Green Logistics: Global Trends and Issues

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Decoding Sustainable Logistics Trends  
*World Bank*  
*Washington DC*

26th June 2012
Close correlation between cutting cost and reducing environmental impact
Tightening Emission Standards

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Emission standard time-lag

- **EU**
  - Euro 1: 1993 (cities) 2000 (nationwide)
  - Euro 2: 1996 2003 2005
  - Euro 4: 2005 2010

- **India (cities)**
  - 2000

- **India (nationwide)**
  - 2000

- **Euro 0**
  - India (cities): 1993
  - India (nationwide): 2000

- **EURO 0**
  - NOx (g/kWh) Particulates (g / kWh)
Emission of Greenhouse Gases from Freight Transport / Logistics

Logistics accounts for 2,800 mega-tonnes of CO$_{2e}$ = 5.5% of total GHG emissions

Source: World Economic Forum / Accenture
Life Cycle Assessment of the Environmental Impact of Unilever Products

One wash with laundry detergent

Source: http://www.sustainable-living.unilever.com/the-plan/
Average Fuel Efficiency of New European Trucks (38 -40 tonnes gvw)

Steep reductions in fuel consumption and emissions per tonne-km

Growth of total tonne-kms counteracting this trend

Litres / 100 km

Test reports of new truck fuel efficiency 1966 - 2010

Economic Growth Increases Freight Transport Emissions per Capita

Source: Eom, Schipper and Thompson, 2012
Economic development

Improvements to transport infrastructure – mainly road

- Centralisation
- Wider sourcing
- Increased length of haul
- Increased freight transport intensity: ratio of tonne-km to output
- Growth in output

Industrialisation

- New industrial / warehousing development not rail-connected
- Decline in rail freight

New patterns of consumption

- Change in commodity mix
- Lower density / higher value products
- Stronger just-in-time pressures
- Poorer utilisation of vehicle capacity

Growth in output

- Much more freight being moved
- By less green mode
- In less full vehicles

Greater environmental degradation

Higher externalities per unit of freight moved

- Improve fuel efficiency
- Enhance inter-modal capabilities
- Consolidate loads in larger / heavier vehicles

Consolidate loads in larger / heavier vehicles
Projected Growth of Inland Freight Movement (billion tonne-km)

Source: EU Transvisions project (2009)

- EU: +160%, 43 years
- India: +166%, 13 years

(McKinsey, 2010)
Growth of Container Shipping Volumes

Source: Clarksons Container Intelligence Monthly, Jan 2010
Projected Growth of Airfreight

Total freight tonne-kms (FTK)

- International
- Domestic US
- Domestic BRIC

International represents 88% of world FTKs
International represents 86% of world FTKs

Source: Airbus (2011)
Sustainable Freight Transport Framework 1

A-S-I APPROACH

AVOID
- Reduce or avoid need for freight movement

SHIFT
- Shift freight to greener transport modes

IMPROVE
- Improve energy the efficiency of freight transport

System Efficiency

Trip Efficiency

Vehicle Efficiency
Sustainable Freight Transport Framework

Activity Shift Intensity Fuel (ASIF)

\[ G = A \times S_i \times I_i \times F_{i,j} \]

- **G**: Carbon Emissions from Transport
- **A**: Total Activity (passenger or freight travel)
- **S_i**: Modal Structure (travel by mode)
- **I_i**: Modal Energy Intensity
- **F_{i,j}**: Carbon Content of Fuels

- **M S_i**: Modal vehicle kilometer share
- **L_i**: Load factor (passengers or tons per veh-km)
- **E_i**: Technological energy efficiency
- **V_i**: Vehicle Fuel Intensity
- **V C_i**: Vehicle Characteristics

Source: Schipper et al, 2006
Sustainable Freight Transport Framework

- Weight of goods produced / consumed
- Total tonnes lifted
- Tonne-kilometres
- Road tonne-kms
- Total vehicle-kms
- Energy consumption
- Other externalities per vehicle km
- Other non-energy-related externalities
- Noise, vibration, accidents, visual intrusion
- Environmental impact of freight transport
- Output
- Key parameter

Supply chain structure
Modal split
Vehicle utilisation
Energy efficiency
Emission intensity

Relative importance of these factors varies with the level of economic development
Diverging from Business-as-Usual Energy / Emissions Trend

freight transport sector

Carbon emissions

2050

Business-as-Usual trend
red reduced transport intensity

Adapted from Pacala and Socolow, 2004
Limited Evidence of Freight Traffic / GDP Decoupling

Ratio of Tonne-kms to GDP

Objective is not to decouple freight volumes from GDP but rather to decouple freight-related externalities from GDP.

Minimising distances freight is moved will not necessarily minimise environmental impacts on a full life cycle basis.

Sources: Eurostat and Chinese government
Should we reverse the globalisation process?

Local sourcing food from UK or importing it from New Zealand?

New Zealand agriculture emits less greenhouse gas per tonne of product

![Graph showing kg of CO2 per tonne for different produce items from New Zealand and UK.](image)

- **Dairy produce**
- **Lamb**
- **Apples**
- **Onions**

Includes transport by deep-sea container 18000 kms

Source: Saunders, Barber and Taylor, 2006
To Cut Carbon Emissions Should We Return to Decentralised Warehousing?

Potential CO₂ Benefits from Inventory Centralisation:
Lower inventory levels:
- *less energy use in storage*
- *less wastage of product*
Less warehouse space required:
- *less CO₂ in construction, operation and maintenance*
Larger warehouses can be more energy efficient:
- *emit less CO₂ per unit of throughput*

**CO₂ Trade-offs**

- total logistics CO₂
- Inventory-related CO₂
- warehousing CO₂
- transport CO₂

*Minimum CO₂ footprint*

*no. of warehouses*

ultra-low / zero carbon warehousing and materials handling equipment by 2030?
Diverging from Business-as-Usual Energy / Emissions Trend

freight transport sector

Adapted from Pacala and Socolow, 2004
Variations in CO$_2$ Intensity by Freight Transport Mode

- Over-reliance of average modal intensity values
- Sensitivity to assumptions about vehicle loading
- Future trends in modal intensity values
- Need to extend the calculation boundary to include infrastructure and vehicle construction and maintenance

Source: McKinnon / Commission for Integrated Transport
Extending the System Boundary in Measuring Transport CO\textsubscript{2}

SB5  Administrative functions, personnel, etc

SB4  Vehicle/train/vessel/aircraft - construction and scrapping
     Traffic infrastructure and transport infrastructure - construction and dismantling
     Service and maintenance infrastructure - construction and dismantling

SB3  Vehicle/train/vessel/aircraft - service and maintenance
     Traffic infrastructure - operation and maintenance
     Transport infrastructure (terminals) - operation (incl. energy supply and maintenance)

SB2  Energy supply (well-to-tank/power plant)

SB1  Traffic operations
     - propulsion (engines/power plant)
     - evaporation and battery losses
     - cargo climate control

Source: NTM
Carbon Savings from Switching from Road to Intermodal Road-Rail Service

Intermodal
Annual total = 4,250t CO₂

Road
Annual total = 10,626t CO₂

60% saving

www.freightbestpractice.org.uk
Diverging from Business-as-Usual Energy / Emissions Trend

*freight transport sector*

- reduced transport intensity
- freight modal shift
- increased vehicle utilisation

Adapted from Pacala and Socolow, 2004
Utilisation of Truck Capacity

% of truck-kms run empty in the EU: national and international transport 2010

Source: Eurostat report 63/2011

China     50%
India

% of truck-kms run empty in the EU: national and international transport 2010

Source: Eurostat report 63/2011

Higher rates of over-loading in developing countries
  *e.g. UK 8-9% Philippines 17%*

Combined with under-powering → more fuel use

More damage to road pavement + under-maintenance
  → higher fuel use, more accidents, more tyre wear etc
Constraints on Truck Utilisation

- Market-related:
  - Demand fluctuations
  - Uncertainty about transport requirements

- Regulatory:
  - Health and safety regulations
  - Vehicle size and weight restrictions
  - Unreliable delivery schedules
  - Just-in-Time delivery

- Inter-functional:
  - Nature of packaging / handling equipment
  - Limited storage capacity at destination

- Infrastructural:
  - Incompatibility of vehicles and products for backloading
  - Poor coordination of purchasing, sales and logistics

- Equipment-related:
  - Poor coordination of purchasing, sales and logistics
The Maximum Truck Size and Weight Issue
**Need to Adapt Green Logistics Strategies to Local Circumstances**

**Comparison of Indian and European Long-haul Trucks**

- **84% are 2-3 axle rigids**
  - 30 – 40 cubic metres capacity
  - Max GVW: 9 t (2 axle)  25 t (3 axle)

- **5-6 axle articulated vehicle**
  - 82 cubic metres capacity
  - Max GVW: 40 - 44 t

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**Need to allow for differences in:**

- Road infrastructure
- Materials handling system
- Commodity mix
- Order replenishment process
- Structure of the haulage industry  etc
Transport Collaboration – even between Competitors

*Nestle and United Biscuits*

Reduced empty running
280,000 truck-kms saved per annum

‘We compete on the shop shelf, not in the back of a lorry’

New EU-funded project

**Collaboration Concepts for Comodality**
Diverging from Business-as-Usual Energy / Emissions Trend

freight transport sector

- reduced transport intensity
- freight modal shift
- increased vehicle utilisation
- improved fuel efficiency
- electrification of transport
  low / zero carbon electricity

Adapted from Pacala and Socolow, 2004
Future Advances in Truck Technology

- Accelerate the diffusion of new truck technology into developing countries within infrastructural, financial and market constraints.

- Displacement of 2\textsuperscript{nd} hand truck purchases from developed countries with indigenous production of freight vehicles

- Long vehicle life and lack of finance favours retrofitting of vehicles

- Imposition of fuel economy standards for new trucks - a worthwhile policy?
Ways of Improving the Fuel Efficiency of Existing Trucks

- Automatic tyre inflation systems
- Low friction drive train lubricants
- Low friction engine lubricants
- Tare weight reduction
- Wide-base tyres
- Improved Trailer Aerodynamics
- Improved Tractor Aerodynamics
- Driver training and monitoring
- Idling reduction (automatic engine idle)
- Maximum speed reduction (65-60 mph)

Source: Ang-Olsen and Schroer
Telematics

- Improved fleet management
- Increased confidence in schedule for backloading
- Easing the impact of traffic congestion

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**TRAFFIC CONGESTION INCREASES FUEL CONSUMPTION**

<table>
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<tr>
<th>Speed</th>
<th>Fuel Consumption (l/100 km)</th>
<th>Source: Verband der Automobilindustrie (VDA), Germany</th>
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<tr>
<td>50 km/h no stop</td>
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<td>50 km/h 1 stop per km</td>
<td>52</td>
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<td>50 km/h 2 stops per km</td>
<td>84</td>
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Improving the Aerodynamic Profiling of Trucks: 360° perspective

Over cab spoiler

Teardrop

Cheetah

Boat-tails

Trailer under-tray

Dolphin

Limited benefit in developing countries where average truck speed is low
Aerodynamics have limited influence on fuel consumption at lower speeds.

Source: Michelin
Diverging from Business-as-Usual Energy / Emissions Trend

freight transport sector

- cut carbon content of fuel
- reduced transport intensity
- freight modal shift
- increased vehicle utilisation
- improved fuel efficiency
- electrification of transport
- low / zero carbon electricity

Adapted from Pacala and Socolow, 2004
Predicted Decarbonisation of Electricity Generation around the World

Electrifying the Road Network?

Electrifying Freight Transport

Direct transmission to freight transport services:
- Electrified rail services
- ‘Cold ironing’ of ships in ports

Electrifying the road network: Swedish, French and Germany studies

Indirect transmission via batteries or hydrogen
Net GHG savings and environmental sustainability of biodiesel uncertain on life-cycle basis yields significant net GHG reductions.

Projected use of different fuel types in the EU transport sector by 2030:

- LPG
- Biofuels
- Diesel
- Gasoline

Source: DG Tren
International Energy Agency Projections 2005-2050

Trucking

Source: IEA, 2009

‘Blue map shift scenario’
Supply Chain Decarbonisation Measures

- Clean vehicle technology
- Slowing down product flow
- Localised sourcing of agricultural produce
- Optimisation of logistics networks
- Increased energy efficiency of buildings
- Improved packaging design
- Enable low carbon production
- Training and communications
- Freight modal shift
- Reverse logistics / recycling
- Near-shoring / relocationalisation
- Increased home delivery
- Reduction in congestion

Source: World Economic Forum / Accenture
Levels of Logistical Decision-making

- **STRATEGIC:** numbers, locations and capacity of factories and warehouses
  - Restructuring of logistical systems

- **COMMERCIAL:** trading links to suppliers, customers and sub-contractors
  - Reconfiguring supply chains

- **OPERATIONAL:** scheduling of production and distribution operations
  - Rescheduling of freight flows

- **FUNCTIONAL:** day-to-day management of the logistics function
  - Changes in the management of freight transport

Interaction between decisions at different level determines volume of freight traffic and related externalities.

Green measures implemented at lower levels offset by effects of higher level strategic decisions.
Advice and Encouragement on Sustainable Logistics

UK Government: Freight Best Practice Programme

Public Cost per tonne of CO$_2$ saved: £8
Other Schemes to Promote Environmental Best Practice in Freight Transport

UK Logistics Carbon Reduction Scheme
8% reduction in carbon intensity of freight transport between 2010 and 2015
Endorsed by the UK Government
Economic Appraisal of Green Freight / Logistics Measures

Need more research on cost-effectiveness of Green Logistics measures in both developed countries and emerging markets.
Conclusions

- Freight sector has already achieved large reduction in externalities per tonne-km
- Rate of tonne-km growth is exceeding rate of externality reduction per tonne-km
- Little prospect of significant tonne-km : GDP decoupling in emerging markets
- Broad array of mutually re-inforcing technological and behavioural options
- Need to adapt green logistics policies to the circumstances of developing countries
- Most eco-efficiency measures are self-financing often with short payback times
- Still significant ‘low hanging fruit’ to be harvested
- Need more data for the analysis of potential benefits and monitoring trends
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