CO₂ Emissions from Freight Transport
An Analysis of UK Data

Professor Alan McKinnon
Logistics Research Centre
Heriot-Watt University
EDINBURGH

LRN Conference 2007
University of Hull
Estimation Methods

- Input-based measures:
  - top-down
  - based on energy / fuel purchases
  - sectoral - classified by dominant activity

- Output-based measures:
  - bottom-up
  - based on surveys of freight transport operations
  - cross-sectoral
  - multiply volume of freight movement by CO$_2$ emission factor
    
    \[ \text{tonne-kms} \times \text{CO}_2\text{ per tonne-km} \]
Caveats

- Assumptions about the utilisation of vehicle capacity
- Use of parameters derived from international studies
  - e.g. IFEU, INFRAS, Tremove
  - differences in primary energy mix, transport infrastructure, vehicle age profile etc.
- National ‘environmental accounts’ estimate CO₂ emissions only from British companies and on a sectoral basis
- Use of tonne-kms as the measure of freight transport activity
- Movement of freight in passenger vehicles: allocation issues
- Focus on CO₂ – excluding other global warming gases:
  - e.g. N₂O – roughly 1% of carbon equivalent emissions from HGVs
- Analysis confined to CO₂ emissions from domestic freight transport
Modal Energy Intensity and Capacity Utilisation

Source: International Maritime Organisation, 2000
Off-shoring of Manufacturing and the Upstream Supply Chain

- supplier
- processing plant
- retail distribution centre
- warehouse

Export of carbon-generating activities reducing UK’s ‘carbon footprint’

Embedded carbon in imported products

UK contributing to the growth of freight-related CO₂ emissions in exporting countries + growth of CO₂ emissions from international transport
Trends in CO$_2$ Emissions from Road Freight Transport

CSRGT   Continuing Survey of Road Based Transport
NRTS    National Road Traffic Survey
UKEA    United Kingdom Environmental Accounts

37%
Trends in CO₂ Emissions from Road Freight Transport

CSRGT  Continuing Survey of Road Based Transport
NRTS  National Road Traffic Survey
UKEA  United Kingdom Environmental Accounts
Trends in CO₂ Emissions from Road Freight Transport

CSRGT  Continuing Survey of Road Based Transport
NRTS   National Road Traffic Survey
UKEA   United Kingdom Environmental Accounts
Discrepancy in Estimates of CO$_2$ Emissions from HGVs

29% growth in CO$_2$ from HGVs

NRTS / CSRGT: 9% growth
Road Traffic Growth in the UK 1990-2005

Growth of CO₂ emissions 1997-2005
- Cars = + 3.2%
- Vans = + 24.4%
(Source: SMMT)

No CO₂ / km target for vans
EU target being considered

Source: Department for Transport
Vans

- Freight collections and deliveries + associated empty running represents only 35% of total van-kms
- 10.7 bn tonne-kms of freight in 2004 6.6% of total
- Assuming average fuel efficiency of 12 km / litre for vans
- 242 gms of CO$_2$ per tonne-km
- 2.6 million tonnes of CO$_2$
- Not possible to monitor trends for freight-carrying vans
CO$_2$ Emissions from Railfreight

National Atmospheric Emissions Inventory
CO₂ Emissions from Railfreight

- Assumes fixed CO₂ intensity: 49 gms of CO₂ per tonne-km
- No allowance for improvements in fuel efficiency of railfreight operations
- Rail Emissions Model (2000) for SRA: 20 gms of CO₂ per tonne-km
- EWS / DfT estimate – based on high load factors: 14.7 gms of CO₂ per tonne-km
- Using 20 gms of CO2 per tonne-km: 420K tonnes of CO₂ in 2004 (cf 1,012K)
## Other Freight Transport Modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Share of Waterborne Tonne-kms</th>
<th>CO₂ Emission per Tonne-km</th>
<th>Tonne-kms</th>
<th>CO₂ Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal shipping (UK vessels)</td>
<td>97.5%</td>
<td>30 gm</td>
<td>1.74 m</td>
<td>1.74 m tonnes of CO₂</td>
</tr>
<tr>
<td>Inland waterways</td>
<td>2.5%</td>
<td>35 gm</td>
<td>53K</td>
<td>53K tonnes of CO₂</td>
</tr>
<tr>
<td>Airfreight (domestic)</td>
<td>0.01%</td>
<td>1600 gm</td>
<td>55K</td>
<td>55K tonnes of CO₂ (2 x global warming potential)</td>
</tr>
<tr>
<td>Pipeline</td>
<td></td>
<td>8.2 gm</td>
<td>90K</td>
<td>90K tonnes of CO₂</td>
</tr>
</tbody>
</table>
CO₂ Emissions from Freight Transport in the UK (2004)

- **HGV**: 78.5%
- **Vans**: 13.3%
- **Waterway**: 6.8%
- **Rail**: 1.1%
- **Air**: 0.1%
- **Pipeline**: 0.3%

**33.7 million tonnes of CO₂**

- **21% of transport CO₂ emissions**
- **6% of total UK CO₂ emissions**

**Drax power station**

**20.6 million tonnes of CO₂**
Variations in CO₂ Intensity by Freight Transport Mode

Assumptions about vehicle load factors
Line-haul rather than door-to-door movements

gms of CO₂ per tonne-km at average loading
Truck > 38 tonne: 90  Railfreight: 20
Research undertaken for the Climate Change Working Group of the Commission for Integrated Transport

Publication of main report and briefing papers

12th September 2007

Contact details

Logistics Research Centre
Heriot-Watt University
EDINBURGH UK

A.C. McKinnon@hw.ac.uk

http://www.sml.hw.ac.uk/logistics

www.greenlogistics.org