesel per day.**
- **On an average, the health damage cost of rail freight traffic is lower than that of road by a factor of 7, while in case of passenger traffic, it is lower by a factor of 5. The health damage cost of rail is, however, higher if electric traction is considered for carrying passenger traffic.**

Results - IV

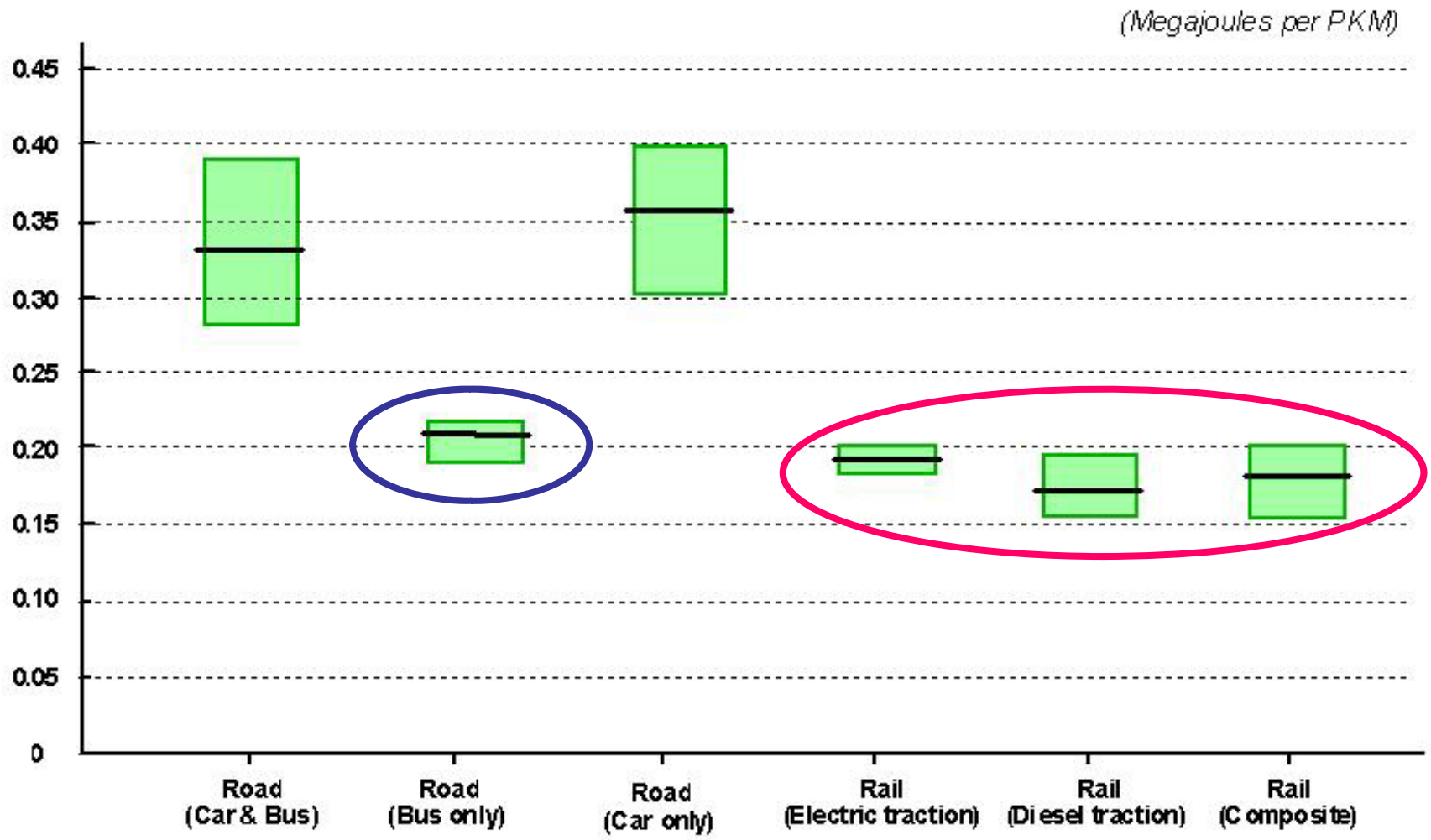
- **The accident costs on road are significantly higher than those on rail. In the case of passenger traffic, the costs are higher by a factor of 8, while for freight traffic, these are higher by as much as 45 times.**
- **In terms of social costs, also termed as all-inclusive costs, railways have a huge cost advantage over road transport. The advantage is greater in freight traffic than in passenger traffic.**
- **The effect of congestion is more pronounced in the case of road transport as compared to rail, thereby further enhancing the cost advantage of rail.**

Energy consumption: Intercity freight road & rail



Source: AITD, Environmental and Social Sustainability of Transport: Comparative Study of Rail and Road

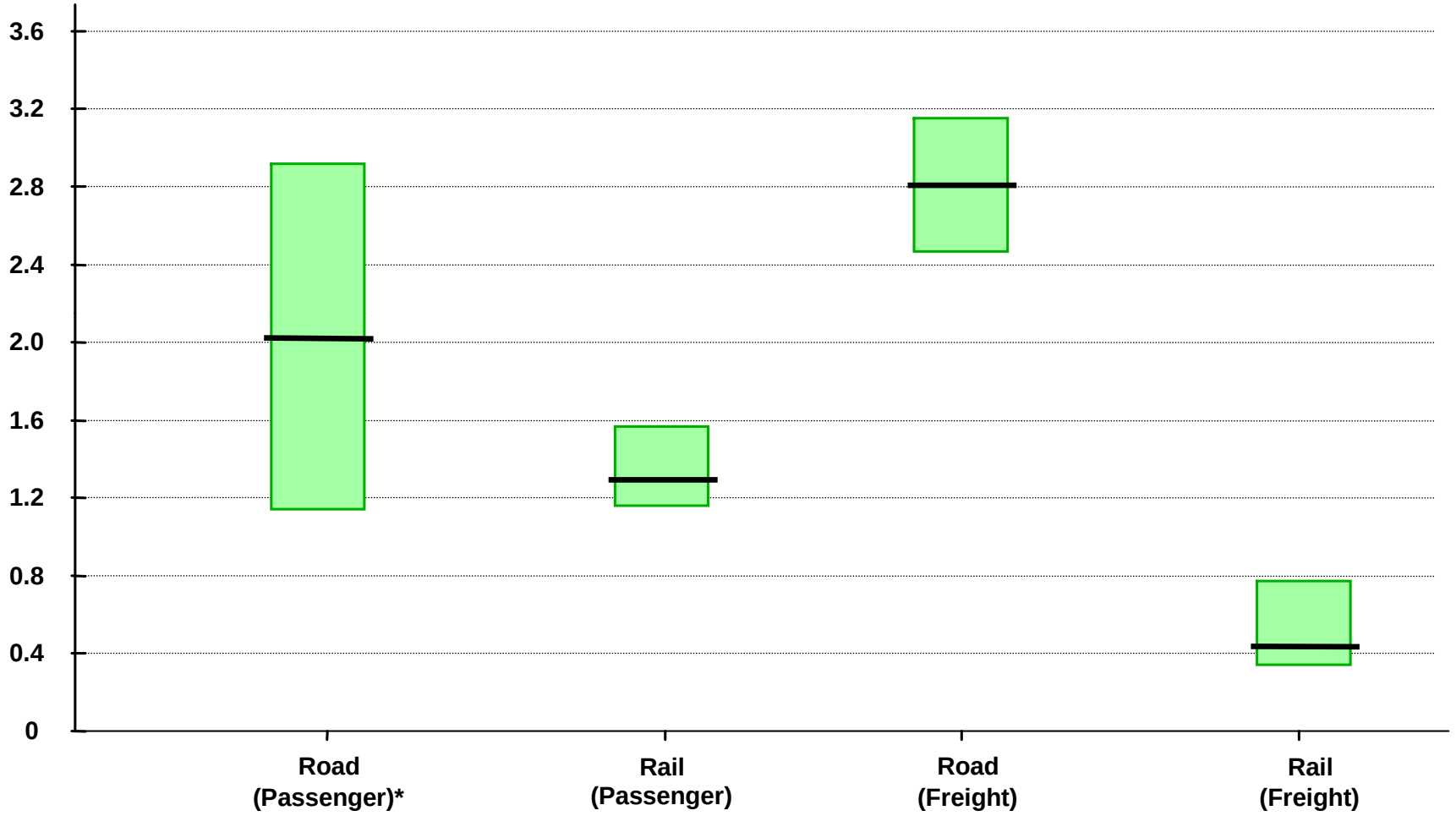
Energy Consumption: Intercity passenger road & rail



Source: AITD, Environmental and Social Sustainability of Transport: Comparative Study of Rail and Road

Social Costs:
Intercity Freight & Passenger Transport

(Rs. per PKM/NTKM)



** The option of 'bus only' is considered for road passenger transport.*

Source: AITD, Environmental and Social Sustainability of Transport: Comparative Study of Rail and Road

Signposts for the Future

- **The empirical results provide a framework for bringing about policy changes to induce shift of modal choice in favour of rail, particularly for freight traffic and in favour of public road transport over personalised transport.**
- **Regardless of the socio-political context in each country, the movement to effect this modal shift should begin sooner than later.**