Transportation Scenario 2030 and Environmental Impact

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Prologue

The Authors have brought out the present & the expected transport scenario for the major transport modes like railways, roadways, airways and shipping. An overview of the growing concern for environmental pollution and climate change due to the transport sector has been given. There is a wide range of mitigation choices and those relevant to the transport sector have been covered in greater detail.

Further, in view of the growing world wide concern for environment and climate change, the need for an early and joint global action has been reiterated. The Authors emphasise that to achieve a reduction in CO₂ emissions, there should be a shift in the modal balance from transport modes with the higher climate/gas emissions (cars/aircrafts) to less harmful transport modes (Railways/coastal shipping/inland waterways).

The emerging global financial crisis, however, is likely to impair the availability of resources for the ‘cleaning-up’ act. Nevertheless, if we act with sufficient speed globally, we may perhaps not have to make a choice between averting climate change and promoting growth and investment.

- Editor

Introduction

Since man’s emergence on earth, the evolution of living conditions has been shaped largely by sustenance and transportation needs. Although invention of wheel is considered as one of the most important development by mankind, environmental pollution is now considered civilization’s original sin, the ‘apple’ episode notwithstanding.

The rapid evolution and availability of automobiles have extended the advantages of mobility. Better roads have facilitated the opening up of greater economic opportunities for many nations. The capability to acquire a personalized vehicle by the common man,
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according to his need and desire, has added to the numbers during the recent decades. Like energy, all forms of mechanized transport have an adverse impact on the environment, which has now emerged as one of the urgent and important global issues. These developments, through the rapid increase in the road transport, have brought major concerns for our environment, our living space, and our very lives.

Transport Scenario

Transport and trade have always been closely linked. Over the centuries, the epicentres of maritime trade have tended to shift with the ebb and flow of history. It was Venice in the 15th century, Antwerp and Amsterdam in the 16th & 17th century, London in the 18th century, North America in the 19th century, Japan and South Korea in the 20th century, and now it is China and India.

The size of the global transport market is about US$ 3.5 trillion. Also, logistics has a major share in the output (GDP) of a country. While in the USA this share is 10%, in India it is 13%. China has a 20% logistics share in its GDP.

An assessment of the share of global output through the ages makes for interesting reading. (Table 1)

<table>
<thead>
<tr>
<th>Year</th>
<th>India</th>
<th>USA</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>1AD</td>
<td>33 %</td>
<td>0 %</td>
<td>27 %</td>
</tr>
<tr>
<td>1500AD</td>
<td>25 %</td>
<td>0 %</td>
<td>25 %</td>
</tr>
<tr>
<td>1820AD</td>
<td>15 %</td>
<td>2 %</td>
<td>33 %</td>
</tr>
<tr>
<td>1950AD</td>
<td>4 %</td>
<td>28%</td>
<td>5 %</td>
</tr>
<tr>
<td>Present</td>
<td>6 %</td>
<td>21%</td>
<td>13 %</td>
</tr>
</tbody>
</table>

The variations in the shares between civilisations is thought-provoking.

Scenario in India

An assessment of the existing and projected traffic scenario in India for 2029-30 is shown at Table 2.

<table>
<thead>
<tr>
<th>Mode</th>
<th>2006-07</th>
<th>2029-30</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mill. Tonnes</td>
<td>%Share</td>
</tr>
<tr>
<td>Rail</td>
<td>728</td>
<td>34.60</td>
</tr>
<tr>
<td>Road</td>
<td>1300</td>
<td>62.00</td>
</tr>
<tr>
<td>Coastal Shipping</td>
<td>70</td>
<td>3.30</td>
</tr>
<tr>
<td>Air</td>
<td>2</td>
<td>0.10</td>
</tr>
<tr>
<td>Total</td>
<td>2100</td>
<td></td>
</tr>
</tbody>
</table>

Table contd.
Passenger

<table>
<thead>
<tr>
<th>Mode</th>
<th>2006-07 Nos. (Bill.)</th>
<th>%Share</th>
<th>2029-30 Nos. (Bill.)</th>
<th>%Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail</td>
<td>6.20</td>
<td>15.70</td>
<td>19.20</td>
<td>13.00</td>
</tr>
<tr>
<td>Road</td>
<td>33.00</td>
<td>84.05</td>
<td>125.20</td>
<td>84.00</td>
</tr>
<tr>
<td>Coastal Shipping</td>
<td>0.001</td>
<td>0.05</td>
<td>0.009</td>
<td>0.10</td>
</tr>
<tr>
<td>Air</td>
<td>0.090</td>
<td>0.20</td>
<td>2.30</td>
<td>2.90</td>
</tr>
<tr>
<td>Total</td>
<td>39.291</td>
<td></td>
<td>146.709</td>
<td></td>
</tr>
</tbody>
</table>

_Highlight_

**Rail**

Rail transport is an energy-efficient and capital-intensive means of mechanised land transport and a vital component of logistics. Railways in India have a route length of 63,400 km. Presently, IR owns 210,000 wagons, 45,000 coaches and 8200 locomotives and runs more than 18,400 trains daily, including about 9,000 passenger trains and 9,400 goods trains.

**Road**

In India, 70% of vehicles are two wheelers. They are likely to rise from 101 per thousand population to 393 by 2030 in all towns (having more than 1 lakh inhabitants). By 2030, India will be the third largest auto market, behind US & China. In fact, by 2050, India will have the largest number of cars on the road.

It is estimated that there are 875 million motor vehicles world-over, of which 75% are personal automobiles and that the number of registered vehicles in 2029-30 would be around 2300 lakhs.

**Aviation**

India’s air travel (largely passenger) is expanding at about 25 per cent a year and by 2025 the growth in this sector is expected to outpace the global average.

**Global Transport Scenario**

The total transport demand has been growing 10% every year. At the current growth of global economy, the total transport volume by this century-end is expected to be four times the present levels. However, in view of the current global financial scenario, the estimates could actually be lower.

The volume of road traffic would multiply by about five-fold in the next 20 years.

The growth rate in air traffic would be about 20% every year and air passenger traffic would increase four-fold over the next twenty years. About 30% of world trade (by
value) moves by air. It has been estimated that over the next 20 years, world air-cargo volumes could treble. Similarly, coastal shipping freight’s yearly growth rate would be about 6 % in the next 20-25 years.

It is interesting to know that amongst the non-motorised transport, bicycles form one of the most convenient transportation means. In Netherlands, bicycles account for 27% of the road mileage and the average distance cycled/year per person is about a 1000 km.

**Global Energy and Consumption**

It is estimated that 20% of the global population in the West is responsible for 75% of the global energy consumption.

US is by far the largest consumer of energy, both in absolute and per-capita terms. The 3.6 billion people in developing countries (about 65% of the world’s population) account for only 23% of the world’s total energy used.

<table>
<thead>
<tr>
<th>Table 3 : Energy mix fuel-wise</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>World (%)</strong></td>
</tr>
<tr>
<td>Oil</td>
</tr>
<tr>
<td>Natural Gas</td>
</tr>
<tr>
<td>Coal</td>
</tr>
<tr>
<td>Nuclear Energy</td>
</tr>
<tr>
<td>Hydro Electricity</td>
</tr>
<tr>
<td>Renewable</td>
</tr>
</tbody>
</table>

The global primary energy consumption growth is about 1.4 % annually. China and India, who are on a comparatively higher growth path than the developed countries are, however, fast catching up. It is estimated that two thirds of the additional energy demand (in 2030) will be from developing countries, largely due to faster economic and population growth.

Transport consumes about 26 % of world’s total energy used. However, transport is dependent on oil for more than 97% of its energy requirements and uses about 2.5 trillion litres of oil annually.

When we consider the mode-wise share of energy consumption in India’s transport sector, it is seen that road transport has the major share :

- Railways 10 %
- Road Transport 78 %
- Civil Aviation 11 %
- Water Transport 1 %
The railways use only one-ninth of the energy vis-à-vis that for road transport and one-thirtieth of that used by air transport (tkm basis). Interestingly, shipping is one of the most energy-efficient cargo transportation modes.

Environment Scenario

The Intergovernmental Panel on Climate Change (IPCC), in its latest Assessment Report (Fourth), has brought out that Global Warming is taking place largely due to human activity, resulting in increased emissions of greenhouse gases (GHGs). There has been a 37% increase in atmospheric CO\textsubscript{2} between the years 1750 and 2005 (380 ppm). Further, during the last hundred years, there has been a temperature increase of 0.74°C. This is expected to increase by another 1.1°C during the next 50 years. At the current rate, it may rise between 1.8°C to 4°C at the end of this century.

Glaciers have been receding and the ice in the polar regions is melting rapidly. The area of Indian glaciers has reduced by more than 20% in the last 45 years. This would lead to rise in sea levels. It is being predicted that consequent to global warming and climate change, there would be heavy rains/floods/stormy weather during rainy seasons, and increased water stress during dry months. In the 20\textsuperscript{th} century, sea levels have increased by about 17 cm and may rise between 20 cm to 58 cm by the 21\textsuperscript{st} century under different temperature-rise scenarios. Flooding of low-lying coastal areas, submergence of islands and about 30% drop in agriculture production has been predicted.

Kyoto Protocol

The historic Kyoto Protocol was a first step in the collective global response to tackle climate change. The industrialised countries were required to reduce collective emissions of GHG by 5.2% at the end of 2010 from the 1990 levels. This would be about 29% less than the 2010 projected emission levels. The “Polluter Pays” principle was recommended. Also, the technology for emission reduction measures was to be transferred from the developed countries to the developing countries (Clean Development Mechanism - CDM). Further, GHG concentration was sought to be restricted to 445 ppm – 650 ppm.

Transportation and its Effect on Environment

An analysis of Green House Gas (GHG) emissions sector-wise shows that energy generation (supply) has the largest impact on environment.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy supply</td>
<td>26 %</td>
</tr>
<tr>
<td>Transport</td>
<td>13 % (74% is from road transport)</td>
</tr>
<tr>
<td>Industry</td>
<td>19 %</td>
</tr>
<tr>
<td>Buildings</td>
<td>8 %</td>
</tr>
<tr>
<td>Agriculture</td>
<td>14 %</td>
</tr>
<tr>
<td>Others</td>
<td>20 %</td>
</tr>
</tbody>
</table>
It is seen that transport, which is a major component of trade and output of a country, has a sizeable impact on the environment.

At present, the biggest contributor to CO₂ emissions is the USA.

<table>
<thead>
<tr>
<th>Country</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>24%</td>
</tr>
<tr>
<td>Germany</td>
<td>3.5%</td>
</tr>
<tr>
<td>China</td>
<td>14%</td>
</tr>
<tr>
<td>India</td>
<td>4.5%</td>
</tr>
<tr>
<td>Others</td>
<td>51.5%</td>
</tr>
<tr>
<td>UK</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

Incidentally, USA is not a signatory to the Kyoto Protocol.

Road

It is seen that road transport accounts for about 74% of the total transport CO₂ emissions. Of these, the CO₂ emissions from private cars are three times higher than those from passenger trains. Further, the road haulage vehicles have a five times more adverse climatic impact than that by goods trains.

Air

It is estimated that CO₂ emissions from global air travel are about 2% of the total GHG emissions. This is now projected to increase by 4% every year. The climatic impact of air transport emissions is, however, about four times greater (compared to road transport), since in case of aviation the GHG are directly emitted into the higher atmospheric strata.

Shipping

The CO₂ emissions from global shipping are presently about 950 million tonne. These would go up to about 1350 million tonne by 2030. In fact, CO₂ emissions from the international shipping sector as a whole exceed the annual total GHG emissions from most of the nations listed in the Kyoto Protocol. Also, the impact of the international shipping is quite substantial since 80% of all shipping emissions occur within 400 km of the coastline.

Mitigation Choices in Transport Sector

It has been assessed that with a 2% per year growth in world transportation energy use, carbon emissions by 2030 would be about 80% above the 2002 levels. To achieve a reduction in CO₂ emissions, there needs to be a modern shift from transport modes with the highest climate-gas emissions (cars/aircraft) to the least harmful transport modes (coastal shipping/rail/inland waterways). If a modal shift takes place in which the share of buses and passenger transport (public) were to increase by 10%, the CO₂ emissions would reduce by 9% (at costs $70/tCO₂). It is, therefore, important that the choice of transport mode, should be so optimized that each kind of transport operation is carried out utilizing the higher energy-efficient mode.
The total economic potential for efficiency in the transport sector is estimated to be about 2550 million tonnes CO₂ for a carbon price up to $100/tCO₂-eq.

**Rail**

The use of public transport, particularly the more environment-friendly systems, needs to be encouraged. There are a number of mitigation measures in rail transport which can be undertaken. An important area is the development and commercialization of Hybrid and Fuel Cell propulsion technology in the developed countries. Extensive use of regenerative braking technology and on-board energy storage facilities need to be globally adopted. Interestingly, rail transportation is one of the few areas in which electricity can be used for transportation and hence, its environmental friendliness. The adverse impact of power generation also needs to be addressed urgently.

Incidentally, the well-known film director Wang Kar Wai, had projected in his film “2046” that by 2046 the world would largely be connected by rail tracks. This film had won the Silver Peacock Award at the Cannes Film Festival in 2004.

**Road**

Road transportation, which is the major contributor to green-house gas emissions, needs urgent attention. The next generation environment friendly green vehicles should be developed and introduced on priority. Hybrid Vehicles, Air Cars, Fuel Cell Vehicles all have considerable potential for reducing emissions when the technology is fully developed and commercialized. In fact, hybrid technology and other developments have the potential to double the fuel economy of new vehicles in the next 25 years.

The standards for energy efficiency of vehicles should be further tightened. We must legislate that by 2012 a cumulative CO₂ ceiling of 120 gm/km should be achieved. The mitigation potential of such energy efficient vehicles would be around 0.8 GtCO₂-eq (at costs < $100/tCO₂-eq) by 2030.

As per current estimates, transport bio-fuels (ethanol, bio-diesel, etc.) provide about 2% of global transportation fuels. Development and adoption of new synthetic fuels and improved propulsion technology has considerable potential for carbon mitigation. Since bio-fuels are carbon-neutral over their life cycles, the use of ethanol and other bio-fuels should be encouraged and higher bio-fuel blending should be made mandatory. New bio-fuels should increase their share to about 10% by 2030 (cost $25/tCO₂-eq).

Based on the technological advances, the world could theoretically harvest enough bio-mass to meet the anticipated global demand for transportation fuels by 2050. However, of late, concerns for food vis-à-vis bio-fuels are being raised, which need to be, and are being, addressed.
Aviation & Shipping

Technological developments in aviation sector offers an estimated 30% improvement in fuel efficiency by 2030. The mitigation potential would be about 280 mill. tonnes CO$_2$/year (at costs $< 100/tCO$_2$-eq).

Use of low-sulfur fuel (reduction from 1.5 % S to 0.5 % S) needs to be adopted widely, especially in the marine sector. With the technological improvements and mitigation measures in this sector, emissions from the marine sector could reduce by 28 % by 2020.

Others

It is interesting to know the results of a recent study wherein it has been estimated that if 30% of car journeys below 6 km were done by cycles, it would lead to a 4 % reduction in CO$_2$ emissions from road traffic. The promotion of bicycle related transport as prevalent in a number of countries (Netherlands, China, etc.), should be encouraged in other countries too.

In accordance with the ‘user-pays’ principle, it is imperative that internalising of all external costs (viz. social and environmental) of various transportation modes, must be done and transferred to their users. That is, there should be a ‘level-field’ for all transport modes.

Some Mitigation Steps for India

It has been estimated that a large percentage of future emissions (60%) would be from China and India. We need to consider and adopt various measures for greenhouse gas mitigation.

We should seriously consider restricting ownership of cars. Of course, this implies regulating/restricting car ownership. Tough choices have to be made. In fact, production of diesel cars in India should be brought down. It is surprising to know that the tax burden on public transport vehicles (largely diesel) was considerably higher than that on private vehicles. While some corrective steps have recently been taken by the Government in this regard, more needs be done.

We must also consider taxing fuel inefficient cars. A gas-guzzler tax on inefficient cars must be imposed and a higher excise on them should be considered. Fiscal and other positive/negative incentives should be extended so that the fuel efficiency of cars, category wise, can be increased by say 45 % by 2012 (the last year of the running out of the current Kyoto Protocol). Further, to encourage development of the green auto industry (hybrid, fuel cars, etc), tax breaks/incentives should be provided.

Imperative Need for National/Global Effort

Since environment and climate change issues are all encompassing, global efforts are needed for the “cleaning-up” act.
Historically, the developed countries are largely responsible for most of the greenhouse gas emissions. The US, Europe, Japan and Russia are jointly accountable for almost 70% of the build-up of fossil fuel CO₂ between 1850 and 2004. However, increasing percentage of future emissions could be from China and India. There should be a policy framework to facilitate technology development and dissemination. The most important part of such a policy should be to place a price on carbon that would ensure movement towards a low-carbon economy across the globe.

The energy consumption per capita in industrialised countries is much higher than that in less privileged nations. With the present technology, these advanced countries can improve efficiencies by almost 3.5% annually. As for India, there is a need to adopt a development pattern that is much lower in energy intensity than that followed by the developed nations. This is important since it would also improve India’s energy security too.

To stabilise earth’s temperature increase at an equilibrium level of 2.0-2.4°C, and CHG gases at 450 ppm of CO₂ equivalent, there is an urgent need to convert energy systems from fossil fuels to climate-neutral energy sources. For this, the cost to the global economy would be only 3% of the GDP in 2030. This translates into a reduction of only 0.12% of the global GDP on an annual basis. Time is, however, running out and the global cleaning-up costs would rise exponentially if timely concrete steps are not taken.

It has been estimated that to stabilise CO₂ concentration at 450 ppm, GDP reduction in the year 2050 would not be more than 5% per annum. This means that at the global level, the required GHG emission reduction would lead to a postponement of the projected level of income/prosperity by about a year. However, the impact of the emerging slow-down in global economy could seriously impair the resource availability to tackle the climate change issues.

If we act with sufficient speed globally, we may perhaps not have to make a choice between averting climate change and promoting growth and investment.

**Integrated Transport Systems Study**

There is an urgent need to develop an integrated national strategy for India for inter-modal logistics and to develop combined rail, road, air, shipping and modal transport policies. It is seen that at present rail freight transport is about 80% commercial and road freight is about 50%. Other transport modes also have varying inbuilt fiscal support. A “level-field” approach needs to be taken for costing of rail, road and other modes of mechanized transport, which also includes social/accidental/environmental costs. This would help in formulating appropriate transportation policies based on the principle of least cost to the nation. Planning Commission has assigned such an integrated Study to RITES and it is in an advanced stage of completion.

**Conclusion**

Environment and climate change are the most serious challenges (apart from the emerging global financial meltdown), facing mankind today. The very survival of civilization
is severely threatened. Since the transport sector would continue to be a major contributor to environmental pollution in the future too, urgent mitigating actions are the need of the hour. Joint national/global action needs to be taken NOW.

"Tomorrow may be too late."

References


2. Climate Change 2007, Fourth Assessment Report (AR4), Intergovernmental Panel on Climate Change (IPCC),

3. An Approach Paper to the 11th Five Year Plan, Planning Commission, Govt. of India.


5. www.morth.nic.in (Ministry of Road Transport and Highways, Govt. of India).

6. www.rb.railnet.gov.in (Ministry of Railways, Govt. of India).

7. www.en.wikipedia.org

8. www.ipcc.ch

9. www.shipping.gov.in

10. www.planningcommission.nic.in

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The supreme reality of our time is ... the vulnerability of our planet.
– John F. Kennedy

Conservation is a state of harmony between men and land.
– Aldo Leopold