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BEST PRACTICES IN GREEN FREIGHT FOR AN ENVIRONMENTALLY SUSTAINABLE ROAD FREIGHT SECTOR IN ASIA

(EST Session 5A of the Provisional Programme)

Final Draft

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UNCRD and CAI-Asia, 2011. "Best Practices in Green Freight – for an Environmentally Sustainable Road Freight Sector in Asia." Pasig City, Philippines.

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About CAI-Asia

The Clean Air Initiative for Asian Cities (CAI-Asia) promotes better air quality and livable cities by translating knowledge to policies and actions that reduce air pollution and greenhouse gas emissions from transport, energy and other sectors. CAI-Asia was established in 2001 as the premier air quality network for Asia by the Asian Development Bank, the World Bank and USAID as part of a global initiative that includes CAI-LAC (Latin American Cities) and CAI-SSA (Sub-Saharan Africa).

Since 2007, this multi-stakeholder initiative is a registered UN Type II Partnership with more than 230 organizational members and eight Country Networks (China, India, Indonesia, Nepal, Pakistan, Philippines, Sri Lanka, and Vietnam). The CAI-Asia Center is its secretariat, a non-profit organization headquartered in Manila, Philippines with offices in China and India. Individuals can join CAI-Asia by registering at the Clean Air Portal: www.cleanairinitiative.org. Its flagship event, the Better Air Quality conference, brings together over 500 air quality stakeholders.

CONTENTS

LIST OF ABBREVIATIONS

ADB	Asian Development Bank
APUs	Auxiliary power units
ARB	California Air Resources Board
CAI-Asia	Clean Air Initiative for Asian Cities
CTA	Canadian Trucking Alliance
CO_2	Carbon dioxide
CIRC	China Insurance Regulatory Commission
DOC	Diesel Oxidation Catalyst
DPFs	Diesel Particulate Filters
ESCOs	Energy service companies
EST	Environmentally sustainable transport
ECF	European Cyclists' Federation
FRA	Federal Railroad Administration
EGR	Exhaust Gas Recirculation
GAC	General Administration of Customs of the People's Republic of China
GHG	Greenhouse gas emission
GDP	Gross domestic product
HVAC	heating, ventilation, and air conditioning
HIV/AIDS	Human immunodeficiency virus / Acquired immune deficiency syndrome
I&M	Inspection and maintenance
JICA	Japan International Cooperation Agency
LCVs	Light commercial vehicles
LPG	Liquefied petroleum gas
LCCC	London Construction Consolidation Centre
LRR	Low rolling resistance
MPS	Ministry of Public Security
NYSDOT	New York State Department of Transportation
ORNL	Oak Ridge National Laboratory
NOx	Nitrogen oxides
PM	Particulate matter
SSCCAP	Sustainable Supply Chain Center for Asia Pacific
STI	Sexually transmitted diseases
SCR	Selective Catalytic Reduction
TKM	Ton kilometer
TSE	Truck Stop Electrification
UNCRD	United Nations Centre for Regional Development
WHO	World Health Organization

EXECUTIVE SUMMARY

The efficient movement of goods and services is important in achieving sustainable development. All main modes of freight – road, water, air, and rail – have impacts on the economy, environment, and society that need to be managed. Freight trucks account for 24% of global carbon dioxide (CO_2) emissions from transport vehicle use and also have a major impact on fuel use and fuel security, air pollution, traffic accidents, and HIV/AIDS.

This paper focuses on the road freight sector as it is the dominant mode of freight in Asia. It is a sequel to the paper "Challenges and Opportunities for an Environmentally Sustainable Road Freight Sector in Asia" that was prepared for the 5th Regional Environmentally Sustainable Transport (EST) Forum in 2010.

At the 6th EST Forum that is held in Delhi in December 2011, discussions focus on the implementation of the Bangkok 2020 Declaration which includes sustainable transport goals and indicators. The following goal was agreed for freight transport:

- Goal 12: Achieve improved freight transport efficiency, including road, rail, air and water, through policies, programmes, and projects that modernise the freight vehicle technology, implement fleet control and management systems, and support better logistics and supply chain management
- Draft indicators: (a) Quantify improvements in freight vehicle fuel efficiency (b) Quantify changes in freight vehicle types (c) Quantify network efficiency gains

An analysis of freight in the EST host country India found that road freight activity, in billion ton-km, is in India is expected to be 9 times higher in 2050 compared with 2000 level. This is higher than the total growth for Asia over the same period of 645 per cent, and the global growth of 241 per cent. Road infrastructure investments have resulted to a gradual shift of freight from rail to road: 12 per cent of total freight the 1950s to more than 60 per cent in 2005. With 65 per cent bulk commodities and 75 per cent of freight transported over 400 km, this represents a missed opportunity for rail freight which would be more efficient and result in lower emissions and traffic accidents. Despite relatively low truck numbers (5 per cent of total vehicles), the impact from road freight in India is significantly higher than for other vehicles, including accidents (26 per cent), PM emissions (59 per cent) CO_2 emissions (63 per cent) and in total diesel consumption (74 per cent). For India's freight sector to become more competitive, efficient and environmentally sustainable, several challenges must be overcome including (a) policies and institutional arrangements; (b) fragmented freight sector; (c) truck composition and characteristics (d) lack of skilled drivers; and (e) lack of freight data that inhibits sound road investment and policy planning.

An integrated approach employing avoid (reduce travel), shift (to other modes) and improve (energy efficiency and reduced emissions) strategies is needed in addressing the road freight transport issues in Asia. To assist Asian governments in advancing green freight in their countries, this paper goes in more detail into available strategies to improve fuel efficiency and reduce CO_2 and air pollutant emissions, and provides best practice examples from around the world. It is noted that examples are more readily available for the US, Canada and Europe, pointing to the need to a depository for Asian practices in green freight. Strategies include:

- Technologies: tires and wheels, aerodynamics equipment, idling reduction technologies, emissions control technologies, fuel and oil, and engines and vehicles
- Logistics solutions: drop-and-hook, backloading and milk-run concept, logistics information platform, freight company consortium, and freight consolidation centers
- Modal shift: freight shift from road to rail and ships, and use of cargo bikes in cities.

Asian governments can facilitate the adoption of green freight best practices and overcome some of the issues and challenges identified. The first way is through policies and regulations. Policy interventions that stimulate increased fuel economy of trucks include fuel economy standards, technology mandates, import restrictions, economic instruments, and traffic control measures. To reduce air pollutant emissions from trucks governments can adopt and tighten standards for vehicle emissions, fuel quality, requirements to include biofuels in the fuel mix. To guide governments, the "Road Map for Cleaner Fuels and Vehicles in Asia" was prepared through a multi-stakeholder approach. As an integral part of a comprehensive strategy to reduce vehicle emissions vehicle inspection and maintenance (I&M) programs, fuel inspection and compliance programs and restrictions on the import of new and used trucks and engines based on age, technology and emissions will be critical for Asian developing countries in improving the fuel efficiency of trucks and reducing air pollution.

The second way is though Green Freight Programs, which are being established around the world and most are modeled after or based on the US SmartWay program. China is the first Asian country where a national program is being set up, and its program components could also serve as a basis for other developing Asian countries to develop national green freight programs: clean technologies, freight logistics, financing mechanisms, knowledge & capacity, and partnerships. The role that governments can play includes

- Facilitating the program, as is the case in the US, although the program in Europe will be managed by a neutral body
- Establishing a national technology verification and certification system for clean technologies applicable to the freight sector, to ensure independent and objective information is available on the costs and performance of technologies
- Support for pilot projects for demonstration of clean technologies and logistics solutions
- Support the development of training programs for drivers and companies
- Providing financing mechanisms for freight companies and drivers to acquire technologies
- Adopting policies and legislation in favor of clean technologies, improved freight logistics and mode shift to rail, ships and smaller vehicles (see Table 5 for types of policies)
- Forming collaborations or partnerships with private sector companies and other stakeholders

The following indicators linking efficiency, economy, environment and safety are proposed for measuring progress against Goal 12 of the Bangkok 2020 Declaration:

- Number of kilometers of freight rail lines
- Number of inland dry port
- Freight transport emissions per ton-km or energy use in relation to output measures as ton-km
- Freight transport intensity (ratio of total freight moved to GDP
- Traffic fatalities involving freight vehicles – number and percentage of total traffic fatalities.

Asian countries should integrate green freight efforts in a broader strategy to move towards a green economy that is low carbon and pollutants, resource efficient and socially inclusive. The following ten recommendations are made for green freight towards a green economy:

1. Adopt measures that improve the fuel economy of trucks.
2. Reduce air pollutant emissions from trucks.
3. Introduce fleet management systems to reduce emissions, fuel and improve the well-being and economic situation of drivers.
4. Reduce truck empty miles to fuel use and emissions and improve the net income of drivers as well as companies.
5. Shift from road freight to rail and waterways and from trucks to vans and cargo bikes to reduce the carbon footprint.
6. Improve intermodal transfer of freight between road, rail, waterways and ocean.
7. Address safety impacts of freight transport through the adoption of measures that improve the safety record of trucks and better law enforcement.
8. Take steps to halt the spread of HIV/AIDS and other sexually transmitted diseases among truck drivers..
9. Introduce a national Green Freight Programs that ensure the inclusion of all stakeholders of the freight sector, which is essential for a successful transformation to a greener sector
10. Adopt indicators to measure progress towards green freight and its contribution to a green economy, covering economic, environmental and social aspects.

1. INTRODUCTION

The efficient movement of goods and services is important in achieving sustainable development. All main modes of freight – road, water, air, and rail – have impacts on the economy, environment, and society that need to be managed. Freight trucks account for 24% of global carbon dioxide (CO_2) emissions from transport vehicle use.[1]

The United Nations has been leading the promotion and development of sustainable transport policies with Asian governments. Since 2005, the United Nations Centre for Regional Development (UNCRD) in collaboration with the Ministry of the Environment, Government of Japan, has organized the annual 'Regional Environmentally Sustainable Transport (EST) Forum in Asia' attended by senior government officials from environment and transport ministries from 22 Asian countries.

This paper focuses on the road freight sector as it is the dominant mode of freight in Asia. It is a sequel to the paper "Challenges and Opportunities for an Environmentally Sustainable Road Freight Sector in Asia" that was prepared for the 5th Regional Environmentally Sustainable Transport (EST) Forum in Asia in 2010. The paper for the 5th Forum described the main sustainability issues and challenges facing the road freight sector and recommended that an integrated approach employing avoid, shift and improve strategies is needed in Asia to address them.[2]

At the 6th EST Forum that is held in New Delhi from 4 to 6 December 2011, discussions focus on the implementation of the Bangkok 2020 Declaration which was agreed upon at the 5th EST in 2010. The declaration includes 20 sustainable transport goals and relevant indicators. The following goal was agreed for freight transport:

- Goal 12: Achieve improved freight transport efficiency, including road, rail, air and water, through policies, programmes, and projects that modernise the freight vehicle technology, implement fleet control and management systems, and support better logistics and supply chain management
- Draft indicators: (a) Quantify improvements in freight vehicle fuel efficiency (b) Quantify changes in freight vehicle types (c) Quantify network efficiency gains

This paper is an input for the EST Session 5A: Green Freight and Co-Benefits at the 6th EST Forum and includes the following chapters:

- Chapter 2 summarizes freight growth and issues in Asia and provides a more detailed overview of the freight sector in India, including challenges.
- Chapter 3 describes technologies and logistics strategies to improve fuel efficiency and reduce CO_2 and air pollutant emissions, and provides best practice examples from around the world.
- Chapter 4 explains how Asian governments can facilitate the adoption of green freight best practices by policies and regulations, Green Freight Programs, and measuring progress through green freight indicators in line with Goal 12 of the Bangkok 2020 Declaration.
- Chapter 5 provides recommendations for green freight towards a green economy.

[1] International Transport Forum calculations using MoMo version 2011
[2] http://www.uncrd.or.jp/env/5th-regional-est-forum/doc/03_bg_Asia.pdf

2. OVERVIEW OF THE FREIGHT SECTOR IN ASIA AND INDIA

This section provides an overview of the road freight sector in Asia and outlines main sustainability issues and challenges that must be overcome to address these. Subsequently, a more detailed analysis is provided for India as an example.

2.1 Road Freight in Asia

This section is a summary of the 2010 background paper by CAI-Asia "Challenges and Opportunities for an Environmentally Sustainable Road Freight Sector in Asia."[2]

Freight movement plays a central role in economic development in Asia. As the Asian economy continues to grow at a rapid pace, an increase in freight activity is also expected. Figure 1 shows that for road freight, the travel activity (billion ton-km) of heavy and medium trucks in Asia will increase by 645 per cent from 2000 to 2050 (as compared to 241 per cent globally) and will comprise 29 per cent of the global truck travel activity, from 13 per cent in 2000.

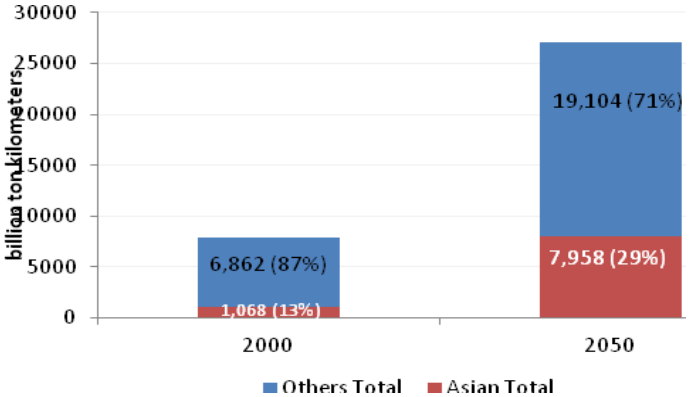


Figure 1: Travel Activity for Heavy and Medium Freight Trucks in Asia (billion ton-km)

Source: WBCSD and IEA (2004)

Road transportation dominates freight in the major Asian countries and ranges from 43 per cent in Vietnam where river and sea freight transport also play a key role, to more than 95 per cent in Pakistan.

The main sustainability issues and challenges facing the road freight sector are:

- Fuel consumption, which is becoming an increasing problem due to looming oil shortages, dependency on fuel imports and fluctuating prices. It is estimated that by the year 2050, medium and heavy freight trucks worldwide will consume 1,240 billion liters of fuel (gasoline equivalent), 138 per cent larger than 2000 levels.[3] The share of trucks operating within Asian countries to global truck energy use will increase from 19 per cent in 2000 to 34 per cent in 2050. Fuel costs can be up to two-thirds of freight costs and for countries dependent on fuel imports, rising fuel prices and fuel security are becoming key constraints for economic development.

[3] WBCSD, IEA (2004)

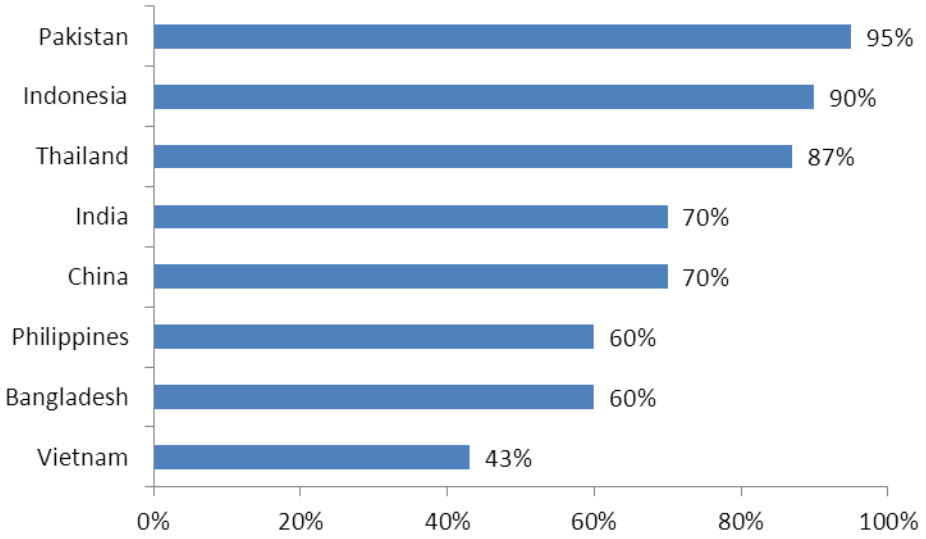


Figure 2: Percentage Share of Road Transport in Freight Activity in Selected Asian Countries

Source: Pakistan: Government of Pakistan, Engineering Development Board, Ministry of Industries, Production and Special Initiatives (2006). Indonesia: Sopadang, A. (2007). Philippines: Patdu, I. (2005). Vietnam: Lubis, H. and M. Isnaeni. (2005). China: ADB (2008). India and Bangladesh: World Bank (2008).

- Emissions, including air pollutants (especially particulate matter (PM) and Nitrogen oxides (NOx), greenhouse gas (GHG) emissions and noise, which affects people's health and causes climate change, amongst others. According to the World Health Organization (WHO), the estimated mortality attributable to outdoor air pollution in cities amounts to 1.34 million premature deaths in 2008.[4] Aside from CO_2, black carbon, which is the "soot" component of PM, from diesel trucks is a significant contributor to global warming in the next decades because of its heat absorbing capacity. The IEA estimates that the transport sector accounted for 23 per cent of the world's CO_2 emissions and transport CO_2 emissions in developing countries are expected to increase by 45.6 per cent between 2005 and 2030.[5] Trucks' contribution to fuel use and CO2 emissions is relatively high compared to vehicle numbers as shown in Figure 3. Similarly, although only 4 per cent of vehicles in China are trucks, they are responsible for 57 per cent of particulate emissions from transport.[6]
- Road accidents, which are exacerbated because of truck overloading, lack of maintenance or old age, coupled with unsafe behavior of the drivers. Across Asia, although trucks are relatively small in number, they are involved in a relatively high share of road accidents.
- Truck driver health, as particularly long-distance drivers are at high risk of getting sexually-transmitted diseases such as HIV/AIDS.

[4] http://www.who.int/mediacentre/news/releases/2011/air_pollution_20110926/en/index.html
[5] 2006 estimates- See Bellagio Declaration on Transportation and Climate Change. Available: http://www.sutp.org/bridgingthegap/downloads/cornie/Bellagio_Declaration_on_Transportation_and_Climate_Change-Final.pdf
[6] Green Freight China Seminar, Mr. Tan Xiaping, Ministry of Transport *"Low Carbon Actions in Chinese Trucking Industry"*. May 2011, http://cleanairinitiative.org/portal/node/7313

HIV/AIDS

International research indicates that transport sector workers, particularly long distance commercial drivers, are significantly more vulnerable to HIV/AIDS and to sexually transmitted infections (STIs) in general because truckers drive over long distances and are away from home for long periods of time.[7] For example, a recent study in India documented HIV prevalence rates of 16% along one particular route in southern India, while the national rate was less than 1%.[8]

Development banks are taking the lead in infrastructure projects funded by them. In fact, in 2006, the World Bank, Asian Development Bank, African Development Bank, the Department for International Development of the United Kingdom, the Japan International Cooperation Agency (JICA), and German government-owned development bank KfW agreed to recommend that infrastructure construction contractors conduct HIV/AIDS awareness programs to reduce risks of HIV transmission among their workers and the local community.[9]

Recommendations in dealing with HIV/AIDS in the transport sector, including freight are[10]

- HIV/AIDS should be an integral element in the transport agenda. Regular counselling is needed for behaviour change among the truck drivers.
- HIV/AIDS awareness programs need to "go beyond" truckers and involve communities surrounding highway stops/toll plazas/border check posts, etc.
- Monitoring and evaluation of HIV/AIDS should be part of projects in the transport sector (measurement of results)
- Capacity building is an important ingredient for successful implementation of a project in the sector (using toolkits as developed by international labour organization)
- To reduce the incidence of various STIs among long distance truckers appropriate clinical interventions are required. This also includes providing supplementary services, such as, general health services, rest and recreation facilities, insurance etc., that are observed community needs.
- Information can be conveyed through radio about the mode of transmission of HIV/AIDS and other STDs — as the radio is one of the companions most of these drivers have throughout their journey.
- Free availability of condoms through condom vending machines at various petrol pumps/ gas stations/truck lay byes
- Mandatory free health check-ups of truck drivers and cleaners (paid by operators)
- Enabling women's economic empowerment and education

[7] http://siteresources.worldbank.org/EXTAFRSUBSAHTRA/Resources/1513929-1237901978086/HIV-Mainstreaming-Transport.pdf
[8] Cited in International Labour Organization (ILO). 2005. HIV/AIDS and Work, Using the ILO Code of Practice on HIV/AIDS and the World of Work: Guidelines for the Transport Sector
[9] http://development.asia/issue05/feature-04.asp
[10] This is based on series of literature generated by development banks and other agencies

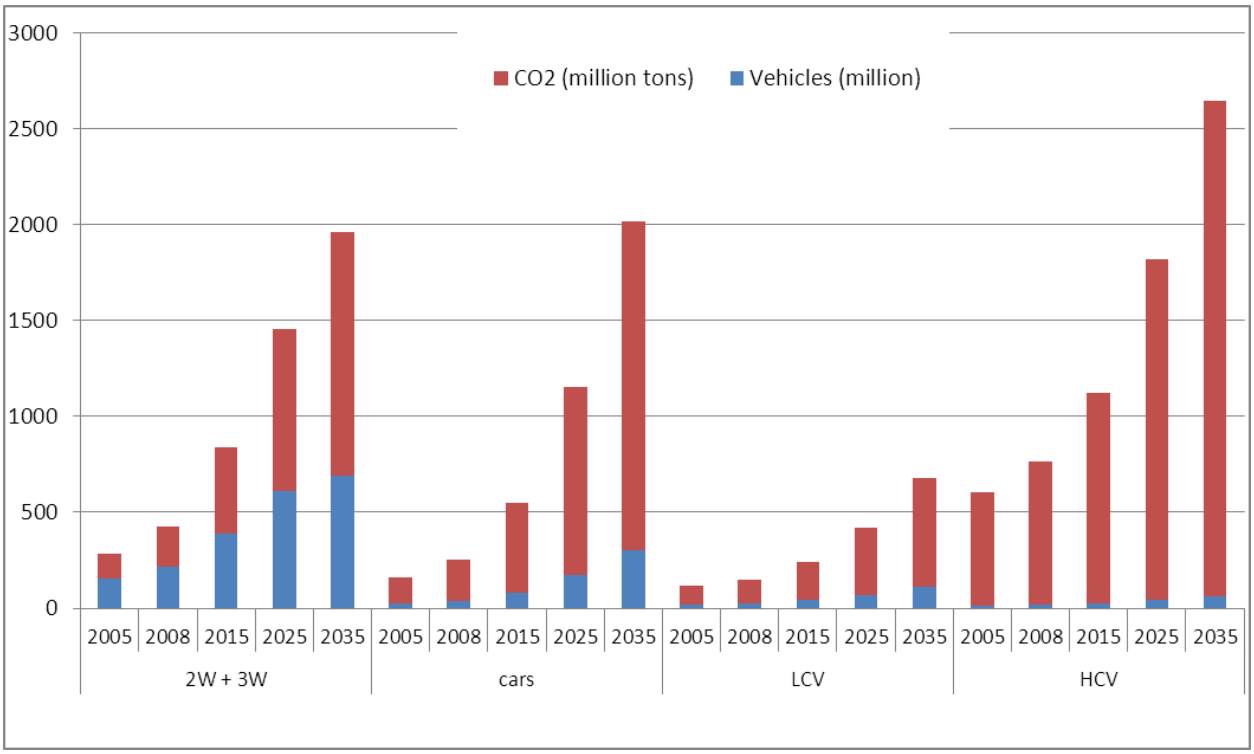


Figure 3: CO_2 Emissions and Vehicle Population from different Vehicle Types in Selected Asian Countries

(China, Indonesia, Thailand, Philippines, Vietnam)
Source: CAI-Asia, data from Segment Y

The main challenges that Asian countries must overcome to effectively address these issues relate to:

- Policies and institutional arrangements. Policies that deal with the environmental performance of trucks and the trucking industry are often lacking or limited, and poorly enforced. Furthermore, freight is seldom included in the design and planning of urban transport systems and in policy development, which results in ad hoc policies to mitigate problems associated with urban freight. The wide range of government agencies with a stake in the freight industry makes it difficult to assess and develop policies to develop the sector more sustainably.
- Freight sector. The road freight sector is highly fragmented with a majority owner-driver trucks, which makes it difficult for government agencies to reach them with information and policies on, for example, new technologies. The high percentage of empty hauls combined with systemic overloading of trucks is common and results in economic loss, higher fuel use and emissions, and safety issues.
- Technologies and financing mechanisms. The adoption of cleaner technologies is vital for developing Asia as many trucks are old and poorly maintained. Driver training and technologies can render significant fuel savings, which is important in developing Asian countries where the fuel costs are the largest component of truck operational costs. Challenges for wide-spread technology adoption are limited availability, a fragmented suppliers' network, and the presence of few case studies for Asia. Certain technologies face particular challenges, such as aerodynamics technologies as these work only at higher speeds, or diesel particulate filters (DPFs) because high sulfur diesel will corrode the filters. Financing green technologies is hampered by high

investment costs (despite potential large savings and short payback periods), the reluctance of banks and financiers to lend money to trucks drivers and small companies, the lack of experience of ESCOs (energy service companies) with trucking fleets. Financiers often do not know how to appraise financing of technologies for trucks and policymakers have minimal experience in applying economic instruments the trucking sector.

2.2. Road Freight in India

2.2.1 Freight Growth

Freight transport in India is dominated by the road sector with a share of 4.5 per cent in India's GDP in comparison to railways that has a mere 1 per cent share of GDP in 2004-2005[11]. Interestingly, the increase in percentage share of transport in GDP since 1999/2000 has come from the road transport sector only. The average 10 percent annual growth in the road sector outpaced the overall GDP growth of 6 per cent, and is expected to continue to do so, even with GDP being targeted to grow at 8-9 per cent in the future. It is estimated that investments in logistics infrastructure tripled from about USD 10 billion in 2003 to USD 30 billion in 2010 and is expected to grow at an accelerated rate to USD 500 billion in 2020.[12]

Increased GDP and investments in freight and logistics have translated into increased activity of trucks and light commercial vehicles on Indian roads, especially in the last two decades as shown in Figure 4. Freight activity (billion km) in India is expected to be 9 times higher in 2050 compared with 2000 level.[13] In terms of total number of trucks, the growth expected is 15 times in 2050 when compared to 2000 levels. This growth is only matched by China.

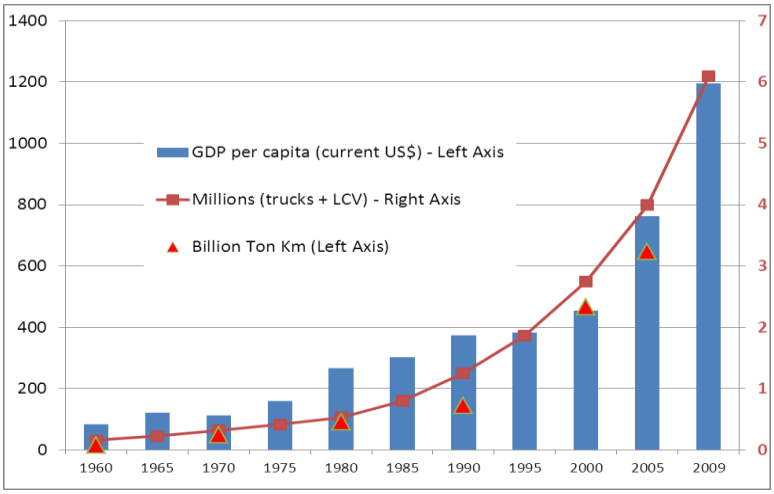


Figure 4. Growth in Vehicle Numbers and Activity in India compared to GDP Growth
Source: Author computations based on World Bank economic data and Indian Planning Commission reports[14]

[11] http://planningcommission.nic.in/aboutus/committee/wrkgrp11/wg11_roadtpt.pdf
[12] http://www.mckinsey.com/locations/india/mckinseyonindia/pdf/Logistics_Infrastructure_by2020_fullreport.pdf
[13] Based on IEA/SMP Model Documentation and Reference Case Projection- http://www.wbcsd.org/web/publications/mobility/smp-model-document.pdf
[14] Planning commission of India – five year plans - http://planningcommission.nic.in/sectors/index.php?sectors=infra

The road infrastructure improvements have resulted to a gradual shift of freight from rail to road (Figure 5). The share of road freight increased from around 12 per cent of total freight in the 1950s to more than 60 per cent by 2005. Experts have argued that unless a serious effort is made to reverse this trend, the share of road freight can increase to 85 per cent. This shift from rail to road has an enormous impact, because road freight transport is highly energy intensive and expensive compared to rail. The majority of India's freight (65 per cent) comprises bulk commodities and 75 per cent is transported over more than 400 km.[15] Transporting bulk goods by rail over these distances would be more efficient and result in lower emissions and traffic accidents.

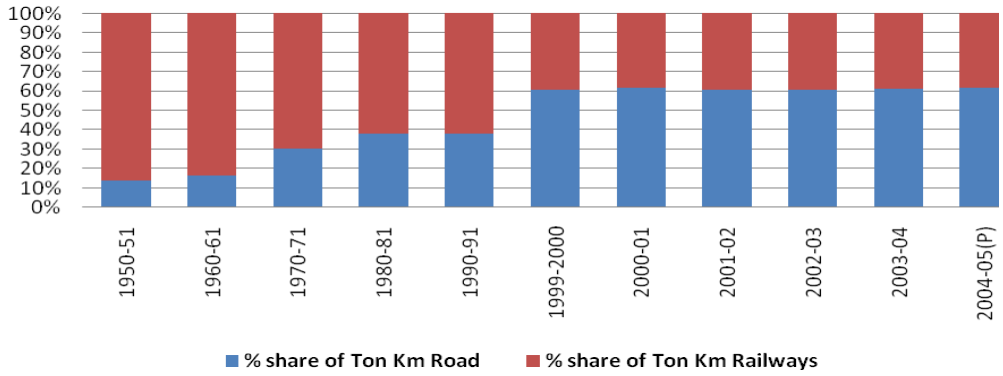


Figure 5. Increase in Road Freight versus Rail Freight in India from 1950 to 2005
Source: Working Group on Road Transport for the Eleventh Five Year Plan, India[16]

2.2.2 Road Freight Impacts

Figure 6 shows that despite relatively low truck numbers (5 per cent of total vehicles), the impact from road freight in India is significantly higher than that of other vehicles, including accidents (26 per cent), PM emissions (59 per cent) CO_2 emissions (63 per cent) and in total diesel consumption (74 per cent).

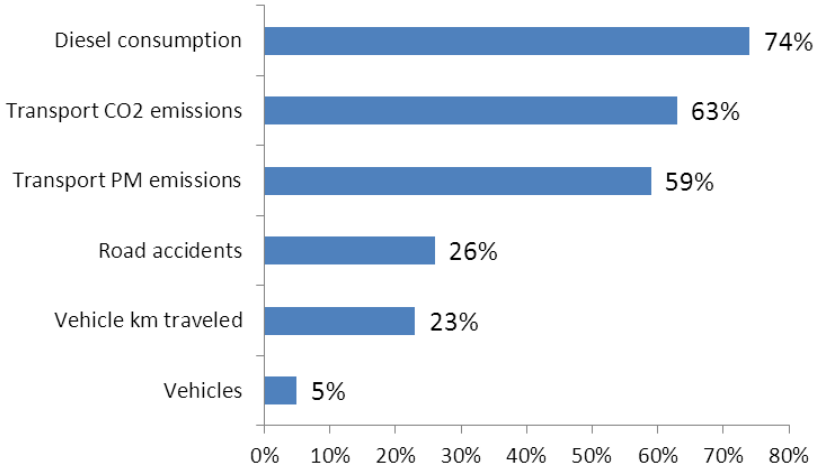


Figure 6. Contribution of Road Freight in India
Source: Author computations

[15] http://www.mckinsey.com/locations/india/mckinseyonindia/pdf/Logistics_Infrastructure_by2020_fullreport.pdf
[16] http://www.cci.gov.in/images/workshop/17-18/17Sriraman.pdf?phpMyAdmin=NMPFRahGKYeum5F74Ppstn7Rf00

TRUCK ACCIDENTS IN INDIA

- Trucks are responsible for 30 per cent of total accident fatalities, although they represent only 5.2 per cent of the vehicle population
- Around 36 per cent of truck accidents occur during normal sleeping hours
- More truck accidents occur in summer than in winter and May and June are the most accident-prone months
- Head-on accidents, followed by rear-end collisions form represent 70 per cent of truck accidents
- Nearly 50 per cent of accidents involving trucks occur near road junctions and inhabited areas
- About 48 per cent of accidents are hit-and-run cases and is highest for State highways and lower category roads
- Rough and negligent driving is the biggest cause of truck accidents (65 per cent)
- 70 per cent of injured persons die at the scene of the accident, and 7 per cent die on the way to hospital
- Deficiencies in highway design are the cause of many fatal truck accidents
- Overloading of vehicles, long hours of crew duty, intoxication and low levels of training are the major contributing factors

Based on studies by CRRI, IIT & AITD as documented in http://lawmin.nic.in/ncrwc/finalreport/v2b3-5.htm

2.2.3 Road Freight Challenges

Several challenges exist in India that must be overcome to make the road freight sector more competitive, efficient and environmentally friendlier. Challenges for India are similar to those for other Asian countries summarized in section 2.2. The following challenges are described in more detail for India: (a) policies and institutional arrangements; (b) fragmented freight sector; (c) truck composition and characteristics (d) lack of skilled drivers; and (e) lack of freight data.

a) Policies and Institutional Arrangements

The road freight sector is subject to multiple laws that are issued, implemented and enforced by multiple agencies, which makes road freight a complex operation. Laws can relate to vehicles, drivers, and type of good transported and can be national or location specific. Some of the relevant laws to freight transport in India are:[17]

- Laws Governing Access Control to National Highways: (a) National Highways Act, 1956; (b) National Highways Rules, 1957; (c)The National Highways Authority of India, 1988; (d) National Highways (Land and Traffic) Act, 2002 and (e) Highways Administration Rules, 2003.
- Laws Governing Inter-state movement of goods: (a) Central Sales Tax Act, 1956; (b) Various State Sales Act/State VAT and (c) Various Local/Municipal Acts governing Octroi and Entry Tax
- Laws Governing Inter-state movement of Vehicles: (a) The Motor Vehicle Act (MVA), 1988; (b) The Central Motor Vehicle Rules (CMVR), 1989 (Amended in 1994, 2000 and in 2002) and; (c) Various State Motor Vehicles Act, 1989. The various sections/provisions of MVA relate to regulation of safety/quality, axle load, emissions, etc.
- Laws related to environment: (a) Environment (Protection) Act, 1986; (b) Environment (Protection) Rules, 1986; (c) Hazardous Waste (Management and Handling) Rules, 1989; (d)

[17] http://morth.nic.in/writereaddata/sublinkimages/Road_Transport_Policy27333191.pdf

Manufacture, Storage and Import of Hazardous Chemical Rules, 1989; (e) Manufacture, Use, Import,, Export and Storage of hazardous Micro-organisms/Genetically Engineered Organisms or Cells Rules, 1989; (f) Biomedical waste (Management and Handling) Rules, 1998; (g) Wildlife Protection Act 1972, Rules 1973 and Amendment 1991; (h) Forest (Conservation) Act, 1980 and Rules 1981, (i) Air (Prevention and Control of Pollution) Act, 1981, (j) Air (Prevention and Control of Pollution) Rules, 1982; and (k) Atomic Energy Act, 1982 Air (Prevention and Control of Pollution) Amendment Act, 1987.

One specific example relates to the Motor Transport Workers Act, which unintentionally has created a disincentive for consolidation and better organization of the road freight sector. This act is applicable to every motor transport undertaking employing five or more transport workers. In order to escape the regulations, the operators register their fleet under different persons with four or less employees in order to avoid these regulations. Some of the provisions of the act include

- No adult motor transport worker shall be required or allowed to work for more than eight hours in any day and forty-eight hours in any week
- The hours of work in relation to adult motor transport workers on each day shall be so fixed that no period of work shall exceed five hours and that no such motor transport worker shall work for more than five hours before he has had on interval for rest for at least half-an-hour
- The State Government may make rules requiring that in every place wherein one hundred motor transport workers or more employed in a motor transport undertaking ordinarily call on duty during every day, one or more canteens shall be provided and maintained by the employer for the use of the motor transport workers.
- In every place wherein motor transport workers employed in a motor transport undertaking are required to halt at night, there shall be provided and maintained the employer for the use of those motor transport workers such number of rest rooms or such other suitable alternative accommodation
- The State Government may, by notification in the Official Gazette, make rules requiring an employer of a motor transport undertaking to provide for the drivers, conductors and line checking staff employed in that undertaking such number and type of uniforms, raincoats or other like amenities for their protection from rain or cold as may be specified in the rules.

b) Fragmented Freight Sector

The road freight sector continues to be dominated by small operators as shown in Figure 7. According to a study conducted in the late 1990s, almost 77 per cent of truck fleets consisted of a maximum of five trucks while about 10 per cent of operators owned between 6 to 10 trucks.[18] Only about 6 per cent of the vehicles were with operators owning more than 20 trucks. More recent surveys suggest that the situation has not changed significantly a decade later. This highly fragmented road freight sector has resulted in the rise of brokers as the interface between transporters and the operators, which makes the market competitive but inefficient.

[18] AITD, 1999

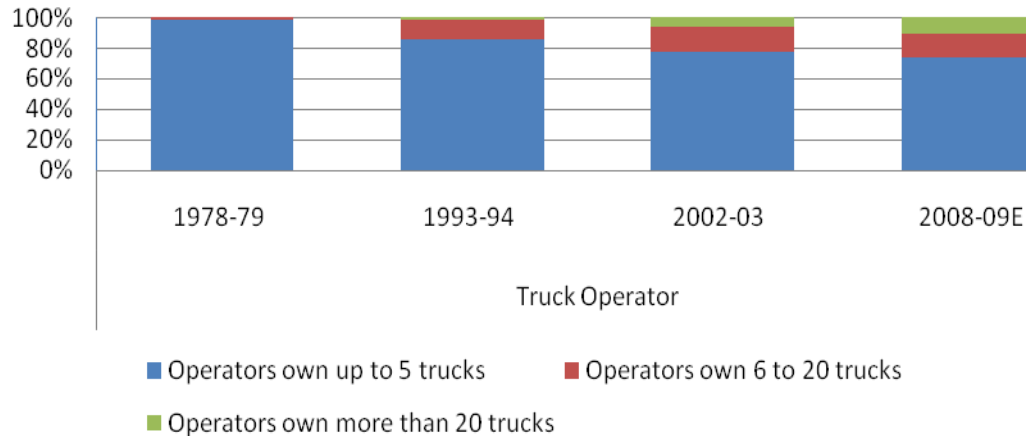


Figure 7. Truck Fleet Sizes in India[19,20]

c) Truck Composition and Characteristics

The majority of trucks in India are two-axle trucks followed by small composition of three-axle trucks, trucks with a small sleeper cab and an open top freight box of 30 to 40 cubic meters (1100 to 1400 cubic feet). The low cubic capacity reflects the present freight market of predominantly heavy, often unpackaged commodities[21]. Using data from six corridors which were widened during the National Highways Development Project program in India (2008), it was observed that nearly 52 per cent of vehicles were freight and only 6 per cent of freight vehicles were multi-axle trucks, as shown in Figure 8. By changing the mode share to multi axle trucks, goods can be transported more efficiently at lower costs.

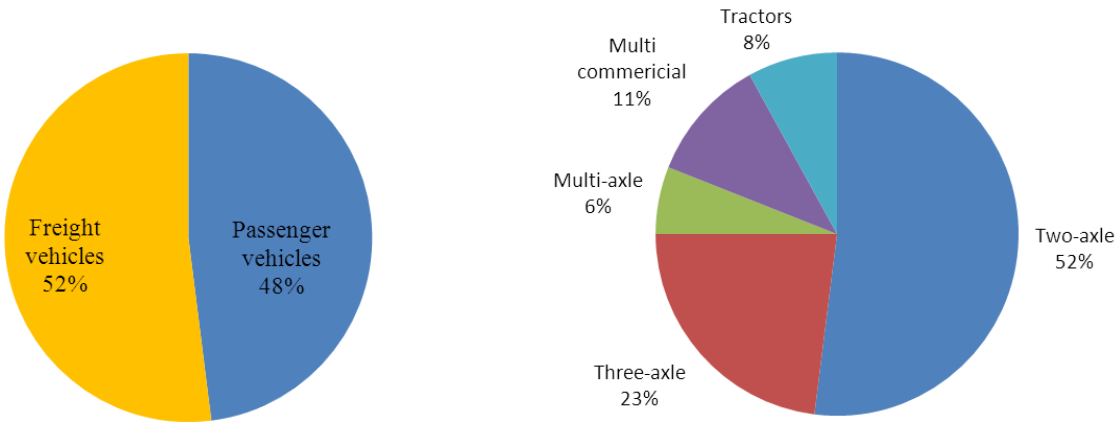


Figure 8. Total Vehicle and Freight Vehicle Composition on National Highways in India
Source: http://www.nhai.org/aboutnhdp.htm

[19] http://www.cci.gov.in/images/media/completed/1Road-goodstrans_20080508111358.pdf, CRISIL research quoted in http://business-standard.com/content/research_pdf/tci_110111_01.pdf
[20] http://www.transparencyindia.org/resource/survey_study/Corruptionper cent20inper cent20Truckingper cent20Operationsper cent20inper cent20India.pdf
[21] http://www.worldbank.org/transport/transportresults/regions/sar/rd-trans-final-11-05.pdf

The average age of commercial vehicles is seven years (nearly 22 per cent of vehicles are older than ten years)[22]. This, combined with often poor inspection and maintenance practices, results in fuel inefficient and polluting trucks on India's road.

Furthermore, axle load surveys carried out on national highways indicate high degree of overloading and empty trips by freight vehicles as shown in Figure 9. Overloaded vehicles constitute not only high share in accidents but also cause 60 per cent more damage to road surface than a truck with loads within legal limited.[23] Equally worrisome is the high percentage of empty hauls of trucks in India, which ranges from 37 per cent to 46 per cent of trips, depending on the type of truck.

TRUCK SURVEY SOUTH INDIA TRUCKS

A survey was carried out at one of South India leading truck hubs, Sankagiri near Salem. The survey involved over 50 three axle trucks carrying commodities, construction materials and other goods. The main findings were:

- The average age of the truck was about four years, indicating they are Euro II configuration.
- The average load was nine tons, although 25 tons is the load limit for three axle trucks. This highlights the importance of fleet 'right sizing', where a smaller capacity truck can carry a load in a more energy efficient manner than a larger truck.
- The average distance travelled by a truck was 127500 km annually, with 220 running days translating to 580 km per day at an average speed of 50 km per hour. With 12 hours of driving with a single driver, this points to the need for training drivers on road safety and for a second driver for long haul trips.
- The average fuel efficiency was 4 km per liter.
- Measures to improve fuel efficiency were lacking: drivers were not trained on road safety, eco-driving (5% improvement potential), maintaining correct tire pressure (3% improvement potential). While 53% of the drivers checked the tire pressure once in ten days, 17% checked it once in two to three weeks and 14% once a month.

Survey carried out by CAI-Asia, 2011

[22] Y Segment (2008) estimates for CAI-Asia and ADB

[23] India's legal single axle load limit is now 10.2 tons, which used to be 8.16 tons a decade earlier. The available data shows that the Vehicle Damage Factor (VDF) on most of the National Highways is in the range of 10 to 12 for Northern India and 7 to 8 for the Southern part of the country. These values are more than the VDF of 4.5.
http://morth.nic.in/writereaddata/sublinkimages/Road_Transport_Policy27333191.pdf

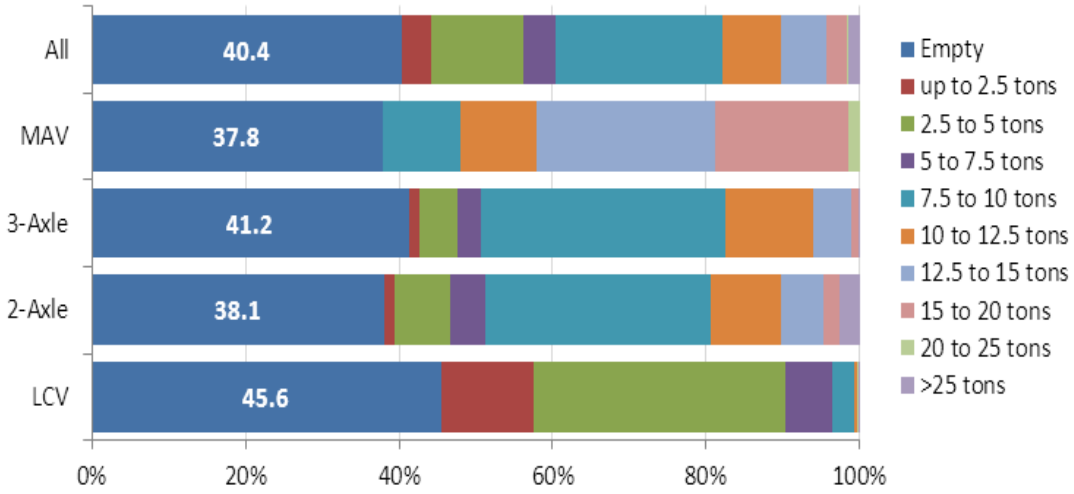


Figure 9. Load Distribution of Freight Vehicles in India
Source: Feasibility for 6-laning of NH-1 from Panipat Jalandhar in the State of Haryana/Punjab, India

The truck manufacturers industry is dominated by few players as shown in Figure 10. This creates an opportunity for India to establish collaborative efforts between these manufacturers to introduce efficiency improvement measures such as promoting technologies, training drivers and promoting preventive maintenance of fleets. Truck manufacturers in India have started driver training schools in India. For example, with every Volvo truck sold in India, Volvo trains at least 2 customer drivers. Manufacturers also train drivers from the open market. Ashok Leyland operates two centers of excellence in driver training – one in Namakkal (Tamil Nadu) and the other in Burari (near Delhi). The training covers all aspects of driving and road management, such as safe driving, fuel conservation, repairs, trouble shooting, fire-fighting, stress management, aids awareness and first aid.

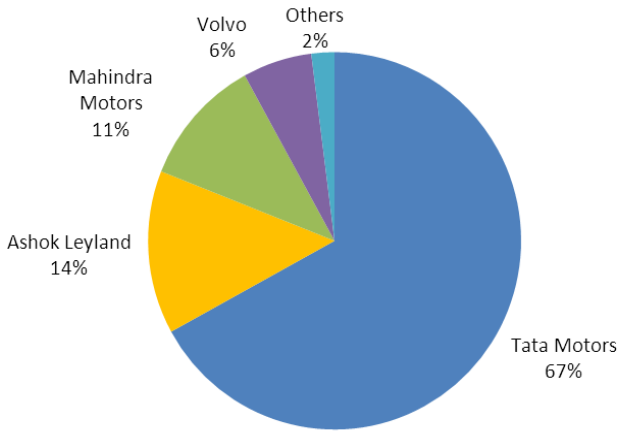


Figure 10. Manufacturers Share in India's Commercial Vehicle Market
Source: Based on SIAM data, Ashok Leyland data and ICRA commercial vehicle outlook

d) Lack of Skilled Drivers

The high growth in freight transport requires more manpower. Estimates suggest that for road freight transport, the number of people employed will grow from 12.83 million in 2007 to 17.64 million in 2012 with almost 70 per cent in the Goods Vehicles category.[24] At the same time the sector faces a lack of skilled drivers. Surveys show that the majority of the drivers have not been professionally trained on safe and eco-driving techniques, preventive maintenance etc. This has resulted in low awareness of drivers and operators and low fuel efficiency of the trucks when compared with other developed countries.

e) Absence of Freight Data

What does not get measured does not get done. The general lack of data and reliable data for India's freight sector makes it difficult to understand, plan and manage freight transport, and makes it virtually impossible to measure the effectiveness of any policies to improve competitiveness and efficiency. For example, at present there is no mechanism in place for regular collecting and reporting data on freight and haulage (ton kilometer or TKM). No comprehensive data on freight movement is available that indicates origin, destination, type and size of freight carried on roads by motorized transport.[25] Furthermore, freight transport is not segregated by different types of trucks such as light commercial vehicles (LCVs), two-axle, three-axle, etc. As a consequence, road infrastructure plans and investments and policies are based on projections that have a high degree of variation and thus uncertainty, as shown in Table 1 for road freight activity in billion ton-km.

Table 1. Different Projections of Road Freight Activity in India

Year	Billion ton-km by road	Source
2005	**317**	SMP Model-IEA
2005	**656**	The working group report for Road Transport for the eleventh Five Year Plan
2007	**518**	Interim report of the expert group on low carbon strategies for inclusive growth
2007	**755**	Building India Transforming the nation's logistics infrastructure

[24] http://planningcommission.nic.in/aboutus/committee/wrkgrp11/wg11_roadtpt.pdf
[25] http://morth.nic.in/writereaddata/sublinkimages/Road_Transport_Policy27333191.pdf

3. BEST PRACTICE STRATEGIES FOR TRUCKS AND FLEETS

An integrated approach employing avoid, shift and improve strategies is needed in addressing the road freight transport issues in Asia.[26]

- *Avoid* strategies reduce the need to travel or the travel distance for road freight vehicles.
- *Shift* strategies refer to those which transfer freight activity to more energy-efficient and/or environmentally-friendly modes.
- *Improve* strategies are the ones which improve the energy efficiency of the current road freight transport modes, their operations and technologies.

Examples are provided in Table 2 and are described in more detail in the next sections. It is noted that a suite of strategies will be required to significantly reduce fuel and emissions, and that different strategies will be suitable for different trucks, fleets and countries.

Table 2. Avoid, Shift and Improve Strategies for Trucks and Fleets

Avoid	Shift	Improve
• Drop-and-Hook • Backloading and Milk Run Concept • Freight Consolidation Centers • Logistics Information Platform (Freight Exchange) • Freight Company Consortium • Match vehicles capacities to loads	• Shift from road to rail and ships • Shift from trucks to cargo bikes, motorbikes	• Tires and wheels technologies • Aerodynamics equipment • Idling reduction technologies • Emissions control technologies • Low-sulfur diesel • Low viscosity lubricants • Oil by-pass filtration system • Fleet replacement • Lighter weight tractor / trailer • Hybrid trucks • Inspection and Maintenance • Speed management, eco-driving, driver training

3.1 Technologies

Figure 11 shows the various energy losses on a typical truck travelling on urban and intercity travel. Technologies can be applied to the tractor, trailer, engine or fuel. The main technologies available on the market are introduced below and can help improve fuel efficiency, reduce CO_2 emissions, and/or reduce PM, NOx and other air pollutant emissions. These include tires and wheels, aerodynamics equipment, idling reduction technologies, emissions control technologies, and technologies relating to fuel, engines and vehicles. For several of these case study examples are given. Table 3 shows savings found for heavy duty trucks in the United States. Fuel savings vary between technologies, trucks and operating conditions and would thus be different for trucks operating in Asian countries.

[26] Adopted from Dalkmann and Brannigan (2007).

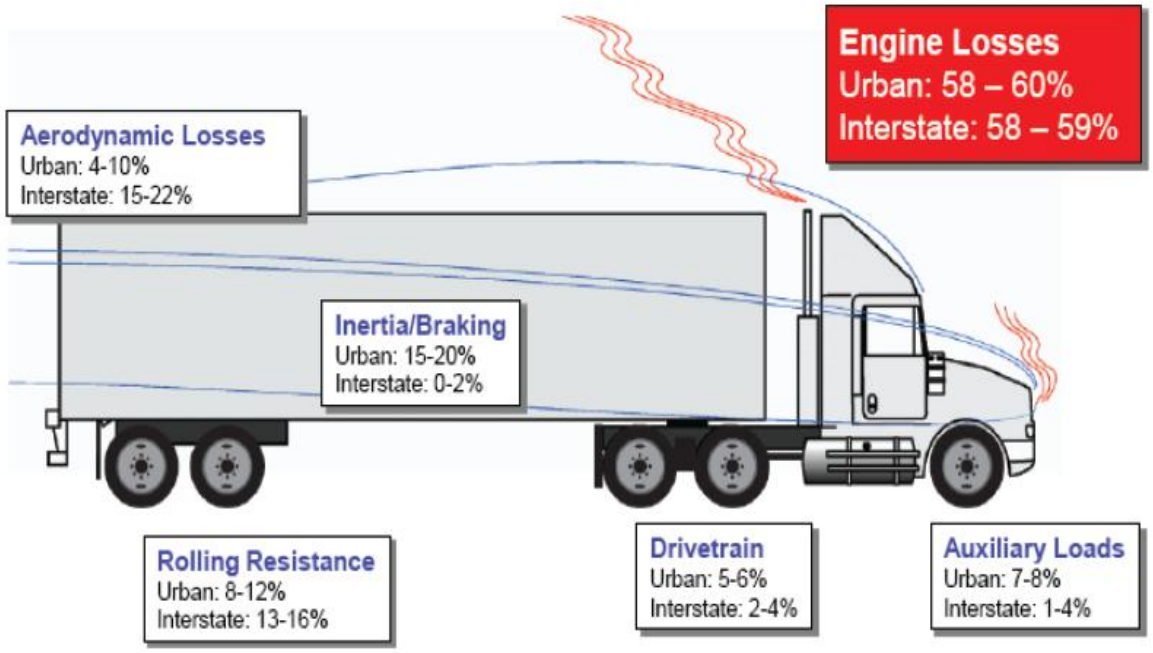


Figure 11. Energy Losses of Trucks[27]

Table 3. Fuel Reduction Potential for Heavy-Duty Vehicle in Operation in the United States[28]

Technology Type	Fuel Reduction Potential
Tires reducing rolling resistance	4.5 to 9 per cent
Aerodynamics equipment	3 to 15 per cent
Auxiliary Loads	1 to 2.5 per cent
Vehicle mass (weight reduction)	2 to 5 per cent
Idling reduction	5 to 9 per cent
Intelligent Vehicle Technologies	8 to 15 per cent

3.1.1 Tires and Wheels

Technologies for tires and wheels include

- Aluminum rims that are lighter than steel rims
- Low rolling resistance (LRR) tires that reduce the friction between the tires and the road thus reduce fuel use and tire wear. Single wide-based LRR tires replace two tires with one wide tire, resulting in even greater fuel savings. The RR between tires on the market varies from 7kg/t and 14kg/t for passenger cars, resulting in 10 per cent fuel use difference. For truck tires, a 1kg/t variation in RR means on average a 5 per cent fuel saving[29]
- Automatic tire inflation systems that keep the tire pressure at optimum levels, whereas tire pressure monitoring systems signal when tire pressures are too low
- Nitrogen-filled tired instead of air-filled tires

[27] See http://www.tc.gc.ca/eng/programs/environment-ecofreight-road-tools-casestudies-cta-2541.htm
[28] TRB, 2010 as cited in CAI-Asia, 2011
[29] Axel Friedrich - http://baq2010.org/sites/default/files/Yellow%205%20Friedrich%20BAQ%202010.pdf

Low Rolling Resistance Tires Aluminium Rims Tire Pressure Monitoring System

Figure 12. Selected Tires and Wheels Technologies[30]

Example: Low Rolling Resistance Tires at Guangzhou Garbage Trucks

Fuel and emissions savings for garbage trucks in Guangzhou, China, equipped with low rolling resistance tires and a tire pressure monitoring system were about 18 per cent. This figure is much higher than the 3-5% savings seen in the United States, most likely because aside from reducing friction with the road, the new tires also made the truck more stable, thus reducing fuel use.[31]

Example: Nitrogen Tire Inflation on Canadian Long-haul Trucking

Tire rubber is more permeable to air than to nitrogen, thus tires inflated with compressed air deflate over four times faster. Drexan Corporation in Canada found that long-haul trucks with nitrogen-filled tires used 4 per cent less fuel than control trucks, and increased tire tread life by 86 per cent. In a separate study 33 new truck tires were inflated with nitrogen and 21 were inflated with air and run side by side on the same tractor units until they failed or wore to tread wear indicators. Nitrogen inflated tires ran 26 per cent more miles.[32]

3.1.2 Aerodynamics Equipment

Aerodynamic drag (wind resistance) accounts for most truck energy losses at highway speeds. Reducing drag can improve fuel efficiency. The longer the drive and the higher the speed, the greater are the potential efficiency benefits. For example, cutting drag by 25 percent could raise fuel economy up to 15 percent at highway speed.

Side skirts Nose cone Cab extenders Trailer Tail

Figure 13. Selected Aerodynamics Equipment[33]

[30] Photos from Michelin (tire), Alcoa (aluminium rim) and Doran (tire pressure monitoring system)
[31] See http://cleanairinitiative.org/portal/GreenTrucksPilot. Guangzhou Green Trucks Pilot Project: Final Report for the World Bank "Truck GHG Emission Reduction Pilot Project"
[32] See http://www.tc.gc.ca/eng/programs/environment-ecofreight-road-tools-casestudies-drexan-107.htm
[33] Photos from www.greenfreightandlogistics.org, http://www.arb.ca.gov/msprog/truckstop/faq/faq_ts.htm

Truck tractor aerodynamics can be improved by roof fairings (an integrated air deflector mounted on the top of the cab), cab extenders (known as gap fairings or gap seals, which reduce the gap between the tractor and the trailer), side fairings, and a front bumper air dam (to reduce air flow beneath the truck).

Trailer aerodynamics can be improved by nose cones (installed on the front of the trailer and reduces air turbulence), specifying wheelbase and fifth-wheel settings (position the trailer as close to the rear of the tractor as possible to reduce tractor-trailer gap), side skirts (panels that hang down from the bottom of a trailer to enclose the open space between the wheels to reduce wind underneath the trailer), and trailer tails.

Example: Aerodynamics Equipment - Guangzhou Long Haul Trucks, PR China

Fuel savings of long distance trucks equipped with low rolling resistance tires, a nose cone and side skirts was about 6.7 per cent. This was less than expected because pilot trucks traveled at lower speeds than the 75 km/hour needed for aerodynamics technologies to significantly reduce drag and fuel use. At lower speeds the aerodynamics of the trucks are also slightly improved but the increased fuel use due to the weight of the equipment offsets fuel savings.[31]

Example: Side Skirts - Cascades Transport Inc., Canada

Cascades Transport Inc. field-tested aerodynamic side skirts on 242 of its 500 trailers (two- and three-axle) that were hauled by 56 trucks. Side skirts varied in length depending on the truck, were 30 inches in height and had a 15-inch ground clearance, making it possible for trailers to negotiate loading ramps. The overall fleet efficiency improvement recorded was 5.26 % and this led to annual fuel savings of 188,160 liters, which translates to 506.2 tons of CO_2 emission reductions. The payback period for each truck with installed side skirts was five months. There was no appreciable increase in maintenance required by the installation of the skirts and the skirts reduced splashing, thereby improving visibility for other vehicles.[34]

3.1.3 Idling Reduction Technologies

Idling reduction technologies are aimed at reducing idling of trucks and thus reduce fuel consumption. The US EPA has verified idling technologies and some of the main ones are described below.[35]

a). Advanced Truck Stop Electrification

Truck Stop Electrification (TSE) reduces idling of trucks at truck stops and rest areas by providing an electric power source for heating and cooling of the sleeper cab. Idling increases fuel and maintenance costs, emissions, and noise. TSE can also be provided inside a truck using heating, ventilation, and air conditioning (HVAC) subsystem.

Example: Shorepower TSE demonstration study - New York Interstate 87 Northway, United States

The establishment of the demonstration TSE system involved developing and installing a shorepower TSE system at a truck stop, and developing a payment system for TSE system use. A truck-board equipment package was tested on one Class 8 sleeper cab and then installed on 19 additional heavy-duty sleeper cabs. Operational and environmental

[34] See http://www.tc.gc.ca/eng/programs/environment-ecofreight-road-aerodynamic-trailer-skirts-2540.htm
[35] http://www.epa.gov/smartway/technology/verified-tech.htm

data was collected and analyzed for one year. Estimates indicate 15,500 gallons of fuel savings through two off-board TSE facilities, resulting in over $25,000 savings for drivers and fleet owners. Approximately $1.12 is saved for every hour of avoided idling while connected to the TSE system after deduction of TSE charges.[36]

b). Auxiliary Power Units (APU)

Auxiliary power units (APUs) avoid the need for idling of a truck's base engine and consist of a small diesel engine that provides power for an HVAC system and electrical outlets that service the sleeper cab.

Example: APUs - Wal-Mart, United States

Trucks in Wal-Mart's distribution network drive 900 million miles a year to deliver goods to the retailer's 4,000 stores. Wal-Mart aims to double the truck fleet's fuel economy by 2015 and reduce carbon dioxide emissions by 26 billion pounds by 2020. Aside from tire and aerodynamics technologies, APUs were installed in 2006 on all trucks that made overnight trips, reducing an estimated 100,000 tons of CO_2 emissions and 10 million gallons of fuel.[37]

c). Satellite Tracking

Companies can use satellite tracking to monitor speed and driving behavior of truck drivers and, in combination with feedback and training, can increase fuel efficiency, improve safety and reduce operating costs and emissions.

Example: Satellite tracking - Sunbury Transport Ltd, Canada

Satellite tracking and SensorTRACS data provides information from 250 owner-operator trucks. Driver training, idle reducing equipment and incentives were used to encourage owner-operators to improve driving behavior and reduce idling time and speeding which was as high as 50 and 25 per cent. Over fourteen months, fuel expenses were reduced by US$170,000 and CO_2 emissions by 538 tons.[38]

d). Vehicle Telemetry Units

Vehicle telemetry units provide better understanding of driver behavior and thus enable development of a training program to improve safe and economical driving practices for fleet drivers.

Example: Vehicle Telemetry - Transport Robert Ltd, Canada

The freight transportation company has a fleet of over 850 trucks and 4,000 trailers, travels over 115,000,000 km and consumes nearly 50,000,000 liters of fuel each year. Transport Robert installed 250 vehicle telemetry units and made use of collected acceleration, braking and turning data to develop a training program to improve safe and economical driving practices of 250 drivers. The evaluation of the system suggested that a fuel consumption reduction of 180,740 liters representing savings of $159,576 annually. The system cost CAN$2500 and based on 250 trucks, the payback period was four years.[39]

[36] See http://www.epa.gov/smartway/documents/publications/dewitt-study.pdf
[37] See http://move.rmi.org/markets-in-motion/case-studies/trucking/wal-mart-s-truck-fleet.html
[38] See http://www.tc.gc.ca/eng/programs/environment-ecofreight-road-menu-548.htm
[39] See http://www.tc.gc.ca/eng/programs/environment-ecofreight-road-driver-behaviour-study-using-vehicle-telemetry-2543.htm

3.1.5 Emissions Control Technologies

Emission control technologies for diesel trucks enable significant reductions in exhaust emissions of 50 to 90 per cent. Technologies are often combined to achieve maximum emission reductions of unburned hydrocarbons (fuel), black carbon (soot) and Nitrogen oxides (NOx). This results in significant health benefits and associated health cost reductions. Common technologies are EGR (exhaust gas recirculation), SCR (selective catalytic reduction), DOC (diesel oxidation catalyst) systems, diesel flow through filter, and diesel particulate filters (DPF). What is important to know is that Sulfur levels in diesel of 50 ppm or less are desired for DPFs to work as these filters clog at high Sulfur levels. Hence improvements in fuel quality standards go hand in hand with the ability to reduce air pollutant emissions. Table 4 lists main retrofit technologies and the US EPA has verified specific brands.[40]

Table 4. Diesel Vehicles Retrofit Devices[41]

Typical Emission Reductions (percent)					Typical Costs ($)
Technology	PM	NOx	HC	CO	
Diesel Oxidation Catalyst (DOC)	20-40		40-70	40-60	material: $600-$4,000 installation: 1-3 hours
Diesel Particulate Filter (DPF) Active or Passive	85-95		85-95	50-90	material: $8,000–$50,000 installation: 6-8 hours
Partial Diesel Particulate Filter (pDPF) Partial or Flow-through	up to 60		40-75	10-60	material: $4,000–$6,000 installation: 6-8 hours
Selective Catalytic Reduction (SCR) *		up to 75			$10,000–$20,000 Urea $.80/gal
Closed Crankcase Ventilation (CCV) *	Varies				
Exhaust Gas Recirculation (EGR) *		25-40			
Lean NOx Catalyst (LNC) *		5-40			$6,500–$10,000

* May be combined with DOC or DPF systems to reduce PM, HC and CO emissions.

3.1.6 Fuel, Engines and Vehicles

Strategies apply to fuel, engines and vehicles are often interrelated and combined, and include[42, 43]

- Low-sulfur diesel with Sulfur lower than 50ppm or even 10ppm for on-road trucks can reduce the emission of all in-use trucks with or without other emission-control devices.
- Low viscosity lubricants (synthetic engine and drive train lubricants) are less resistant to flow than conventional lubricants, and reduce fuel losses by up to 3 per cent.
- Oil by-pass filtration system improves oil life performance, resulting in 80 per cent reduced cost of engine oil and related maintenance, and indirectly contributes to fuel efficiency due to reduced engine wear.
- Purchasing a new Euro III truck can reduce diesel particulate emissions by 82% and Oxides of Nitrogen (NO_X) by 64% as compared with old Euro 0 trucks. The PM emission of an old truck can be more than 30 times higher than a Euro IV truck.
- Lighter weight tractor / trailer. Every 10 percent drop in truck weight reduces fuel use between 5 and 10 percent. Generally, an empty truck makes up about one-third of the total weight of the

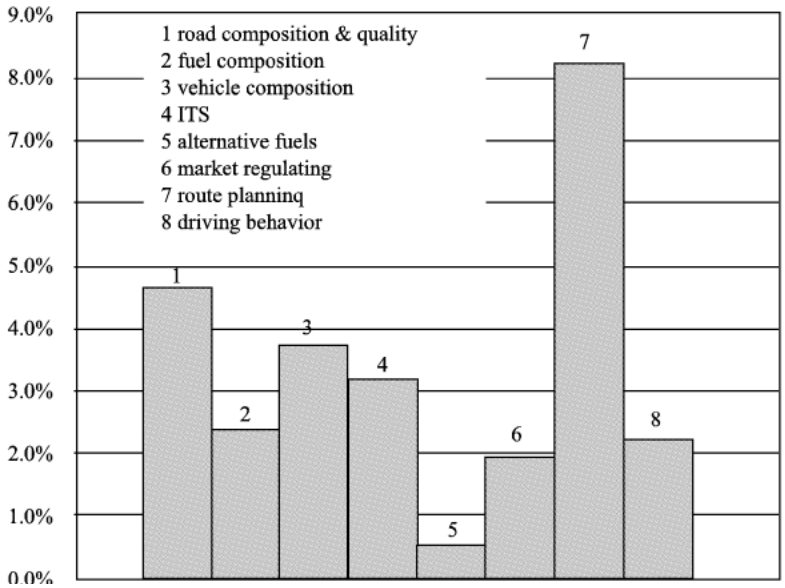
[40] http://epa.gov/cleandiesel/verification/verif-list.htm
[41] http://www.epa.gov/cleandiesel/technologies/retrofits.htm
[42] http://www.epa.gov/smartway/publications/index.htm
[43] http://www.cascadesierrasolutions.org/

truck. Using aluminum, metal alloys and other lightweight components where appropriate can reduce empty truck weight (known as "tare weight") and thus fuel consumption, for example aluminum roof posts, floor joists, upright posts, and hubs and wheels

- Hybrid electric technology combines a conventional propulsion system with a rechargeable energy storage system to achieve better fuel economy. Many hybrid system reduce idle emissions by shutting down the conventional engine at idle and restarting it when needed. Hybrid vehicles are especially suitable for trucks that travel on duty cycles with frequent starts and stops or spend large amounts of time idling.[44] Hybrid diesel-electric system can save fuel consumption by up to 60% and reduce diesel engine idle by up to 87%. The maintenance cost, vehicle GHG emission and engine noise will be also reduced. Other combinations, such as methane and diesel are increasingly applied to trucks also.[45]

3.2 Fleet Management

Fleet management is the management of a company's vehicle fleet, e.g. vehicle financing, maintenance, telematics, driving management, speed management, fuel and health/safety management. Fuel management is the system to maintain, control and monitor fuel consumption and stock in any type of industry that uses transport, including rail, road, water and air. Technological tools, such radio frequency identification tags (RFID), global positioning systems (GPS) and vehicle routing software, can support fleet and fuel management.



Source: ADB TA4877-PRC: Green Transport: Resource Optimization in the Road Sector in the People's Republic of China (ADB, 2009)[46]

Figure 14: Percentage of Fuel and CO2 Reduction per 100 tkm under Different Measures

[44] TIAX. 2009. http://www.nap.edu/openbook.php?record_id=12845&page=1
[45] http://www.gnvmagazine.com/eng/noticia-volvo_trucks_launches_the_new_volvo_fm_methanediesel_truck-2057
[46] http://www.adb.org/Documents/Books/Green-Transport/default.asp

Fleet and fuel management is an important approach to improve freight transport efficiency and fleet fuel efficiency. Due to direct and visible results, relatively low investments and high cost-effectiveness, these strategies apply to small companies also. Key performance indicators relate to cost, operations, service, compliance, maintenance, and environmental performance.

Benefits from fleet and fuel management vary depending on the different measures applied. A study for PR China estimated fuel and CO_2 emission reductions of 0.3 to 10% per 100 tkm traveled.[47]

3.3 Logistics Solutions

Solutions to improve freight efficiency and reduce empty hauls, fuel use and emissions are summarized below, and include drop-and-hook, backloading and milk-run concept, logistics information platform, freight company consortium, and freight consolidation centers.[48]

3.3.1 Drop-and-Hook

Drop-and-Hook is a method to organize transport to "eliminate empty miles and optimize performance", where "Drop" refers to delivering a trailer and dropping at the customer site (or a distribution center), and "Hook" refers to immediately hooking up a loaded trailer and moving it to the destination.[49] The advantage of drop and hook method is that it eliminates the need for the truck to wait in the yard with its engine idling while it waits for the trailer to be unloaded (which can take even days). It improves the efficiency. The key elements of drop-and-hook practice are the truck drop-and-hook movement/route planning, trailer pool, and the trailer pool's management that includes trailer tracking and cross-docking/consolidation procedures at the distribution center.

Example: Drop and Hook - Whirlpool Company, United States

Whirlpool Company uses drop and hook arrangement in its U.S., Canadian, and Mexican operations and to a limited extent, its European operations. In some cases, Whirlpool even provides trailers to carriers to facilitate the practice.[50]

3.3.2 Backloading and Milk Run Concept

Surveys in developing and developed countries consistently show a high percentage empty trips and light trips. Efficiently using the available space in the truck can help to reduce operating costs and increase business revenue through reduced mileage, vehicles needed, fuel and emissions. Strategies include backloading, consolidating loads, load stacking, and the use of multiple-decked vehicles. Backloading involves finding loads that need to be moved between similar areas as the two points planned for the returning vehicle. [51]

[47] China Academy of Transportation Sciences (CATS), 2008. "*Study of Mid-, Long-term Planning for Energy-saving in Road and Waterway Transport*"
[48] CAI-Asia, 2011. "Design of Green Freight China Program: Review of Freight Logistics Solutions." Pasig City, Philippines. http://cleanairinitiative.org/portal/projects/GreenFreightChinaProgram
[49] Interstate Distributor Co. (IDC). IDC's presentation ppt during the US study tour (June 2010) for the GEF Guangdong Green Truck Demonstration Project.
[50] http://www.supplychainquarterly.com/topics/Logistics/scq200802whirlpool/
[51] http://www.freightbestpractice.org.uk/default.aspx?appid=3511&pid=7778

Example: Backloading - Kronospan, United Kingdom

This manufacturing company uses both rail and road for the transportation of timber and related products. Trucks cater for 90 per cent of all freight movement by weight, with a fleet of 200 vehicles, belonging to 35 haulers of differing sizes. Together with suppliers, the company determined new specifications for certain types of trailers and utilized vehicles to carry different loads efficiently. The efficient use of back loading increased the average load per journey by 25 per cent (from 20 to 25 tons) and reduced number of trips by 20 per cent without any increase in the size of the vehicles. Each day, 5,000 liters of fuel is saved and 13 tons CO_2.

A variation to this approach is the Milk-Run concept including collection and distribution. The name is derived from the concept of delivering milk bottles in the past. Truck loaded with bottles in crates drove around neighborhoods to distribute bottles to each house. After all milk bottles were delivered, the truck would pick up empty bottles from homes and transport them back to the dairy plant. The truck would be full in both directions thus ensuring maximum use of truck load capacity. Milk-Run is therefore a frequent parts procurement system implemented in relatively small area, for example a neighborhood, factory yard or port area. Milk Run logistics is used to maximize truck loading rates and reduce the number of trucks and travel distances. This concept has been applied by automobile manufactures in many countries, including India and Thailand.[52].

Example: Milk Run Concept - Ford and TVS Lean Logistics, India

In India, Ford and its logistic partner TVS Lean Logistics use the milk run concept to reduce fuel consumption and increase supply chain efficiency. TVS Lean Logistics has set up hubs in Delhi, Pune, Mumbai, Daman, Bangalore and Chennai to manage material movement specific to Ford's requirements and based on the distribution of its 83 suppliers (20 in North, 15 in West, and 13 South India, and 35 in and around Chennai.). Components are collected following a schedule provided by Ford, consolidated in the hubs and transported to the manufacturing plant.

3.3.3 Logistics Information Platform (Freight Exchange)

A Logistics Information Platform (Freight Exchange) provides opportunity to freight haulers and companies offering cargo loads by allowing them to search advertisements for freight and freight forwarders that offer freight to be transported. It provides efficient communication among transporters; forwarders and logistics companies by provide a sort of matchmaking tool. They also allow freight operators to offer vehicle spaces. Online systems are normally subscription-based with a small charge for advertising (posting) and searching (consulting).[53]

The freight exchange tools/elements consists of - An internet platform for on-line freight information exchange, Freight exchange software with on-line chat window, Freight exchange information in mobile, Freight map, Local legislation and regulation database, Transport companies directory, Carrier rating system & reliable carrier verification/certification, Transport route planning and Debt management.

[52] See http://hermesir.lib.hitu.ac.jp/rs/bitstream/10086/19161/1/0101100501.pdf
[53] Wikipedia, 2011. http://en.wikipedia.org/wiki/Freight_exchange

Example: Henan Anyang Modern Logistics Information Development, PR China

This company was established in 2006 as an online logistics information platform. By providing freight information exchange services and other value-added services, the platform has helped trucking companies in Anyang city (Henan Province in China) to reduce the empty mile percentage from 53 per cent in 2006 to 38 per cent in 2008. The total freight empty mileage saving in Anyang is about 137.5 million km, which saved 27.5 million liter of fuel (equaled to 165 million CNY) in the same period. The platform has since expanded to the entire province with more than 50,000 deals made per month, with average savings per month of 43.9 million km, 8.8 million liters of fuel and 52.7 million CNY (about USD 8.2 million).[54]

Example: Booking logistics - RedBus Intercity, India

Intercity buses have similar issues to the freight sector with regards to passenger loading, fragmented industry, existence of small operators operating over large distances, and many booking and commission agents. Commission agents receive seat quotas from operators but no information on the number of seats given to the other agents, seat vacancies or demand at other locations. This resulted in high inefficiencies due to low occupancies, inability to give preferred seating, high costs for customers, and frictions between bus company and agents.

E-ticketing has revolutionized the intercity bus sector. Inefficiency was largely due to inability of small operators to provide computerized ticketing or reservations, which could be addressed with the fast penetration of internet in India. RedBus (www.redbus.in) offers integration of their operations, occupancy and routing into the redBus server to 150 operators with computerized reservation and route tracking systems. RedBus acts like a travel agent for 550 plus small operators, who receive allocated seats and upload these manually on the RedBus server, and are informed by RedBus by phone once these seats are sold. The firm has now about 75,000 point-of-sale outlets across the country. Details about fares, seat numbers, seat availability, routes, timings and pick-up points is available through the redBus website, call centers and partner businesses. The transparency of the system and ability to check seats and rates provides an incentive for customers to book seats online - individually or through the agents.

Considering the similar issues in freight sector, a similar model can improve efficiency in the freight sector. with fragmented industry, small operators, large distance of operations and low loading for return journeys.

3.3.4 Freight Company Consortium

Small distribution/trucking companies find it increasingly difficult to compete against larger operators, particularly for higher value contracts. Joining forces to form a haulage consortium allows small and medium businesses to pool their resources and strengths in order to win and manage larger and more lucrative logistics contracts.[55] For a road freight sector as highly fragmented as those seen in Asia, small operators could form a consortium to improve back loading, reduce empty loads, improve fleet utilization and create greater opportunities to compete against large operators. Key features are integrated fleet management, information sharing, facilities sharing, and profit sharing.[56]

[54] See http://www.8glw.com/
[55] UK DfT Freight Best Practice program: Case Study – Profit Through Partnership (2006). http://www.freightbestpractice.org.uk/case-studies
[56] See http://webarchive.nationalarchives.gov.uk/20110505121228/http://www.freightbestpractice.org.uk/profit-through-partnership

Example: Freight Company Consortium - Wisbech Roadways Ltd, United Kingdom

The company had 700 trucks of different dimensions formed a consortium to win a large contract with two other operators. By joining the trucking company consortium, the company gained the benefits as quantified below. Comparing with UK's national average, this best practice has significant improvements on vehicle fill, empty mile reduction, and average weight-based factor.[55]

Key Performance Index	Wisbech Roadways Ltd.	National Average
Vehicle fill	85 per cent	69 per cent
Empty running	16 per cent	19 per cent
Average weight-based factor	82 per cent	53 per cent

3.3.5 Freight Consolidation Centers

Freight consolidation centers are the place where goods from different suppliers with the same origin and destination are combined into single shipments, thereby improving efficiency and reducing vehicles on the road. Other terms used are 'freight centers', 'transshipment centers', 'public logistics centers', 'city distribution center' and 'urban platforms.' Consolidation centers have been piloted in several countries, a few of them have succeeded but a large number of freight center projects have failed due to poor design, high cost, location and non-participation by key stakeholders. It is important to have proper discussions with the stakeholders before establishing a consolidation center.[57]

Example: London Construction Consolidation Centre (LCCC), United Kingdom

LCCC acts as a distribution center and delivery service area for construction materials to four major building projects in Central London, based on delivery requests from construction site contractors. It encompasses 5,000 square meters of space and is 40 minutes away from construction sites. The vehicle fleet consists of six different vehicle sizes to accommodate different loading, and has GPS tracking and telematics systems installed. Monitoring surveys showed that nearly 96 per cent of deliveries are on time, CO_2 emissions reduced by 74 per cent, and construction traffic around Central London by 70 per cent.

3.4 Modal Shift

3.4.1 Freight Shift to Rail and Ships

Studies have shown that rail-based freight haulage can be more energy efficient and less carbon intensive than freight carried by road on trucks. Freight movement by rail is especially suitable for the transportation of bulk goods between for example a mine and a factory, or ports and distribution centers, but is less suitable for door-to-door delivery. Similarly, freight can be shifted to transport via inland waterways, which also is suitable for heavy bulk goods. In countries like PR China, bulk good transport between coastal cities with ocean freight is common. Compared to developed countries, the rail systems in many Asian developing countries are still under developed, often have a shared system for passengers and freight transport, and therefore do not provide the reliable transport mode for many shippers. Whether

[57] See http://webarchive.nationalarchives.gov.uk/20110505121228/http://www.freightbestpractice.org.uk/london-construction-consolidation-centre-tool

freight shift to rail is practically and economically feasible and environmentally beneficial has to be determined on a case-by-case basis and consider the complete supply chain from origin to destination.

Example: Freight Shift to Rail - Malcolm Group, United Kingdom

Malcolm Group is one of the UK's major road haulers and since starting using rail in 2001, the number of trains operating has risen more than three-fold. One customer is the supermarket retailer ASDA, which has a rail connection between the national and regional distribution centers, saving 4 million road vehicle miles per year.[58]

Example: Virginia I-81 Marketing Study, United States

The Virginia Department of Rail and Public Transportation examined the potential for new railroad freight services to attract truck traffic from Commonwealth highways to reduce roadway congestion and improve safety. Detailed modeling and cooperative planning with railroad officials were used to establish required investment to shift varying levels of highway volume to rail and the benefits. The study found that efficient intermodal service could divert up to 3 million trucks per year, or approximately 30 per cent of the projected truck traffic in 2020. In the medium term one in seven trucks and a long term one in three trucks could be diverted. The investment were estimated at US$7 to 8 billion, with high economic savings due reduced truck numbers and congestion.[59]

3.4.2 Cargo Bikes

Cargo bikes are designed and constructed specifically for transporting cargo and are generally used for first mile/last mile connections, providing opportunities to small entrepreneurs to collect garbage or provide daily grocery supply etc. In Asian and European countries, freight bikes are extremely common and popular for transporting goods in urban areas – provided that cycling infrastructure and facilities are safe and adequate.

Example: Cycle Logistics Project, Europe

One of the largest initiatives in understanding and promoting cargo bikes in Europe is CYCLE Logistics project. It's a EU funded project implemented from May 2011 to 2014 and spanning across 12 countries. The main stakeholders in this project partnered by European Cyclists' Federation (ECF) are local authorities, the private sector, cyclists' groups, communications experts and energy agencies. In order to promote this shift, CYCLE Logistics will push for behavioral change across a broad spectrum of stake-holders:

- Individuals will be informed on how to use their bicycle to transport goods
- Businesses will be motivated to use bikes or cargo bikes for delivery, with the goods sector being pushed be pressed to increase deliveries by cycle.
- City governments would be encouraged to facilitate the cycle movement by providing sympathetic infrastructure.

CYCLE Logistics aims to save 1300 tons of fuel resulting in savings of 3500 tons of CO2, have 2000 new cargo bikes in use in European urban areas and see at least 10,000 trips shifted to intermodal transport chains.[60]

[58] See (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_586.pdf) & (http://www.rfg.org.uk/case-studies)
[59] http://www.railsolution.org/projects/steel-interstate/rationale-for-resolution.html
[60] http://www.ecf.com/misc/filePush.php?mimeType=application/pdf&fullPath=http://www.ecf.com/files/2/121/CYCLE_Logistics_press_release.pdf

Example: La Petite Reine, France

La Petite Reine is French slang for bicycle (literally 'the Little Queen'), and operations started in Paris in 2001 with a turnover of just 28,000 euros. The growth of the initiative can be compared with the growth of the public bike sharing scheme in Europe. By 2007, the company was operating in four cities (Paris, Bordeaux, Dijon and Rouen), with 50 employees, 53 bikes and a turnover of 1.3 million euros. Estimates suggest that the company transported 700,000 packages, a total of 210,000 km. In the process they displaced nearly 600,000 ton-km of van transport in Paris alone – largely accounted for by the difference in the weight of the vehicles used – and saved 204 tons of CO_2 emissions or approximately saving 79000 liters of diesel.[60]

4. ROLE OF GOVERNMENT IN ADVANCING GREEN FREIGHT IN ASIA

This chapter describes what governments can do to advance green freight practices in Asia and make the freight sector more competitive, efficient and cleaner. Policy interventions that stimulate increased fuel economy of trucks include fuel economy standards, technology mandates, import restrictions, economic instruments, and traffic control measures.

Governments can adopt and strengthen policies and regulations, national programs for green freight, and measure progress using a set of recommended indicators in line with the Bangkok 2020 Declaration goal for efficient freight.

4.1 Policies and Regulations

Table 5. Avoid, Shift and Improve Policy Instruments for Trucks and Fleets

Avoid	Shift	Improve
• Promotion of local production and consumption • Rationalizing number and location of logistics centers and improve coordination between centers • Congestion charging/Road pricing • Parking fees	• Investments in infrastructure for railways, waterways and intermodal transfer • Economic instruments to promote investments in rail infrastructure and transport • Cycling lanes and parking infrastructure in cities	• Fuel economy standards • Vehicle emission standards • Fuel quality standards including alternative fuels • Import restrictions for vehicles and engines based on performance and age • Technology mandates • Test cycles for emissions and fuel economy • Vehicle inspection and maintenance program • Fuel inspection and compliance programs • Emission labeling programs • Low emission zones • Economic instruments – Penalties for manufacturers not meeting standards – Fuel taxes and lower fuel taxes for cleaner fuels – Excise and sales taxes for different truck types – Varied registration fees for different truck sizes, performance and age – Fees for inefficient technologies – Rebates for efficient technologies – Buy-back and scrapping schemes for old trucks – Energy Service Companies (ESCOs)

4.1.1 Fuel Economy Standards

Policy interventions that stimulate increased fuel economy of trucks include fuel economy standards, technology mandates, import restrictions, economic instruments, and traffic control measures. The Global Fuel Economy Initiative established a global database for policy interventions, and although primarily focused on private cars, many measures apply to trucks also.[61]

Countries have adopted or are in the process of adopting fuel economy standards for heavy vehicles include Japan, the US and China, in order to encourage truck manufacturers to build more fuel efficient vehicles and thereby reduce fuel consumption.

Example. Fuel economy standards – Japan and United States

The Japanese government introduced the first fuel economy standards for new medium- and heavy-duty diesel vehicles that will come into effect in 2015. These apply to diesel fueled, type-approved commercial vehicles with GVW > 3.5 t, including trucks, but do not apply to heavy vehicles fueled by gasoline, LPG or other alternative fuels. Each manufacturer is required to meet the fuel economy target for each type of vehicle based upon a sales-weighted average for that category.

Table 6. Summary of Japanese Fuel Economy Regulations for Trucks[62]

Vehicle Type	Vehicle Class	Fuel Economy (km/l)		Improvement (per cent)
		2002 Baseline	2015 Target	
Truck	Tractor	2.67	2.93	9.7
	Other truck	6.56	7.36	12.2
	Total	6.32	7.09	12.2

Note: The 2015 average target and relative improvement assume a constant 2002 vehicles sales mix

The US recently announced a decision to introduce fuel economy standards for heavy trucks. The fuel economy standards are jointly being developed by US EPA and the National Highway Traffic Safety Administration and will affect trucks built from 2014 to 2018. Costs to the trucking industry are estimated at US$8 billion and projected savings for truck operators are U$50 billion from 2014 through 2018.

Example: Technology Mandates - California, United States

The use of technology to improve flow and fuel efficiency is well documented. The California Air Resources Board (ARB) has developed Tractor-Trailer Greenhouse Gas Regulation to reduce greenhouse gas emissions produced by heavy-duty tractors by making them more fuel efficient. It mandates that fuel efficiency will be improved by requiring the use of aerodynamic tractors and trailers that are also equipped with low rolling resistance tires.[63]

[61] http://www.unep.org/transport/gfei/autotool/basic.asp
[62] See http://www.dieselnet.com/standards/jp/fe.php
[63] http://www.arb.ca.gov/cc/hdghg/fact_sheets/HDGHG_Genl_Fact_Sheet.pdf

4.1.2 Fuel Quality and Vehicle Emissions

To reduce air pollutant emissions from trucks governments can adopt and tighten standards for vehicle emissions, fuel quality, requirements to include biofuels in the fuel mix. To guide governments, the "Road Map for Cleaner Fuels and Vehicles in Asia" was prepared through a multi-stakeholder approach that guides Asian governments to reduce transport emissions by improving these standards.[64] Vehicle emissions standards are gradually strengthened across the world, including in Asia. However, the focus is in first instance on light duty vehicles with as a result that standards for heavy duty vehicles are lagging behind and thus relatively high emitting trucks are still added to the fleet. An exception is Singapore, where vehicle emissions standards for heavy diesel vehicles were given priority because of air pollution impacts.

Introducing Euro 4 diesel with a 50 ppm Sulfur level is important because this enables the introduction of various emissions control technologies, such as diesel particulate filters (DPFs). Table 7 shows that based on current and proposed Sulfur levels in diesel, only a few countries will be able to apply such technologies in the future, thus government intervention is critical to advance fuel quality standards. The real challenge is moving beyond Euro IV, which requires the integration of technologies that encompass combustion, air, oil, fuel and water filtration, and exhaust after treatment. This total systems approach can be supplemented with on board diagnostics (OBD) systems that signal the presence of a fault or high emission levels to the driver.

Table 7. Current and Proposed Sulfur Levels in Diesel

Source: CAI-Asia, 2011

	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
European Union	500									50(10)[f]			10							
Japan[b]	500									50		10								
Hong Kong, China		500					50					10								
United States	500										15	10								
South Korea	500							430	100		30	15(10)[f]								
Singapore	3000		500								50									
Taipei, China	3000			500			350		100				50							
Thailand	2500			500					350								50			
China (metros)[g]	5000						2000		500	350			50							
China (national)[e,f]	5000						2000			2000 & 500					350					
India (metros)	5000				2500		500			350[a]					50					
India (national)	5000				2500					500					350					
Malaysia	5000		3000				500[c]							500[d]						
Philippines	5000					2000			500											50[a]
Sri Lanka	10000							5000[d]		3000&500		500					50[a]			
Vietnam	10000											500								
Indonesia	5000									3500					350					
Cambodia					2000				1500											
Bangladesh							5000													
Pakistan	10000						7000[c]													

Notes: a - under consideration/ discussion; uncertain; b = nationwide supply of 50 ppm commenced in 2003 and for 10 ppm in 2005 due to voluntary goals set by the oil industry; c = marketed; d = mandatory; e = voluntary standard of 500 ppm, however formal standard remains 2000 ppm, product in the market nationwide varies 500-1000 ppm; f = various fuel quality available; g = Beijing, Guangdong, Shanghai
Source: CAI-Asia. 2010. Current and Proposed Sulfur levels in Diesel in Asia, EU and USA

[64] See http://cleanairinitiative.org/portal/node/3632.

The International Council on Clean Transportation (ICCT) has outline pathways for China to achieve low emissions from vehicles through sharpening vehicle emissions standards and the application of emissions control technologies. [65]

From the policy interventions listed in Table 5, the following three are an integral part of a comprehensive strategy to reduce vehicle emissions and will be critical for Asian developing countries in improving the fuel efficiency of trucks and reducing air pollution.

- Vehicle inspection and maintenance (I&M) programs are in place in most Asian countries, but few are effective due to lack of enforcement and corruption. Governments play a critical role in improving enforcement and effectiveness of their programs, and can make use of best practices from other countries.[66]
- Fuel inspection and compliance programs are necessary to ensure that fuels used are meeting quality standards. Fuel smuggling and adulteration is a key concern in Asian countries.
- Restrictions on the import of new and used trucks and engines based on age, technology and emissions are important to manage the fuel economy and emission levels of truck fleets in a country. While economic and social considerations for importing vehicles should be considered, putting limits on fuel economy and vehicle emissions for imported trucks are critical to avoid that developing countries' efforts to reduce fuel and pollution are offset by imported polluting and fuel inefficient trucks.

4.1.3 Mode Shift

Many countries are trying to implement a road to rail policy and road to waterways policy by providing incentives and favorable conditions. The Framework Act on Low Carbon Green Growth of the Republic of Korea has set model targets on freight movement. As per the target, by 2012, the railways share should increase from 8 to 15 per cent and coastal shipping share should increase from 18 to 22 per cent.[67]

4.2 Green Freight Programs

Green freight programs are being established around the world and most are modeled after or based on the US SmartWay program. The main ones are described in Table 8. China is the first Asian country where a national program is being set up. In addition a growing number of green freight demonstration projects and other initiatives are established including Japan, Australia, France, and the United Kingdom.[68] In Asia, CAI-Asia and the Sustainable Supply Chain Center for Asia Pacific (SSCCAP) are facilitating the establishment of a Green Freight Asia Network of freight shippers, freight carriers, third party logistics providers and industry associations. In support of green freight initiative and programs, private sector companies have signed the "Private Sector Declaration on Green Freight in Asia towards a Green Economy.[69]

[65] http://www.theicct.org/2011/10/technology-pathways-in-china/ and http://www.theicct.org/2011/04/overview-vehicle-emissions-controls-china/
[66] USAID. 2004. Vehicle Inspection and Maintenance Programs: International Experience and Best Practices.
[67] http://www.greengrowth.org/download/Framework%20Act%20on%20Low%20Carbon%20Green%20Growth%202010.pdf
[68] For an overview see www.greenfreightandlogistics.org
[69] http://cleanairinitiative.org/portal/2ndGreenFreightAsiaWorkshop

Table 8. Main Green Freight Programs

Program	Details	Main components
SmartWay Transport Partnership	Partners: USEPA, freight shippers, carriers, logistics companies and other stakeholders Location: USA Start Date: 2004 Scope: Trucks www.epa.gov/smartway	• SmartWay Transport Partnership • Technology Program: testing and verification program to quantify emission reductions and fuel savings from available technologies • Innovative Finance helps companies to acquire fuel-efficient emission reduction technologies through easier access to financial mechanisms. • Outreach and Education includes partner recognition through the SmartWay website, logo use and awards, partner education, pilot projects, and international activities.
ecoFREIGHT program & FleetSmart	Organization: Natural Resources, Canada Location: Canada Start Date: 2006 Scope: Trucks, marine vessels, fleets (trucks, coaches, buses) http://fleetsmart.nrcan.gc.ca/	The program consists of six initiatives: • National Harmonization Initiative for the Trucking Industry focusing on regulatory barriers and solutions for emissions-reducing technologies. • ecoENERGY for Fleets (FleetSmart) for commercial and institutional fleets via SmartDriver training, fuel management workshops, sharing of best practices, anti-idling campaigns, technical analysis • Freight Technology Demonstration Fund for cost-shared demonstrations • Freight Technology Incentives Program which provides cost-shared funding for proven emission-reducing technologies. • ecoFREIGHT Partnerships to reduce emissions through voluntary actions that can support the regulatory framework. • Marine Shore Power for marine vessels in Canadian ports to reduce air pollution from idling ship engines in urban centers.
SmartWay Europe Program *(This name is only used to refer to the intention to create a program in Europe similar to the USEPA SmartWay*)	Partners: Private sector companies Location: Europe Start Date: 2012 Scope: Road freight transport Website not yet available	Independent voluntary program for improving environmental performance of road freight transport in Europe, reducing carbon emissions by: • Establishing a platform for monitoring and reporting of carbon emissions, that could assist in the procurement of transportation services and based on existing standards • Promoting collaboration between carriers and shippers in driving improvement actions and monitoring progress • Establishing a certification system to reward shippers and carriers who fully participate in the program
Green Freight China Program *(in development)*	Partners: CAI-Asia, China Road Transport Association (CRTA) and Research Institute of Highway (RIOH) Location: China Start Date: 2011 Scope: Road freight transport www.greenfreightandlogistics.org/	The proposed components for a China program includes: • Clean Technologies • Freight Logistics • Financing Mechanisms • Knowledge & Capacity • Partnerships

CAI-Asia in partnership with CRTA and RIOH of the Ministry of Transport, and with support from Energy Foundation, US EPA and Cascade Sierra Solutions, are developing a Green Freight China Program. The program framework in Table 9 can also serve as a basis for other developing Asian countries to develop national green freight programs.

Table 9. Proposed Framework for the Green Freight China Program

Components	Objective	Main Elements
Clean Technologies	• Selecting and advancing of clean technologies for adoption especially by truck carriers that improve fuel efficiency and reduce emissions	• Technology summaries • Technology verification and certification system • Pilot projects • Focus on tire and wheel; aerodynamics; idling control; and emissions control technologies
Freight Logistics	• Supporting the implementation of strategies that improve freight transport logistics and subsequently reduce the "empty miles" of trucks	• Logistics solutions summaries • Pilot projects • Focus on drop-and-hook, logistics information platform (also freight exchange), multimodal transport, fleet and fuel management, and freight company consortium
Financing Mechanisms	• Accelerate the adoption of technologies through financial mechanisms that help reduce the investment barrier especially for carriers	• Financing mechanisms development • Financing services development (e.g. assist with grant applications) • Publications with financial information especially of technologies • Focus on policy-based (taxes, subsidies) and market-based mechanisms (loans, emission credits, ESCOs)
Knowledge & Capacity	• Improve knowledge of especially shippers, carriers and 3PLs on green freight and the capacity to reduce fuel use and emissions	• Freight transport emissions methodology • Green freight website and database • Green freight training
Partnerships	• Establish and facilitate partnerships and cooperation to improve interaction among shippers, carriers, suppliers, government and other stakeholders	Different collaborations between: • Freight companies (shippers, carriers, third party logistics providers/3PLs) • Technology manufacturers and suppliers • Private sector and the Government • Green Freight Network of all stakeholder organizations

The role that governments can play in such programs includes

- Facilitating the program, as is the case in the US, although the program in Europe will be managed by a neutral body
- Establishing a national technology verification and certification system for clean technologies applicable to the freight sector, to ensure independent and objective information is available on the costs and performance of technologies
- Support for pilot projects for demonstration of clean technologies and logistics solutions
- Support the development of training programs for drivers and companies. To ensure green freight, including in the context of a green economy there is a need for skilled workers and qualified employers.
- Providing financing mechanisms for freight companies and drivers to acquire technologies

- Adopting policies and legislation in favor of clean technologies, improved freight logistics and mode shift to rail, ships and smaller vehicles (see Table 5 for types of policies)
- Forming collaborations or partnerships with private sector companies and other stakeholders

Example: Technology Mandates - California, United States

The California's Truck and Bus regulation has its first diesel filter deadlines in January 2012. The regulation provides owners of heavier trucks and buses (those with a gross vehicle weight rating greater than 26,000 pounds) with two options to reduce diesel emissions. They can:

- Follow a staggered implementation schedule that requires 1996-1999 model engines be retrofit with a DPF by 1 January 2012
- Use a flexible phase-in option that requires any 30 percent of vehicles in the fleet to have a DPF. This option requires fleet owners to report information about all their heavier vehicles to CARB by 31 January 2012. Fleets that report also can take advantage of credits and special provisions.

Owners of small fleets (less than three trucks with a GVWR greater than 14,000 pounds) can postpone the January 2012 compliance requirement for their heavier trucks until 2014, but must report their fleet information to CARB. Lighter diesel trucks with a GVWR of 14,001 to 26,000 pounds have no compliance requirements until 2015.[70]

Example: Drop-and-Hook program – China

In Asia, China is actively promoting this measure. In the "Notice on Promoting Drop-and-Hook Development" (MOT 808, December 2009), which was co-issued by MOT, NDRC, MPS71, GDC72, and CIRC73, MOT identified several policy and regulation measures to lift the implementation barriers associated with the application of drop-and-hook such as - reducing the inspection frequency of trailers, adjusting the insurance rate for the trailers, improving/adjusting custom regulations of "drop-and-hook", improving/adjusting road toll collection methods for "drop-and-hook", standardizing tractors and trailers' facilities, improving the license management of the trailers, encouraging transport companies to expand their networks and encouraging cooperation/coordination among logistics market players.

Example: SmartWay Clean Diesel Finance Program – United States

The SmartWay Clean Diesel Finance Program uses cooperative agreements to establish innovative finance programs for buyers of eligible diesel vehicles and equipment. Innovative finance projects include those where the loan recipient receives a unique financial incentive (i.e., better than regular market rates or conditions) for the purchase of eligible vehicles or equipment. SmartWay also provides information on financial institutions that provide loans for purchase of new or pre-owned trucks through their finance center website.[74]

One non-profit institution that provides financial support is Cascade Sierra Solutions. CSS has outreach centers for truckers which are located at major truck stops and ports that provide a non-regulatory, non-profit environment where owner-operators or large fleets can visit a one-stop shop for accurate information on laws affecting their businesses, technology available to meet their needs and low-interest financing to make that technology affordable.

[70] http://www.ccjdigital.com/carb-reminds-truck-owners-of-looming-dpf-mandate/
[71] MPS = Ministry of Public Security
[72] GAC = General Administration of Customs of the People's Republic of China
[73] CIRC = China Insurance Regulatory Commission
[74] http://www.epa.gov/otaq/eparecovery/progfinance.htm and http://www.epa.gov/smartway/financing/govt-funding.htm

Because of the non-profit mission and the bulk discounts CSS negotiate, they can offer SmartWay upgrades and financing at significantly below-market rates. Financing assistance is also provided to purchase and install energy-efficient technologies or to replace old dirty trucks with clean new ones. install may include leases, lease guarantees, grants, tax credits and manufacturer rebates.[75]

Example: Technology verification system – United States

US EPA's SmartWay Technology program develops test protocols, reviews strategies and verifies the performance of vehicles, technologies and equipment that have the potential to reduce greenhouse gases and other air pollutants from freight transport. The program establishes credible performance criteria and reviews test data to ensure that vehicles, equipment and technologies will help fleets improve their efficiency and reduce emissions. Fuel saving benefits of various devices are evaluated through grants, cooperative agreements, emissions and fuel economy testing, demonstration projects and technical literature review. The following technologies were covered: idle reduction technologies, aerodynamic technologies, low rolling resistance tires, and retrofit technologies. Within each of these categories, EPA has verified specific products but does not endorse the purchase of products or services from any specific vendor.[76] US EPA also developed a test protocol to provide a standardized, objective, consistent test procedure to measure the fuel consumption of medium and heavy duty vehicles used in on-road operation.[77]

4.3 Indicators to Measure Progress

The Bangkok 2020 Declaration is an important milestone in the development of sustainable transport in Asia, since it is the first regional declaration on the promoting environmentally sustainable transport in Asia which contains time bound (2011-2020) twenty goals as well as indicators to assess progress in meeting them. Especially, it is the first regional declaration jointly agreed by the Ministries of Transport and Environment of the participating Asian countries, providing a platform for interministerial coordination to address an integrated EST Strategy at national level. Whether to measure progress against goal 12 of this declaration to improve freight transport efficiency or to measure progress for national green freight programs, indicators are needed. Governments need indicators to understand implications of freight transport on the economy, energy consumption, and environment, the relative importance of different modes of goods transport to determine the infrastructure needs, and the effectiveness of policies.

The indicators included in the annex of the Bangkok 2020 Declaration are:

- Number of kilometers of freight rail lines
- Number of inland dry port
- Quantify improvements in freight vehicle fuel efficiency
- Quantify changes in freight vehicle types
- Quantify network efficiency gains

[75] http://cascadesierrasolutions.org/
[76] http://www.epa.gov/smartway/technology/index.htm
[77] http://www.epa.gov/smartway/documents/publications/testing/420p07003.pdf

Other review suggests indicators such as – travel time, travel speed, traffic volume, vehicle loads, level of service, duration of congestion, rail crossing incidents, travel cost, weather related incidents, accidents, travel time reliability, freight-related highway improvement expenditures, vehicles emissions etc. For example, United Kingdom collects information on the following set of core indicators:[78]

- Freight transport intensity (ratio of total freight moved to GDP)
- Lorry traffic intensity (ratio of HGV mileage to GDP)
- Road traffic by type of vehicle (vehicle-km)
- Freight transport by mode (ton-km)
- Energy consumption by road freight
- Energy efficiency of road freight (energy consumption in relation to output measures as ton-km).

The following indicators linking efficiency, economy, environment and safety are proposed for measuring progress against Goal 12:

- Number of kilometers of freight rail lines
- Number of inland dry port
- Freight transport emissions per ton-km or energy consumption in relation to output measures as ton-km
- Freight transport intensity (ratio of total freight moved to GDP
- Traffic fatalities involving freight vehicles – number and percentage of total traffic fatalities.

It is to be noted that freight carriers require a different set of performance indicators. Governments can also work with the private sector and industry associations to develop indicators for freight efficiency improvements in terms of costs, operation, customer service, compliance, maintenance, and CO_2 and air pollutant emissions. Literature review suggests following indicators normally used for fleet management:[79]

- Costs - Average cost per unit delivered ($), Total whole vehicle cost ($/km), Average running cost ($/km), Average standing cost ($/km), Average driver cost ($/km), Total maintenance cost ($/km)
- Operational - Average km per liter, Total km run, Total empty miles run (km), Percentage empty running total, Percentage average vehicle fill, Percentage average time utilization
- Service - Percentage of total late deliveries, Percentage of total damages, Percentage of total complaints
- Compliance - Total number of overloads, Total number of vehicle traffic infringements, Total number of drivers' hours infringements, Total number of traffic accidents
- Maintenance - Percentage of failed inspections total, Percentage of defects rectified in 24 hours total
- Environmental - Total fleet CO_2, Average fleet CO_2.

[78] http://www.internationaltransportforum.org/Pub/pdf/02BenchmarkingE.pdf
[79] "Fleet Performance Management Tool Incorporating CO2 Emissions Calculator" UK DfT Freight Best Practice program

5. GREEN FREIGHT TOWARDS A GREEN ECONOMY

Asian countries should integrate green freight efforts in a broader green economy strategy. The three core elements of a green economy: low carbon and pollutants, resource efficient (energy and fuel) and socially inclusive.[80] The following are the main ten recommendations for green freight towards a green economy:

1. Adopt measures that improve the fuel economy of trucks. For governments this includes policy interventions such as fuel economy standards, technology mandates, import restrictions, economic instruments, and traffic control measures. Truck companies can adopt technologies that include tires and wheels, aerodynamics equipment, idling reduction technologies and technologies relating to fuel, engines and vehicles.
2. Reduce air pollutant emissions from trucks. Governments can tighten standards for fuel quality and vehicle emissions to at least Euro IV, mandate emission control devices, provide effective fuel inspection and vehicle inspection and maintenance programs, and restrict the import of new and used trucks and engines based on age, technology and emissions. Truck companies can improve truck maintenance practices, use cleaner fuels, install emission control technologies for diesel trucks, and replace old trucks with newer ones.
3. Introduce fleet management systems to reduce emissions, fuel and improve the well-being and economic situation of drivers that includes vehicle financing, maintenance, telematics, driving management, speed management, fuel and health/safety management.
4. Reduce truck empty miles to fuel use and emissions and improve the net income of drivers as well as companies by adopting measures such as drop-and-hook, backloading and milk-run concept, logistics information platform, freight company consortium, and freight consolidation centers.
5. Shift from road freight to rail and waterways and from trucks to vans and cargo bikes to reduce the carbon footprint. Governments can investing in rail and waterways infrastructure combined with financial and policy incentives to stimulate a shift in future growth in freight from road to rail and waterways.
6. Improve intermodal transfer of freight between road, rail, waterways and ocean.
7. Address safety impacts of freight transport through the adoption of measures by truck companies that improve the safety record of trucks, including better driver training, maintenance and route planning and scheduling. Governments need to better enforce traffic rules and truck load restrictions and provide for training, especially for driver-owners.
8. Take steps to halt the spread of HIV/AIDS and other sexually transmitted diseases among truck drivers. Governments and companies can adopt HIV/AIDS programs that include awareness raising of men and women, education, monitoring, counseling, and medical support.
9. Introduce a national Green Freight Programs that cover clean technologies, freight logistics, financing mechanisms, knowledge & capacity, and partnerships. Partnerships are essential to ensure the inclusion of all stakeholders of the freight sector, which is essential for a successful transformation to a greener sector.
10. Adopt indicators to measure progress towards green freight and its contribution to a green economy, covering economic, environmental and social aspects.

[80] http://www.unep.org/greeneconomy/

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