Data Deficiencies, Inconsistencies and Opportunities in the Analysis of Freight, Energy and CO_2 Relationships

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International Energy Agency Workshop
'New Energy Indicators for Transport: The Way Forward'
Paris, 29th January 2008

Freight Transport Data

Deficiencies: *vary by country and freight mode*

- Reliable vehicle-km estimates for trucks and vans
- Vehicle utilisation data for all modes
- Volumetric (3D) and deck area (2D) measures of freight
- Survey estimates of fuel efficiency disaggregated by vehicle class / road type /mode
- All statistics relating to the movement of freight in vans
- Differentiation of freight movements, energy and emissions by supply chain link
- Door-to-door energy consumption / emissions for intermodal services

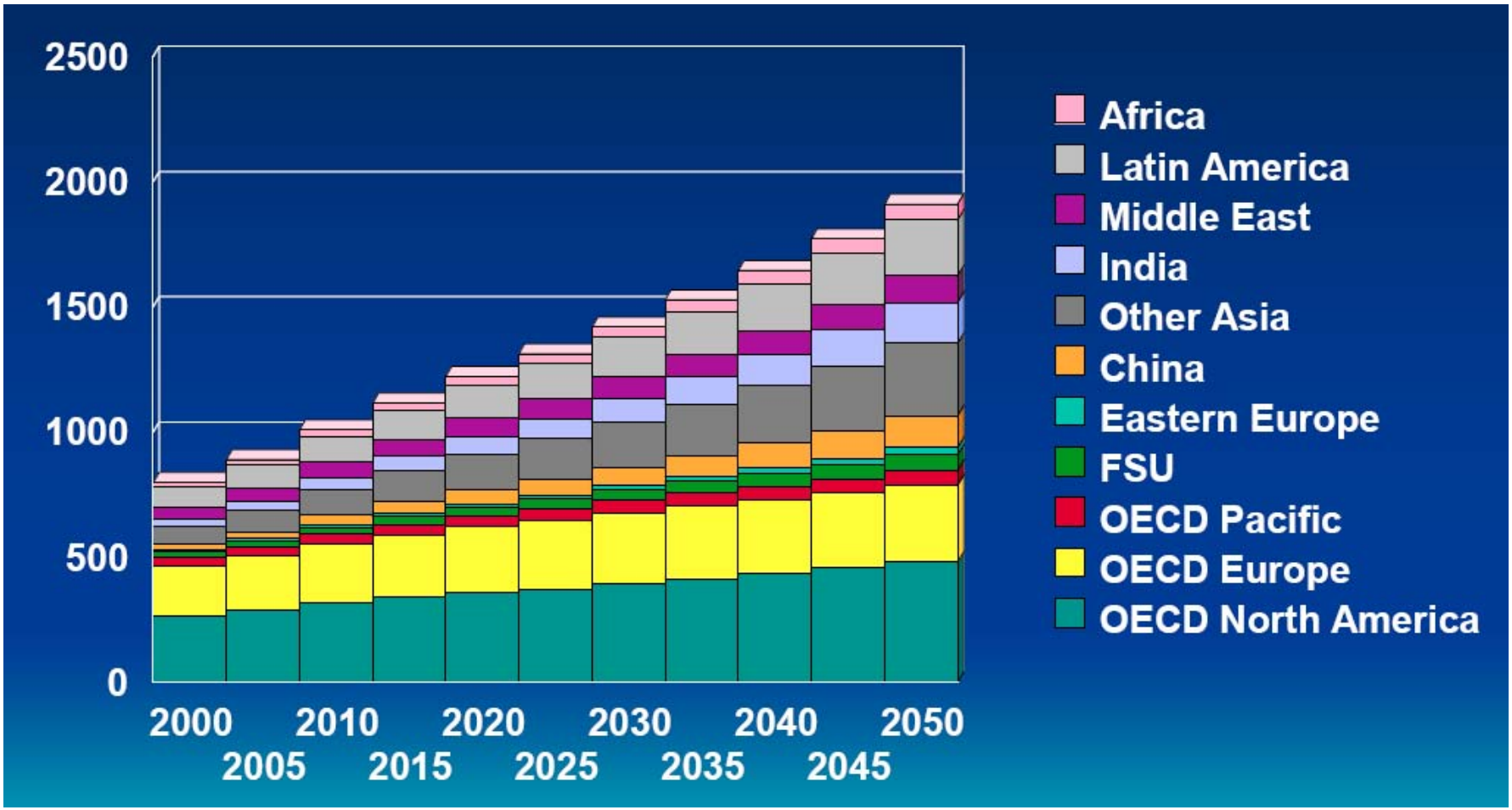
Recent freight transport studies:

- Decoupling of road freight demand from GDP in the UK
- Cost benefit analysis of legalising longer and heavier trucks to operate on UK roads
- Measuring CO_2 emissions from freight transport in the UK
- Modelling business-as-usual trends in freight and environmental variables

Opportunities of upgrading freight / energy / emission data

Forecast Growth of Truck Traffic

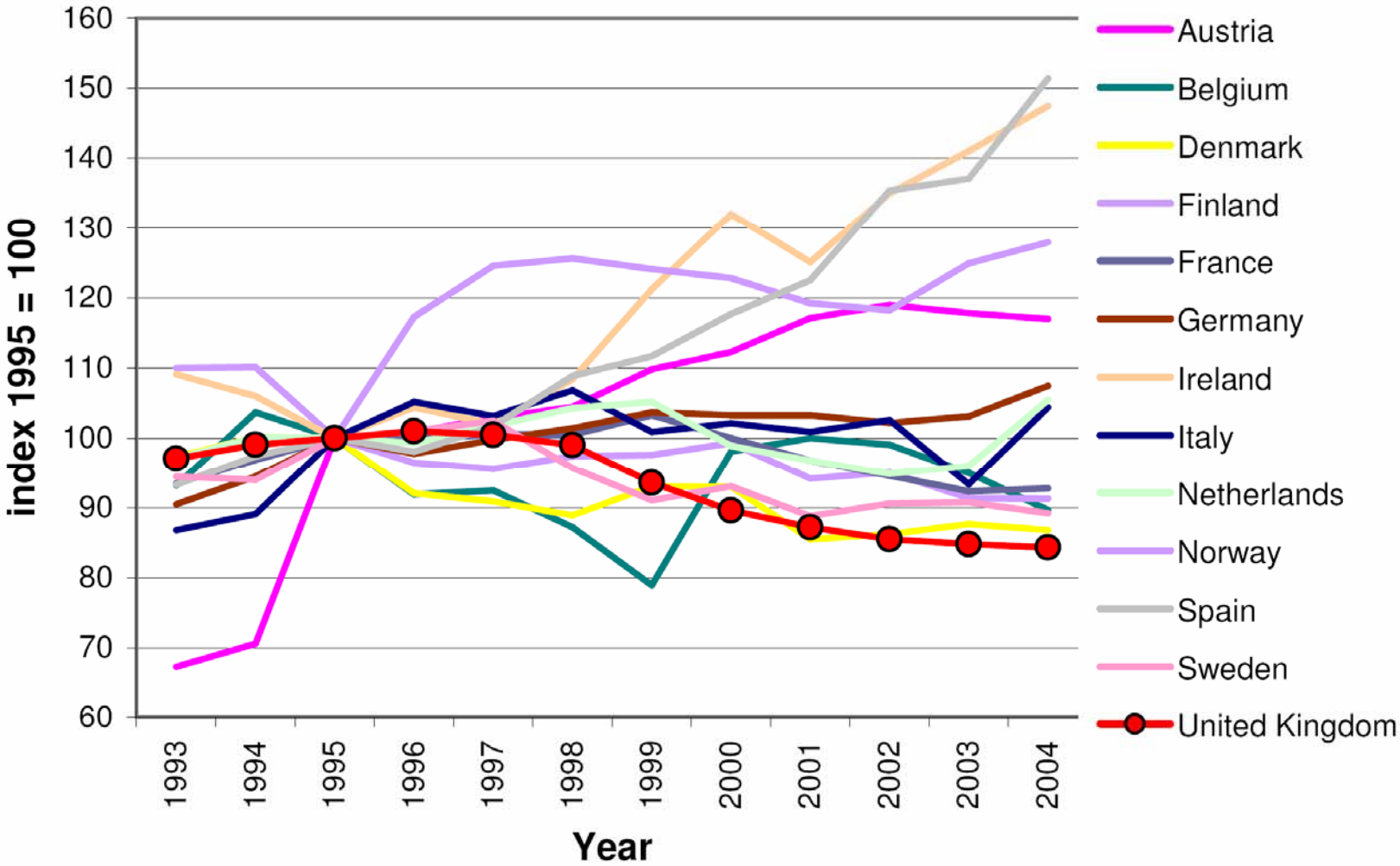
(trillion tonne-km per annum)



Assumes continuing link between economic growth and freight demand

Source: World Business Council for Sustainable Development - Mobility 2030 report

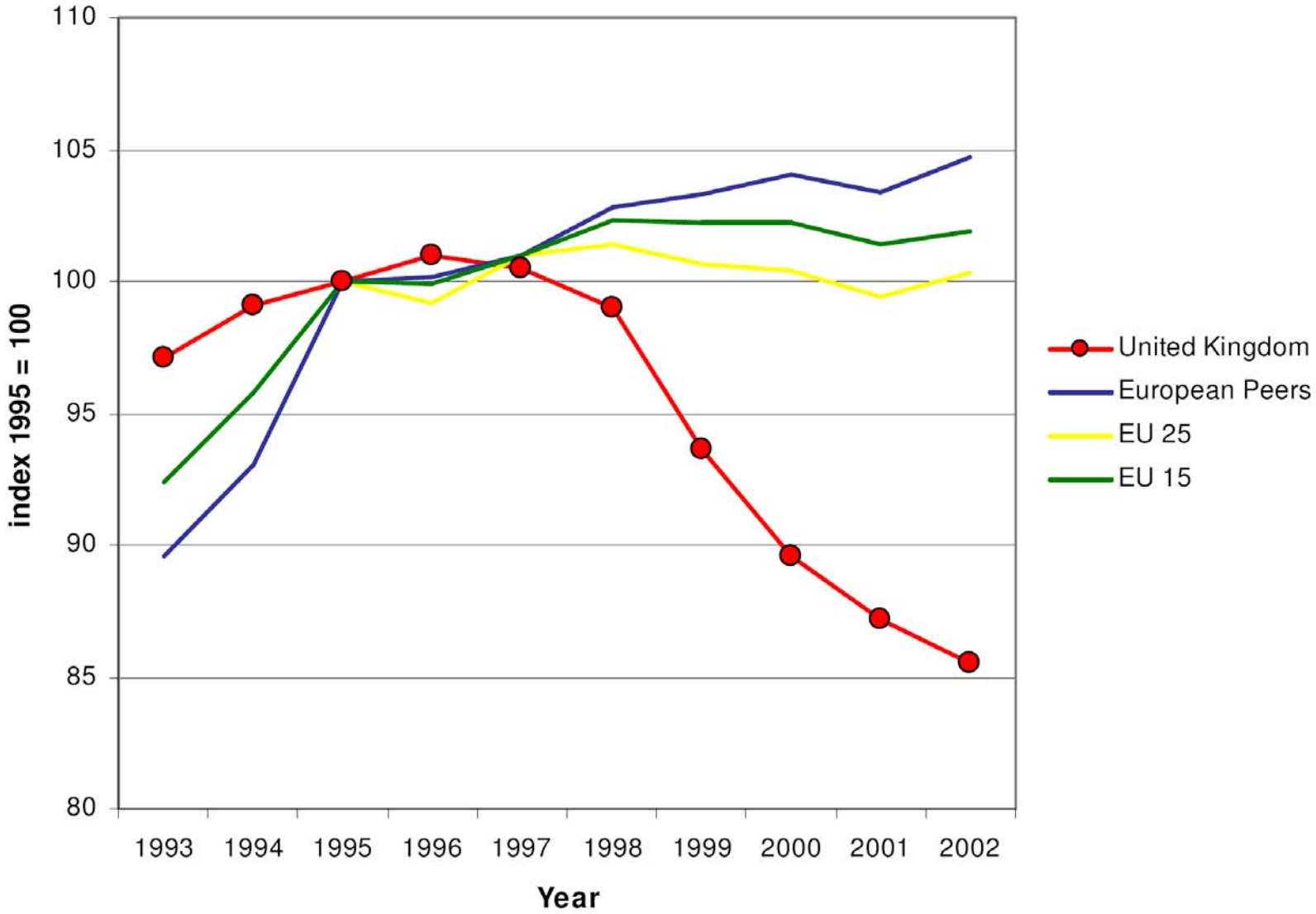
Freight Intensity Trends: European countries



Source: CfIT European Best Practice Report 2007 / Eurostat

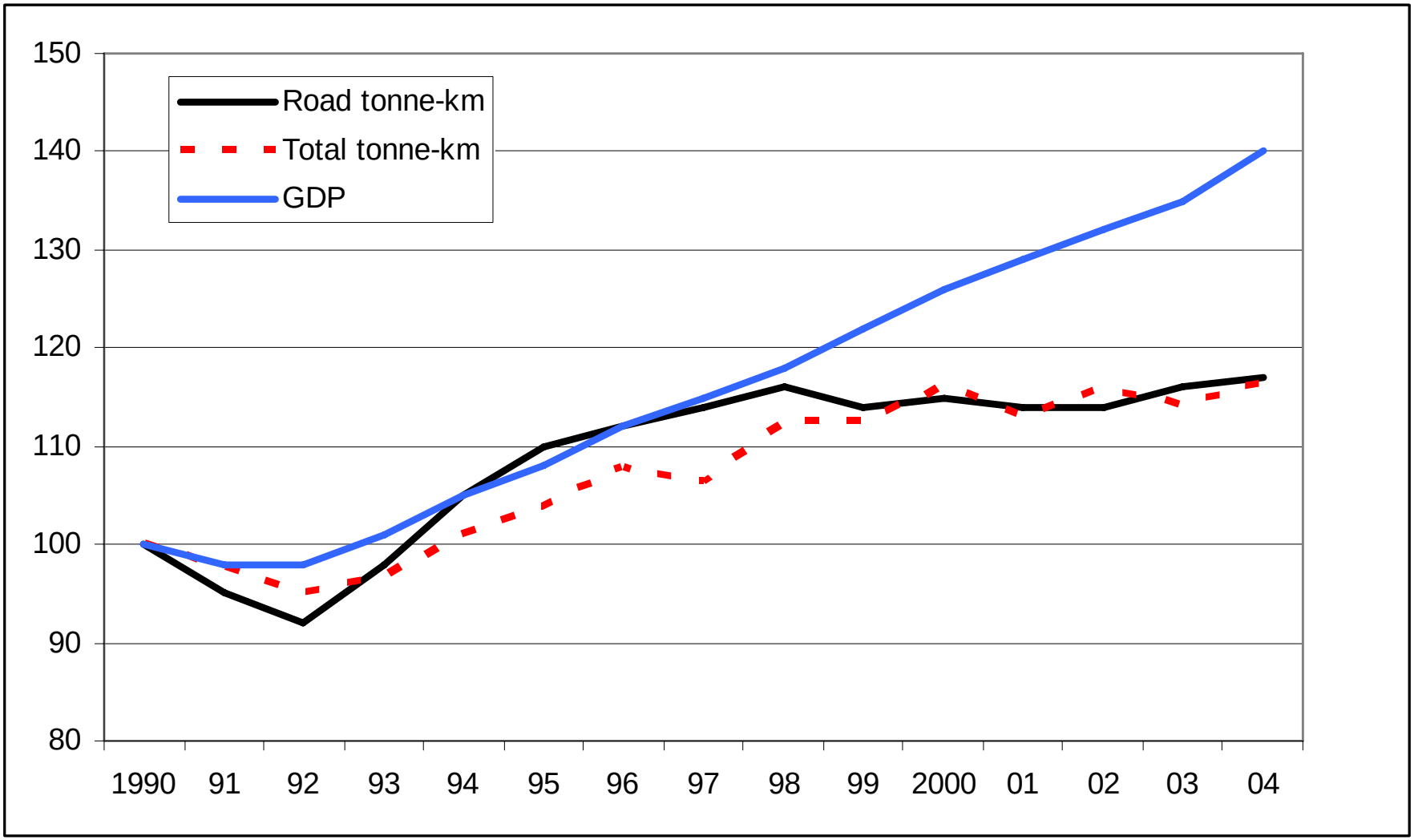
Trend in Freight Transport Intensity

ratio of tonne-kms to GDP



Source: CfIT European Best Practice Report 2007 / Eurostat

Decoupling of Tonne-km and GDP trends: UK

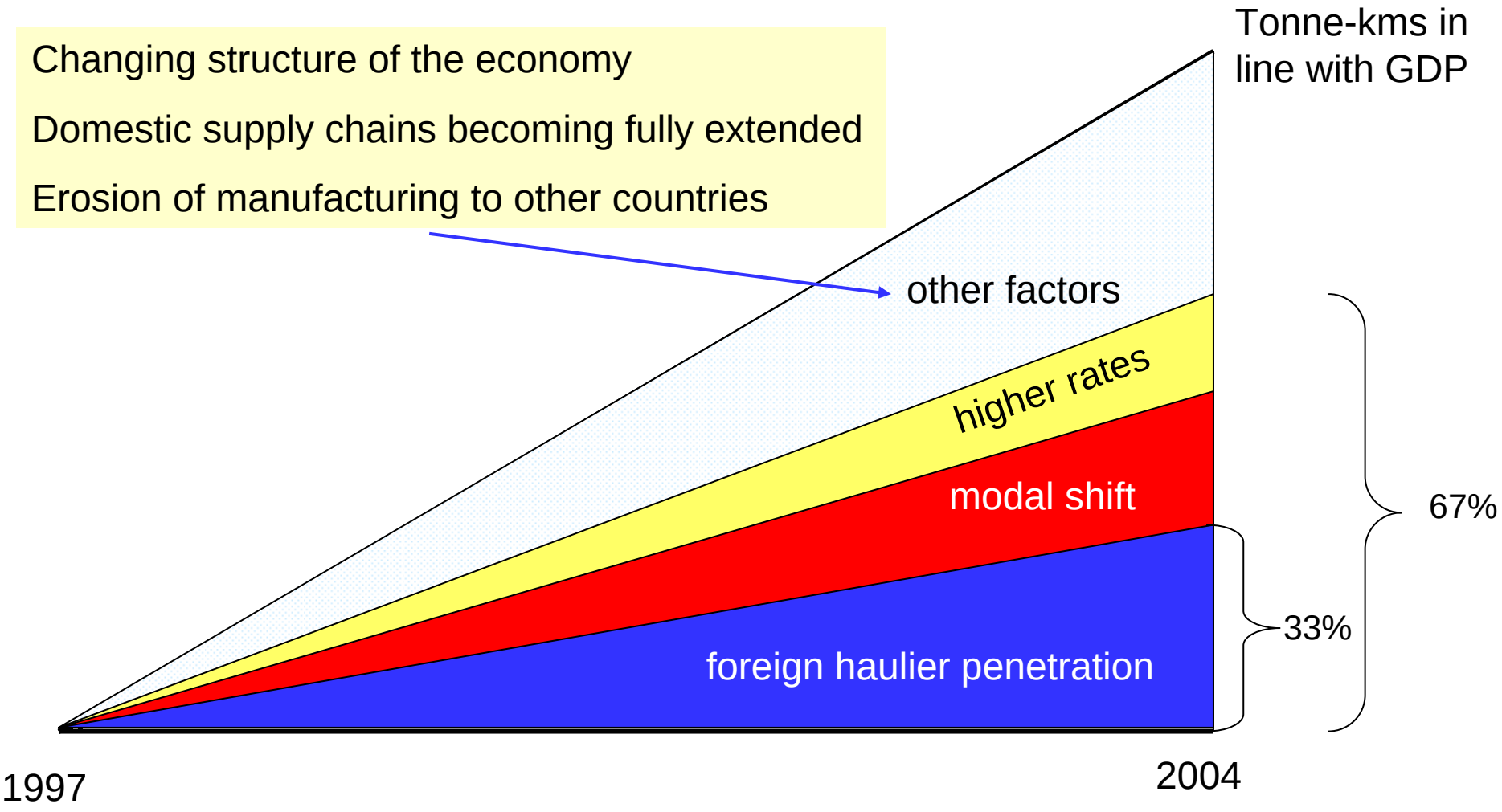


Data source: UK Department for Transport, 2005

Analysis of Road Freight GDP Decoupling: Availability of Data

Possible Factor	Data availability Max *****
Increased penetration of UK haulage market by foreign operators	***
Dematerialisation of the economy	**
End of the era of centralisation	*
Domestic supply lines fully extended: *end to wider sourcing?*	**
Effect of higher freight rates: *high cost of transport dampening demand?*	**
Decline in road's share of the freight market	****
De-industrialisation / off-shoring: *loss of manufacturing*	*
New economic growth in services: *freight generation by service sector*	****
Displacement of freight from trucks to vans under 3.5 tonnes	*

Factors Contributing to the Decoupling of Road Tonne-km from GDP



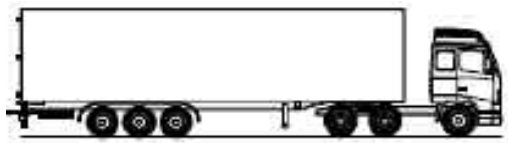
Based on McKinnon, 2006

UK Longer and Heavier Vehicle Study

LHV Scenarios

Gross weights

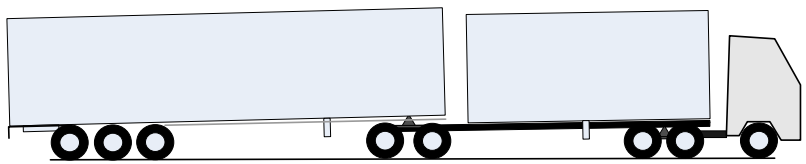
18.7m



44 t

Payload neutral 46 t

25.25m

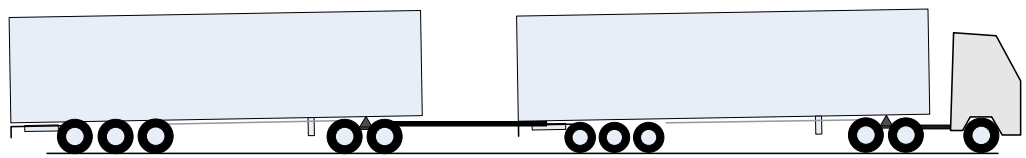


44 t

Payload neutral 48 t

60 t

34 m

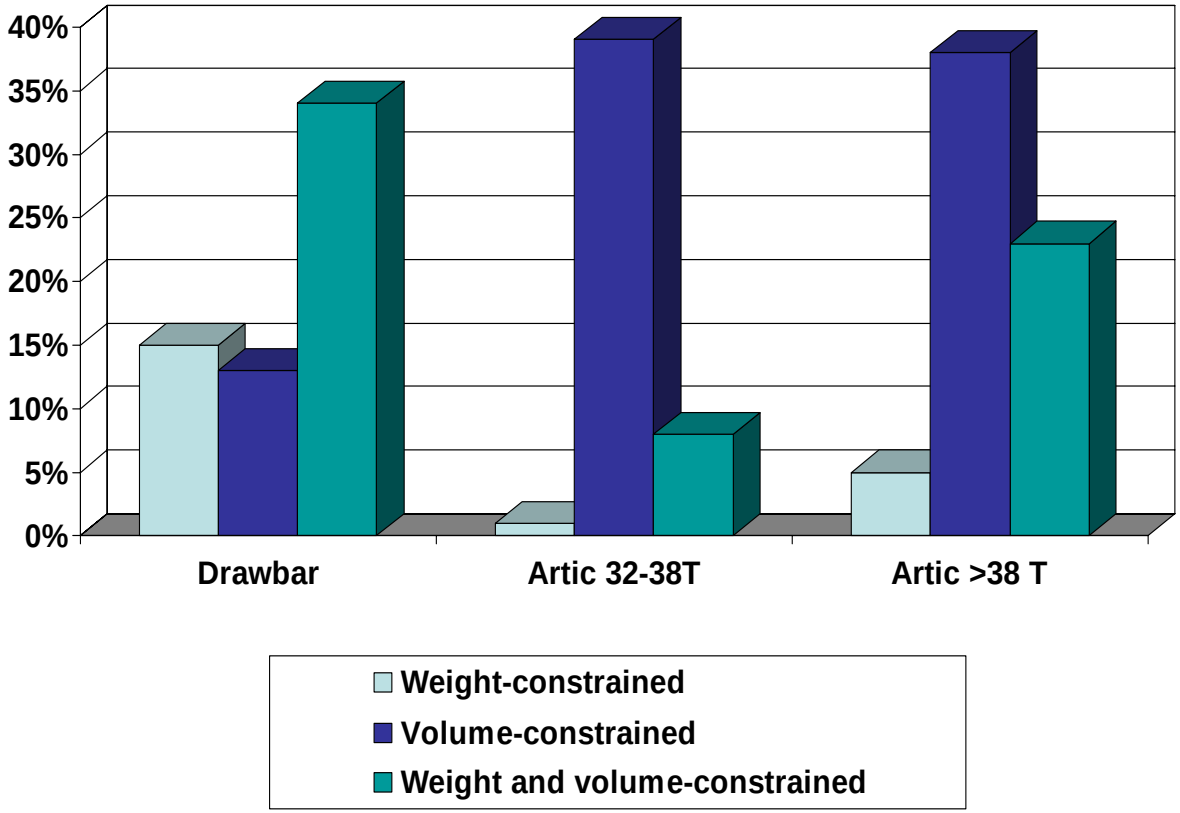


60 t

84 t

Source: TRL / Heriot-Watt University

% of loads constrained by volume and weight



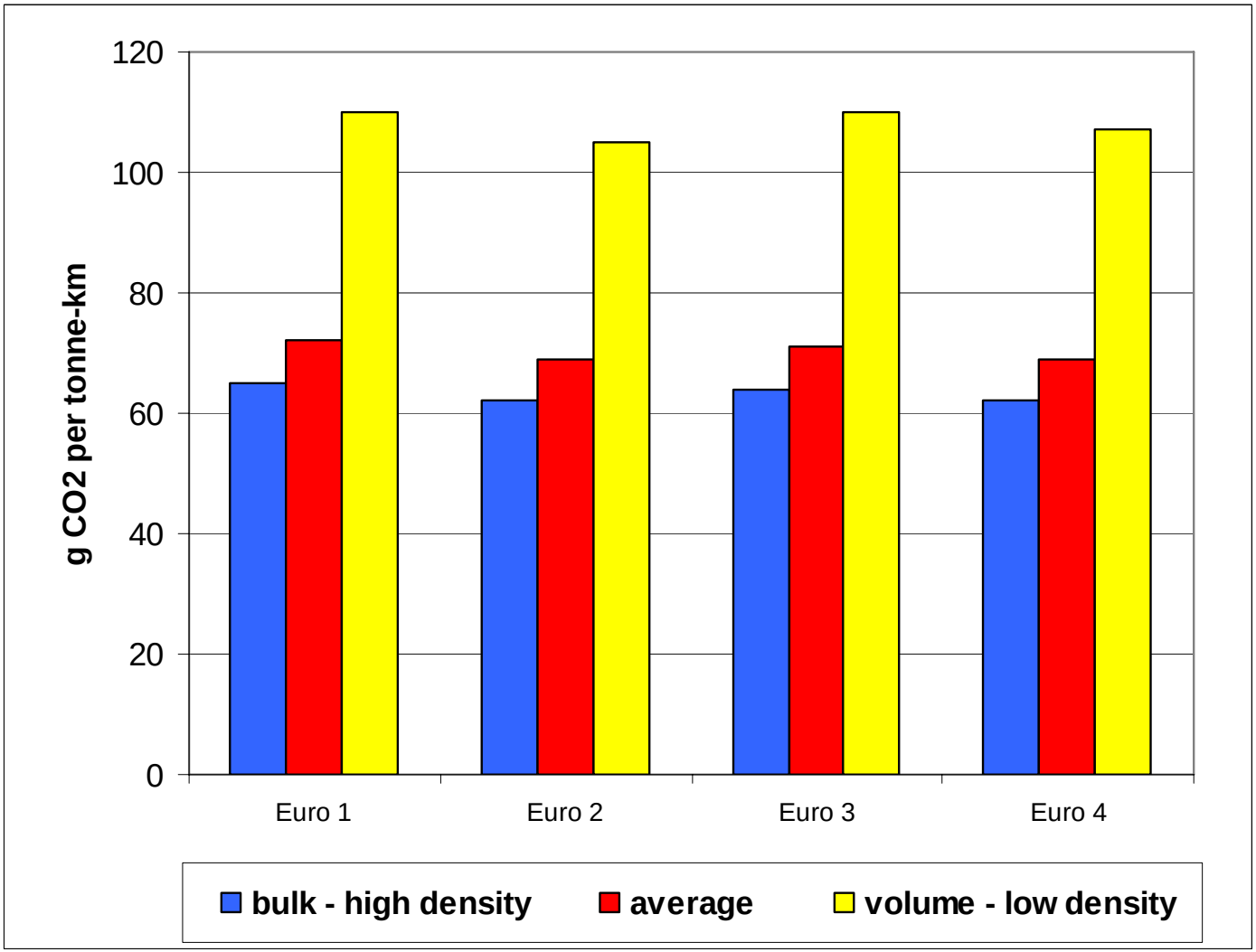
LHV study

Main data deficiencies: *cube / deck area utilisation of vehicle*

statistical distribution of load density

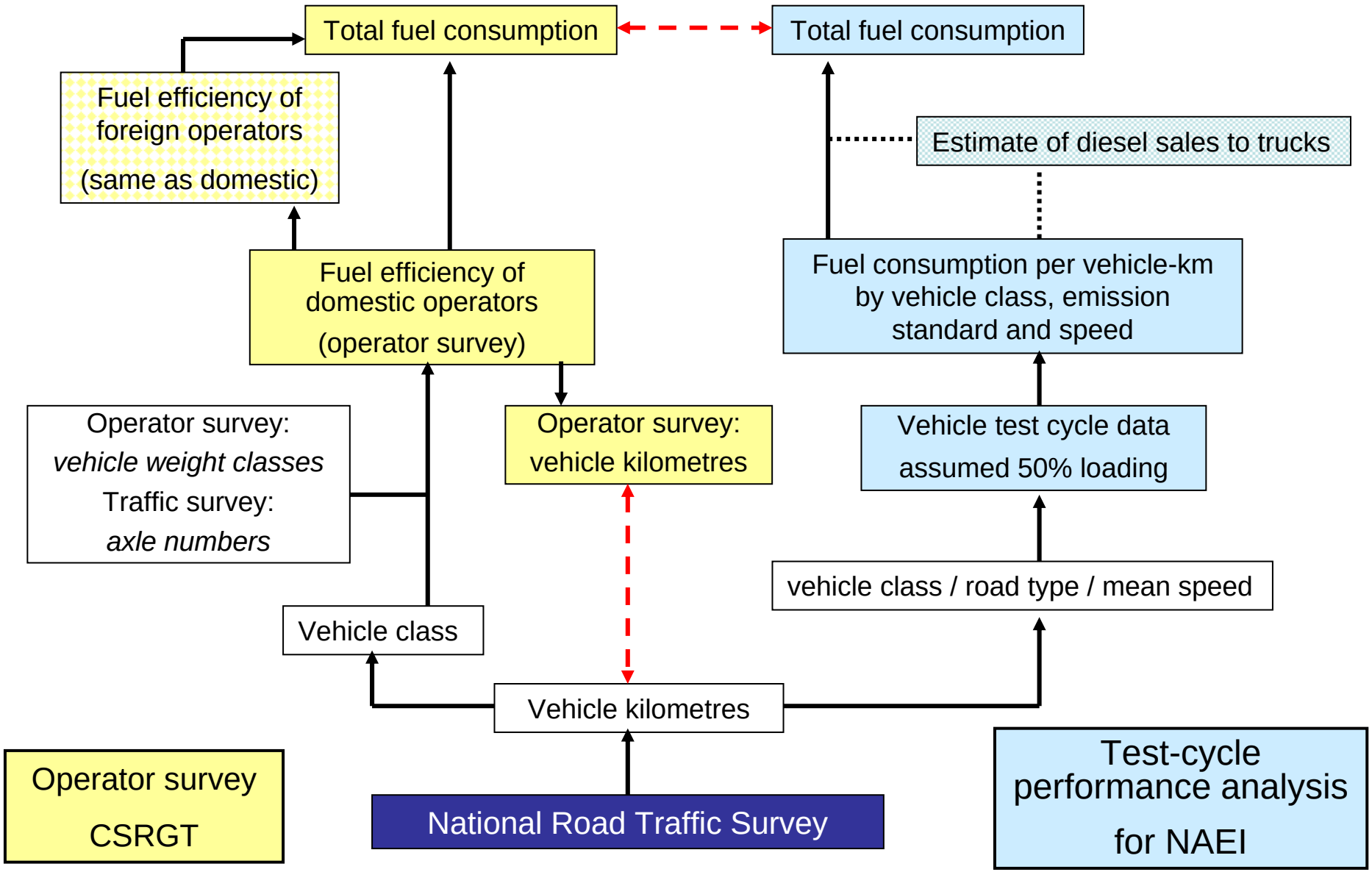
price elasticity of demand (for road freight + cross-modal)

Variation in Carbon Intensity of Truck Operation with Emission Standard and Load Density

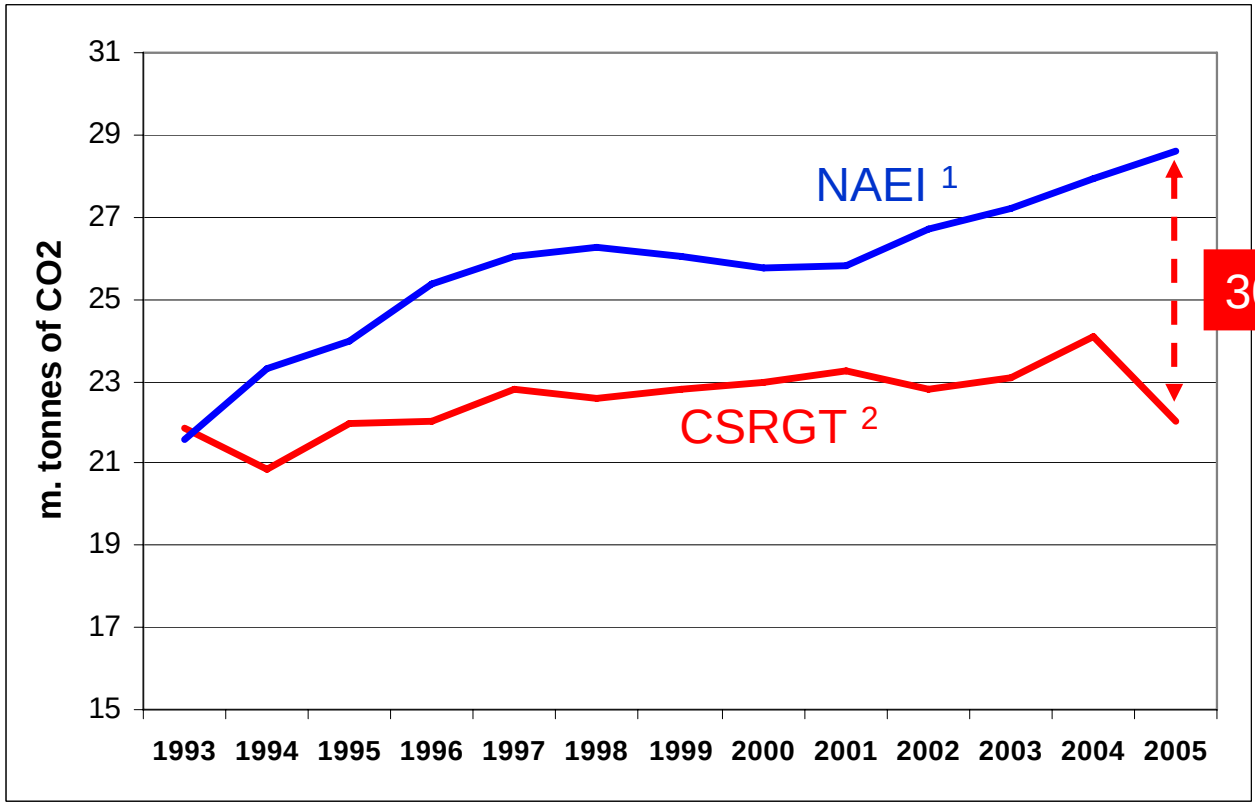


Adapted from IFEU (2005)

Two Methods of Estimating CO_2 Emissions from Trucks



Contrasting Estimates of CO_2 Emissions from Trucks in the UK



1 House of Commons Parliamentary answer (16th Jan. 2008)

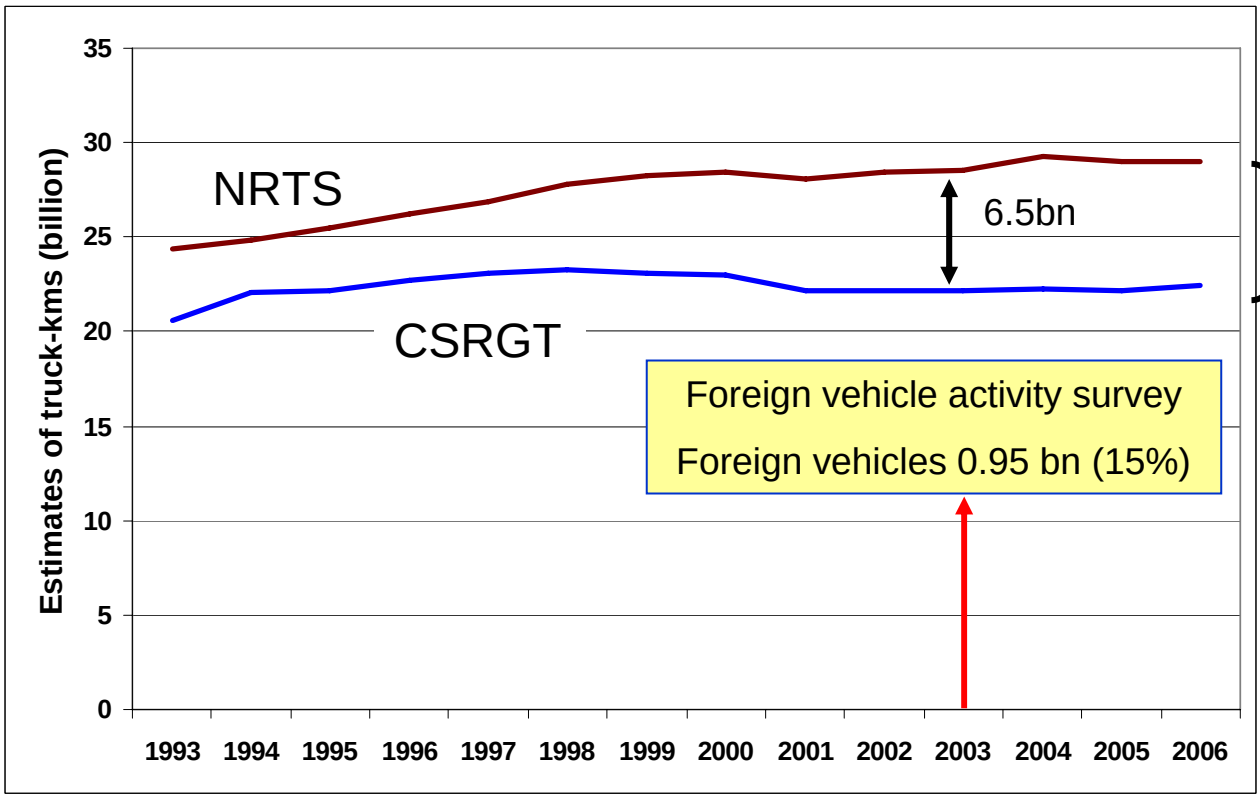
2 Vehicle-km data from the National Road Traffic Survey

Fuel efficiency data from CSRGT (Dept for Transport '*Road Freight Statistics*')

NAEI National Atmospheric Emissions Inventory

CSRGT Continuing Survey of Road Goods Transport

Differences in Estimates of Truck Kilometres



Reasons:

Exclusion of foreign vehicles

Under-reporting of trips in road freight survey (CSRGT)

Mis-classification of vehicles in NRTS – around 3.5 tonne boundary

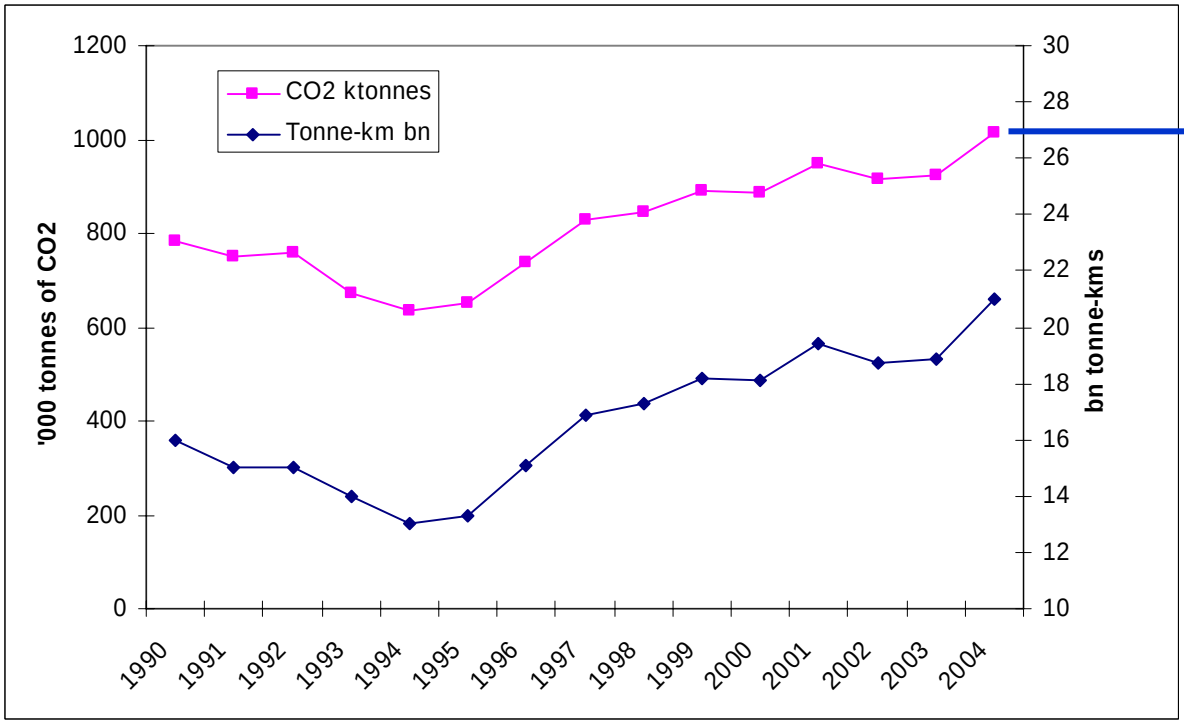
Other variables affected: *Tonne-kms* → under-estimated

Empty running

Fuel efficiency → under-estimated

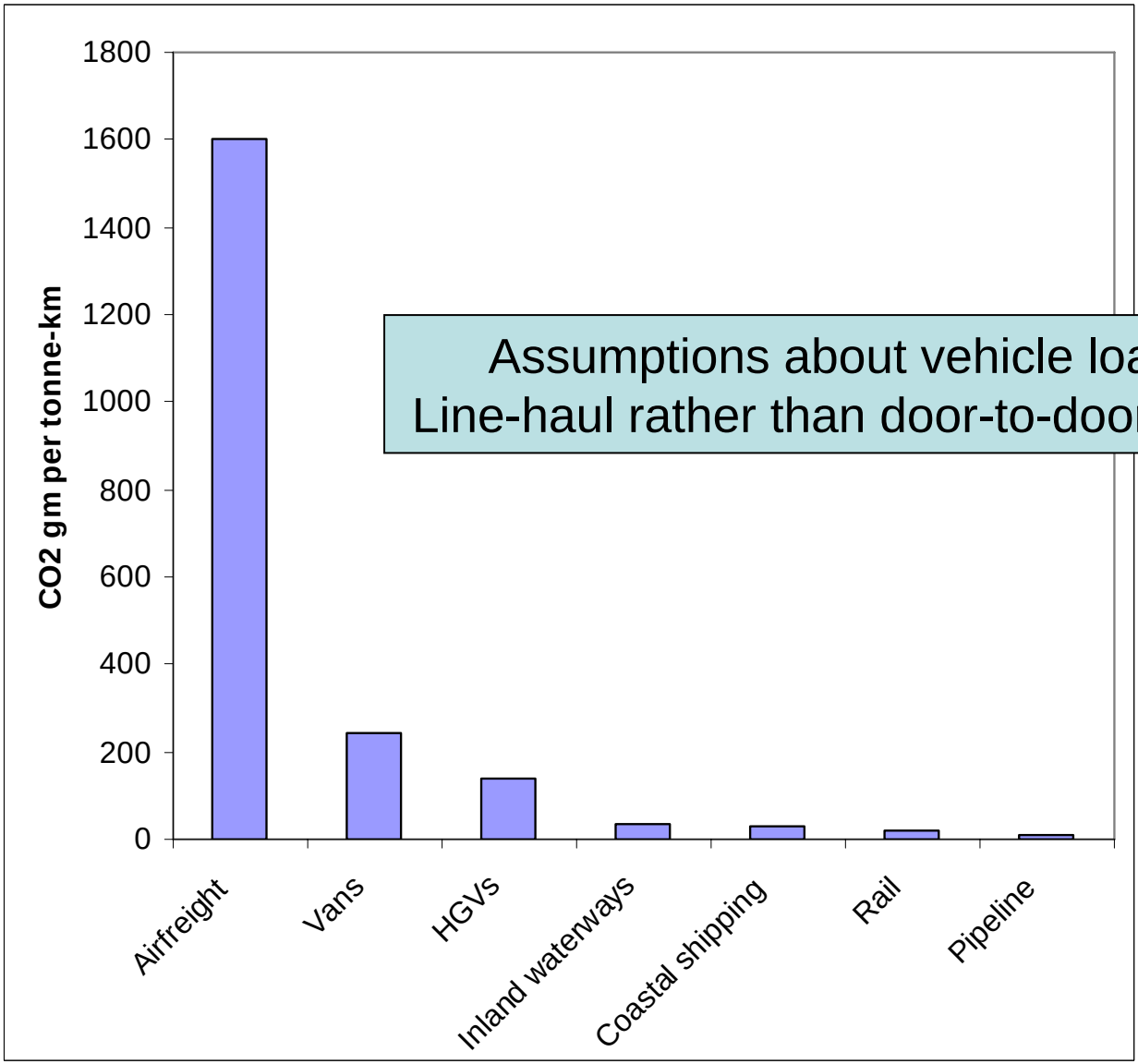
CO_2 Emissions from Railfreight

UK National Atmospheric Emissions Inventory



- Assumes fixed CO_2 intensity: 49 gms of CO_2 per tonne-km
- No allowance for improvements in fuel efficiency of railfreight operations
- Rail Emissions Model (2000) for SRA: 20 gms of CO_2 per tonne-km
- Using 20 gms of CO_2 per tonne-km: 420K tonnes of CO_2 in 2004
- National Atmospheric Emissions Inventory 1,012K tonnes in 2004

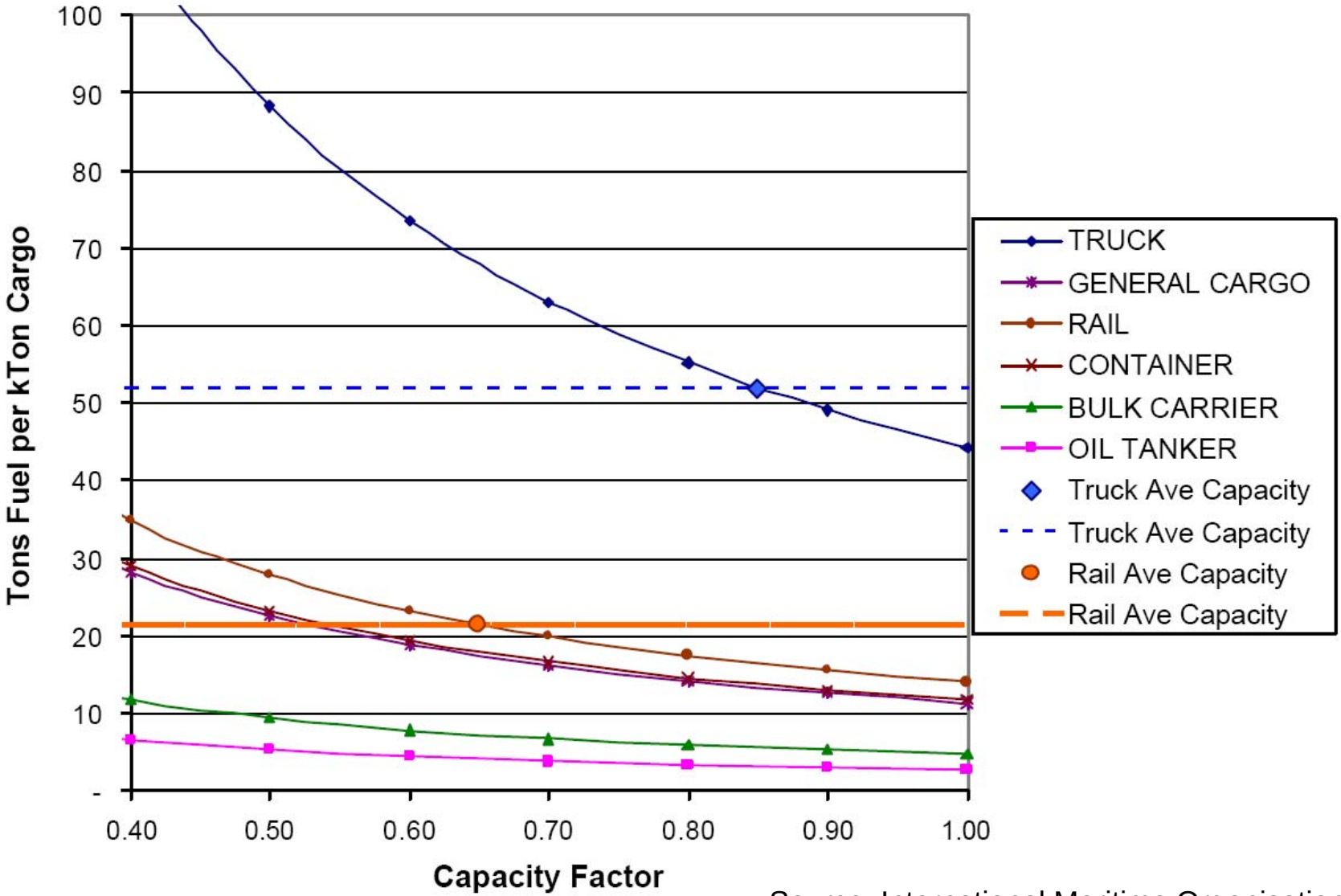
Variations in CO_2 Intensity by Freight Transport Mode (UK)



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

Assumptions about Vehicle Loading in CO2 Intensity Comparisons

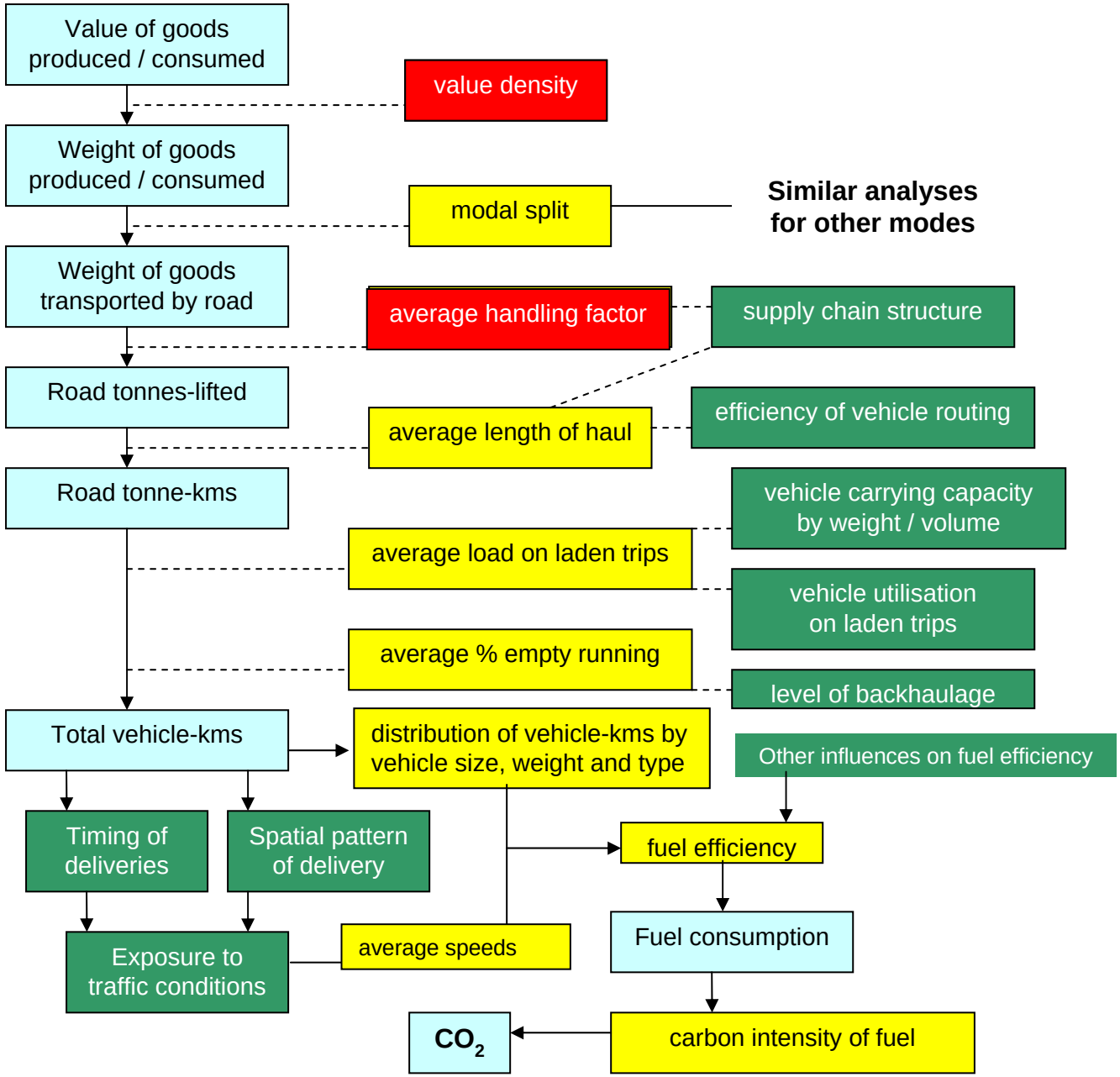
Relationship Energy Intensity and Vehicle Loading



Source: International Maritime Organisation, 2000

Vans

- Fastest growing category of traffic
- Manifestation of switch to a service economy
- High energy intensity per tonne-km
- Only 1/3 of van-kms carry freight or return empty from freight delivery
- Lack of data on freight carried (in UK last collected in 1992)
- Statistical problems:
  - *Mis-classification of vans and trucks around 3.5t threshold*
  - *Growth of online retailing making 'last mile' freight movements statistically visible : transfer from cars to vans*
  - *No operator licensing system for vans*
  - *Very difficult and expensive to survey accurately*


Value of goods produced / consumed
value density
Weight of goods produced / consumed
modal split
Similar analyses for other modes
Weight of goods transported by road
average handling factor
supply chain structure
Road tonnes-lifted
average length of haul
efficiency of vehicle routing
Road tonne-kms
vehicle carrying capacity by weight / volume
average load on laden trips
vehicle utilisation on laden trips
average % empty running
level of backhaulage
Total vehicle-kms
distribution of vehicle-kms by vehicle size, weight and type
Other influences on fuel efficiency
Timing of deliveries
Spatial pattern of delivery
fuel efficiency
Exposure to traffic conditions
average speeds
Fuel consumption
CO2
carbon intensity of fuel

Value Density

Definition: Ratio of product value to weight

- Lack of data on product weight
- Point in supply chain at which weight should be measured?
- No standard unit of measurement for the physical output of industries
- Weight and value data available for trade flows:
  - assumption that value density of traded products is similar to domestic sales
  - Danish research suggests that use of trade data yields poor estimates

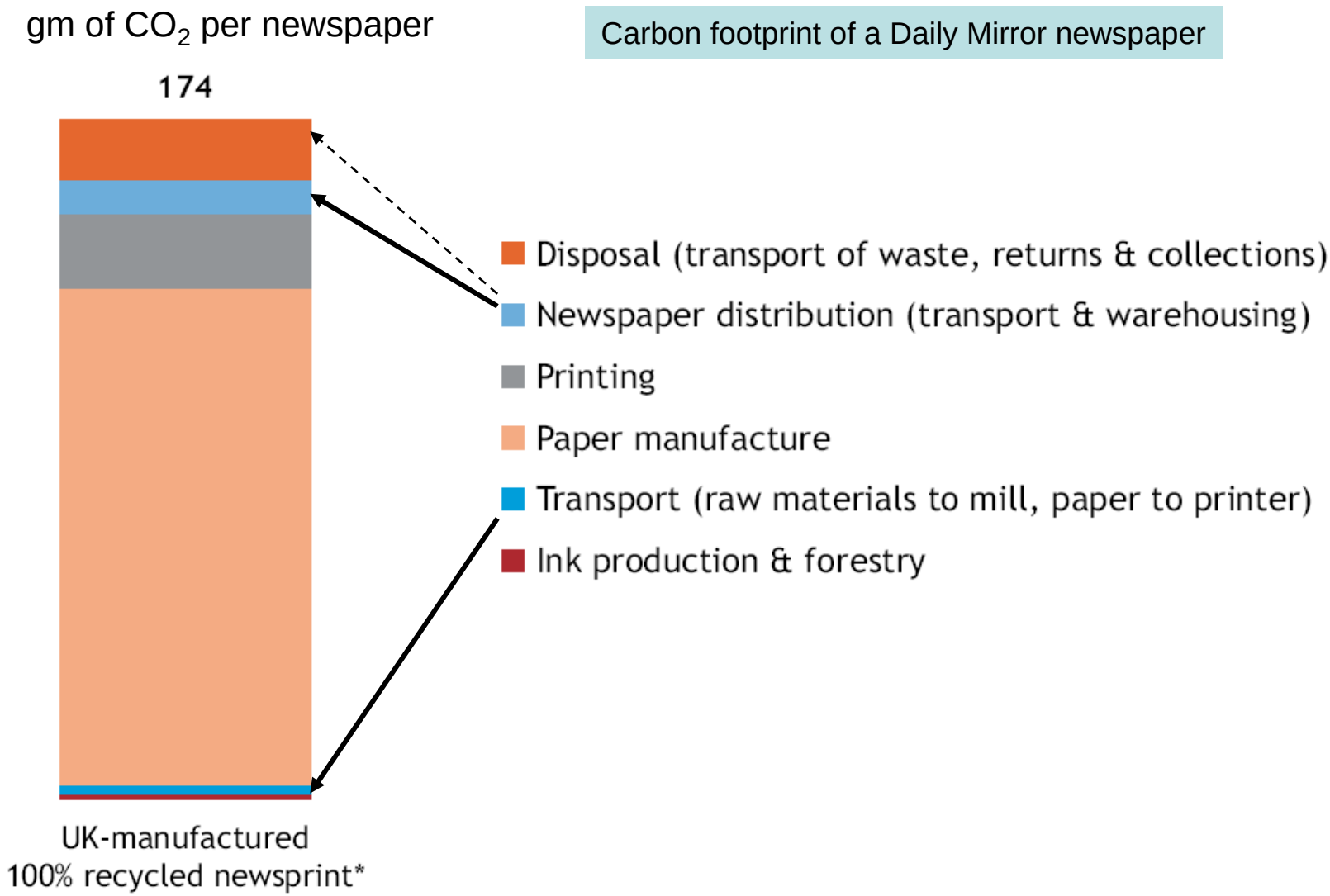
  'imputed value density values from trade flows… induces unacceptably large errors' (Fosgerau and Kveiborg, 2004)
- Use Material Flow Accounting data:
  - for economy as a whole: no sectoral, commodity or supply chain split
  - both input (DMI) and consumption (DMC) measures

Handling Factor

Definition: number of separate journeys / links in a supply chain

- Calculation: ratio of tonnes-lifted to weight of products produced / consumed
- Either aggregate measure for economy or commodity / supply chain-specific
- Reclassification of products as they move through the supply chain
- Lack of data on the weight of products produced / consumed
- Possible use of Material Flow Accounting data for aggregate HF calculation

Carbon Footprint of Newspaper Production, Distribution and Disposal



Source: Carbon Trust

Evolving ‘Science’ of Carbon Auditing

High level estimates of energy consumption

disaggregation

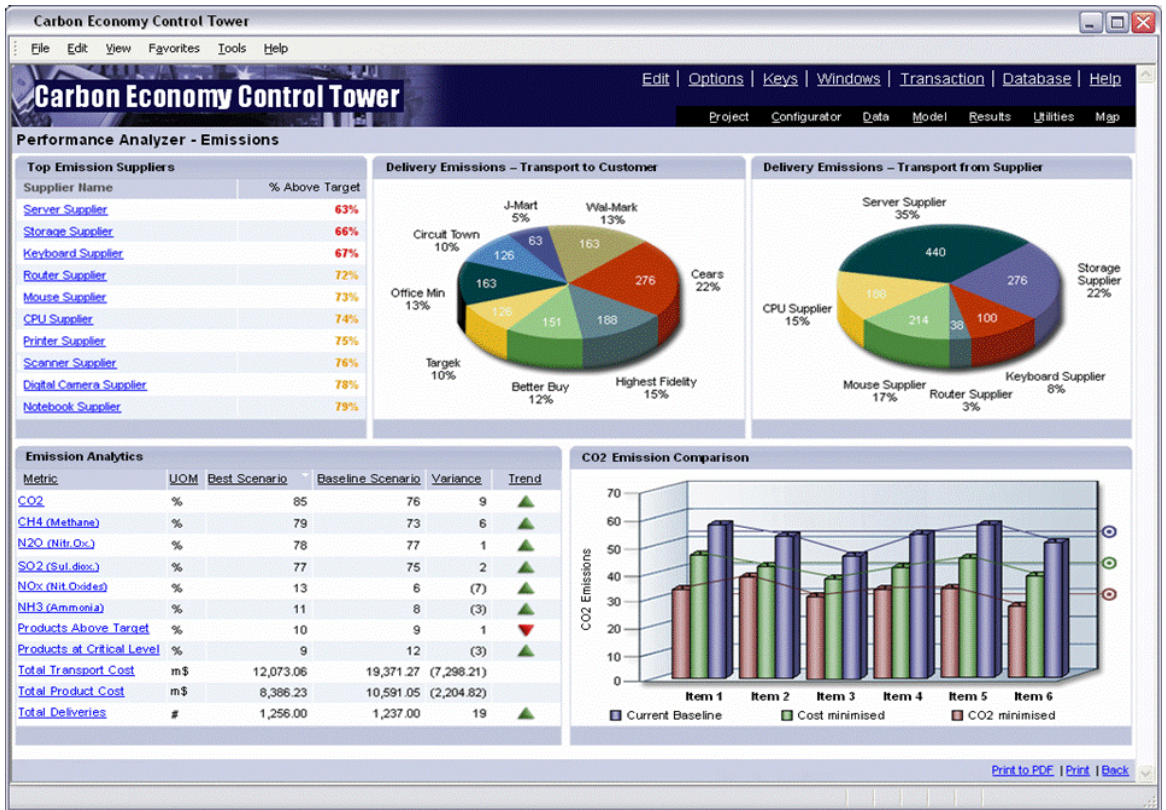
Top-down approach
(input – output methodology)

validation

Bottom-up approach
(process analysis)

Specific energy ratings of equipment and processes

aggregation



Degree of disaggregation:

company

process

activity

product

Source: CarbonView

http://www.carbon-view.com/

DHL GoGreen

GoGreen product – How it works

GOGREEN shipments are processed as any other DHL shipment - no special handling required

Pick-up

Terminal handling

Linehaul (air, road)

Terminal handling

Delivery

Billing

Price for GOGREEN 2% extra charge (min € 0.30 per shipment)

A carbon-neutral shipment

Carbon calculation starts post-transportation

Extracted transport data is processed with emission parameters using our patented methodology.

DHL calculates the CO_2 emissions generated by the customer's shipment as the first step in offsetting them.

Carbon Management guarantees carbon offset

Carbon Management is responsible for acquiring sufficient CO_2 credits from the different internal and external carbon-reduction projects to offset the CO_2 emissions.

Source: DHL

DHL GO-Green: *Carbon Calculation for Clients*

Carbon calculation starts post-transportation

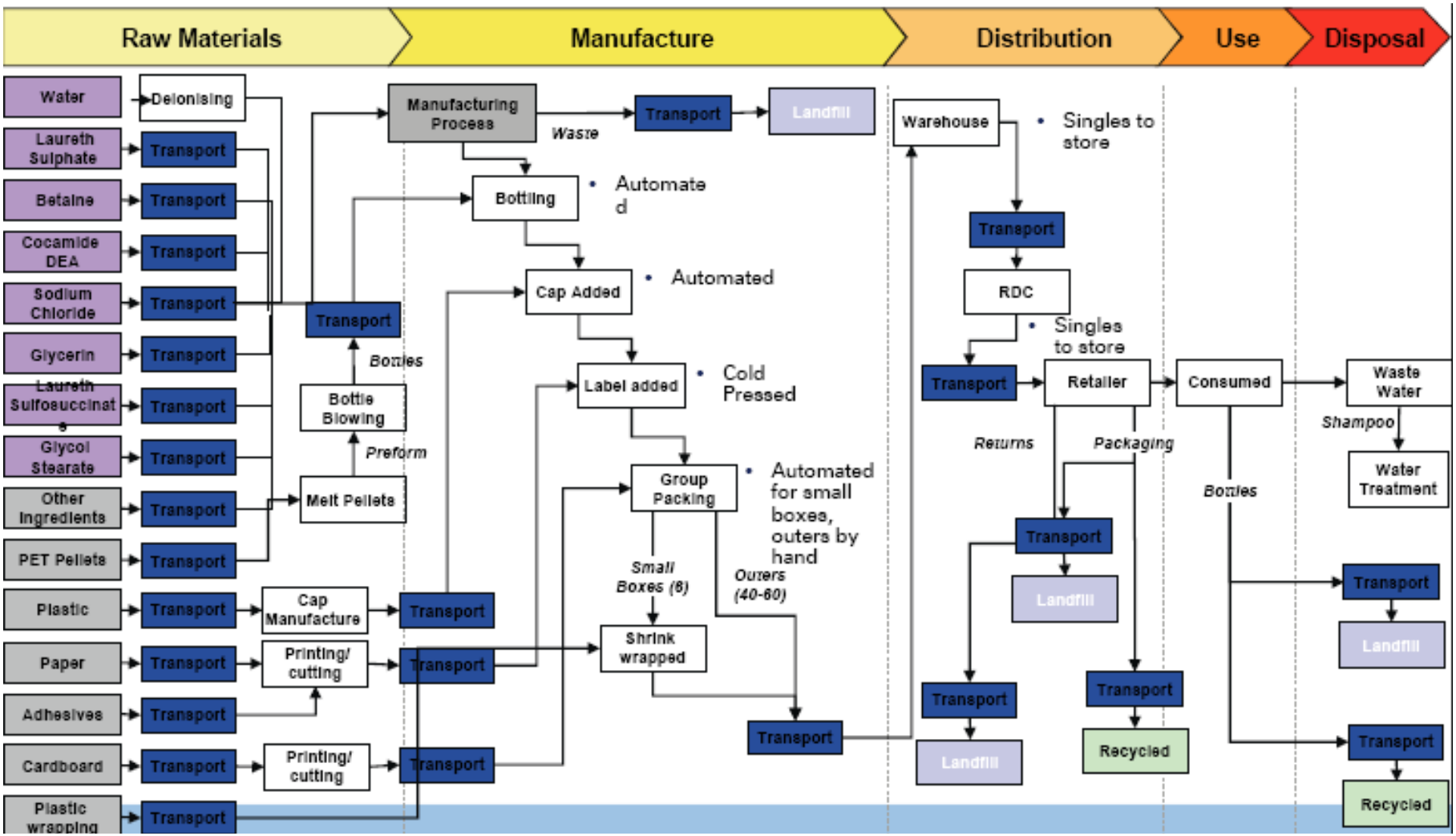
Extracted transport data is processed with emission parameters using our patented methodology.

DHL calculates the CO_2 emissions generated by the customer's shipment as the first step in offsetting them.

Extension of Emission Trading Scheme to freight and logistics will make carbon auditing and verification compulsory

Legitimate data source for Government statistical agencies?

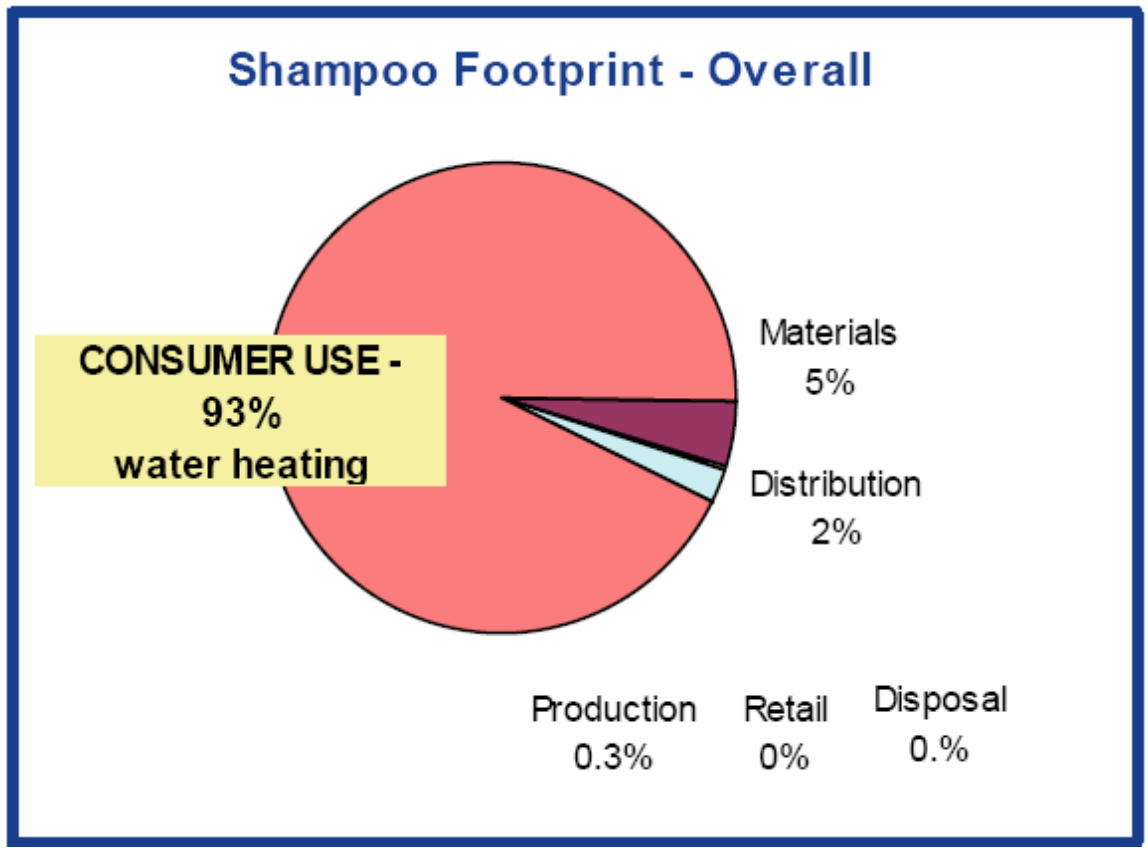
Supply Chain Process Map for Shampoo



Supply Chain Carbon Audit for 8 shampoo products cost £250,000

Source: Boots

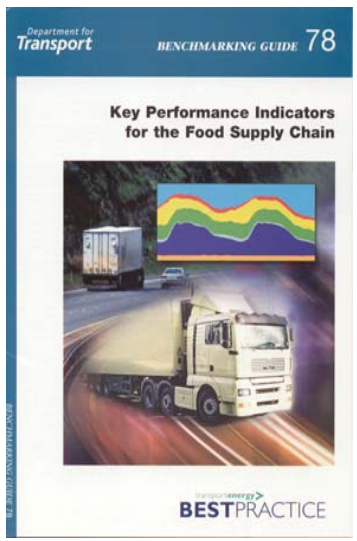
Supply Chain Carbon Footprint for Shampoo

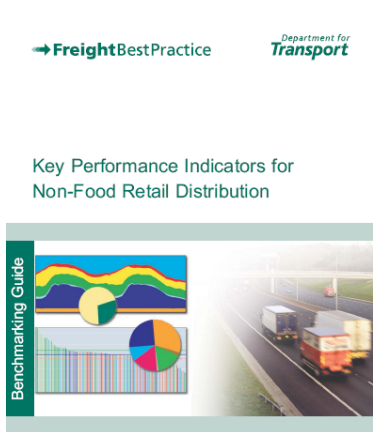


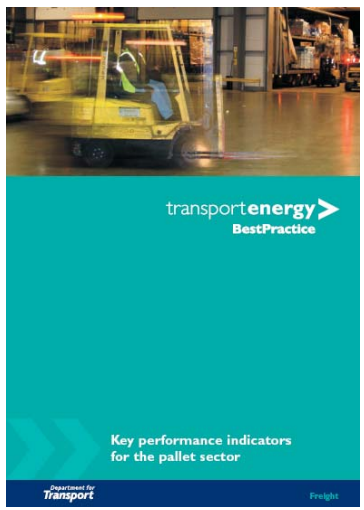
Source: Boots

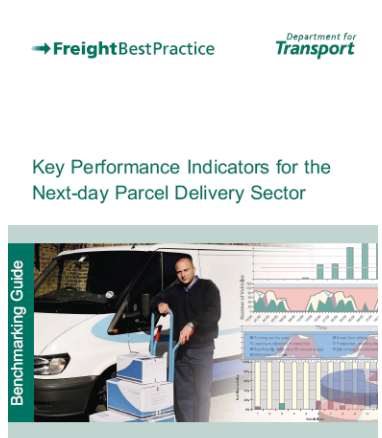
UK Road Transport KPI Programme

- To promote the adoption of standard methods of performance measurement in road freight transport.
- To provide the government with information on a range of transport variables excluded from its main road freight survey
- To calculate the potential for improving transport and energy efficiency across industry sectors.
- To use benchmarking to promote greater transport efficiency









www.freightbestpractice.org.uk

Transport KPI Methodology

5 KPIs: vehicle fill
empty running
fuel efficiency
time utilisation
deviations from schedule

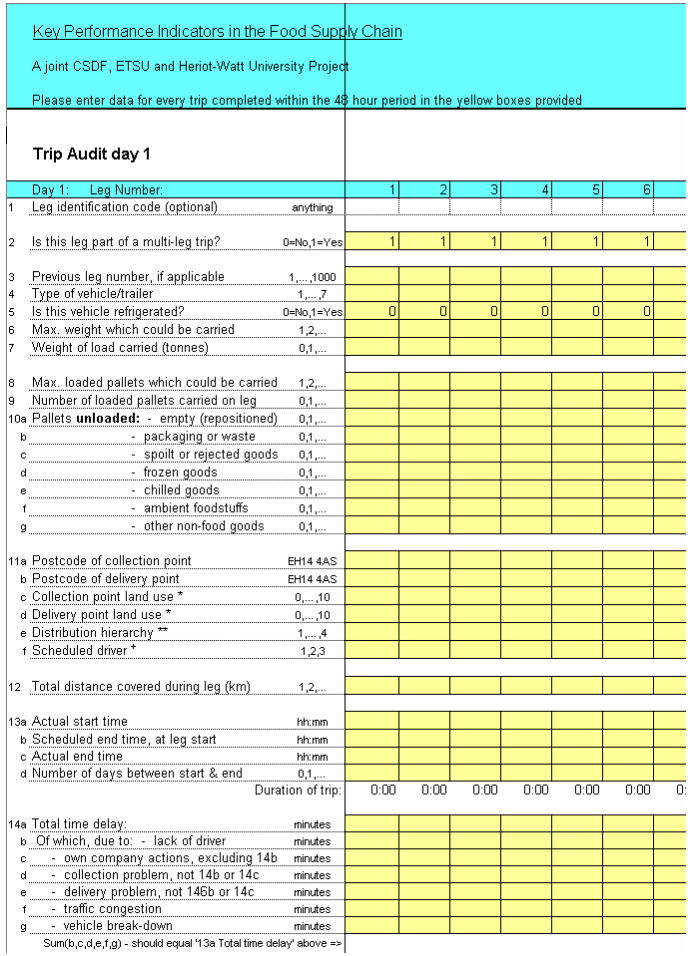
'Synchronised audits' over 48 hour period

<u>3 Exel spreadsheets:</u>

Compilation of general data on vehicle fleet
- *to permit 'grossing-up' of data*

Audit of trailer activity
- *to measure trailer activity over 48 hours*

Audit of journeys
- *to measure utilisation of transport capacity on a leg by leg basis*



Key Performance Indicators in the Food Supply Chain

A joint CSDF, ETSU and Heriot-Watt University Project

Please enter data for every trip completed within the 48 hour period in the yellow boxes provided

Trip Audit day 1

	Day 1: Leg Number:		1	2	3	4	5	6
1	Leg identification code (optional)	anything						
2	Is this leg part of a multi-leg trip?	0=No,1=Yes	1	1	1	1	1	1
3	Previous leg number, if applicable	1,...,1000						
4	Type of vehicle/trailer	1,...,7						
5	Is this vehicle refrigerated?	0=No,1=Yes	0	0	0	0	0	0
6	Max. weight which could be carried	1,2,...						
7	Weight of load carried (tonnes)	0,1,...						
8	Max. loaded pallets which could be carried	1,2,...						
9	Number of loaded pallets carried on leg	0,1,...						
10a	Pallets **unloaded:** - empty (repositioned)	0,1,...						
b	- packaging or waste	0,1,...						
c	- spoilt or rejected goods	0,1,...						
d	- frozen goods	0,1,...						
e	- chilled goods	0,1,...						
f	- ambient foodstuffs	0,1,...						
g	- other non-food goods	0,1,...						
11a	Postcode of collection point	EH14 4AS						
b	Postcode of delivery point	EH14 4AS						
c	Collection point land use *	0,...,10						
d	Delivery point land use *	0,...,10						
e	Distribution hierarchy **	1,...,4						
f	Scheduled driver *	1,2,3						
12	Total distance covered during leg (km)	1,2,...						
13a	Actual start time	hh:mm						
b	Scheduled end time, at leg start	hh:mm						
c	Actual end time	hh:mm						
d	Number of days between start & end	0,1,...						
		Duration of trip:	0:00	0:00	0:00	0:00	0:00	0:00
14a	Total time delay:	minutes						
b	Of which, due to: - lack of driver	minutes						
c	- own company actions, excluding 14b	minutes						
d	- collection problem, not 14b or 14c	minutes						
e	- delivery problem, not 146b or 14c	minutes						
f	- traffic congestion	minutes						
g	- vehicle break-down	minutes						
	Sum(b,c,d,e,f,g) - should equal '13a Total time delay' above =>							

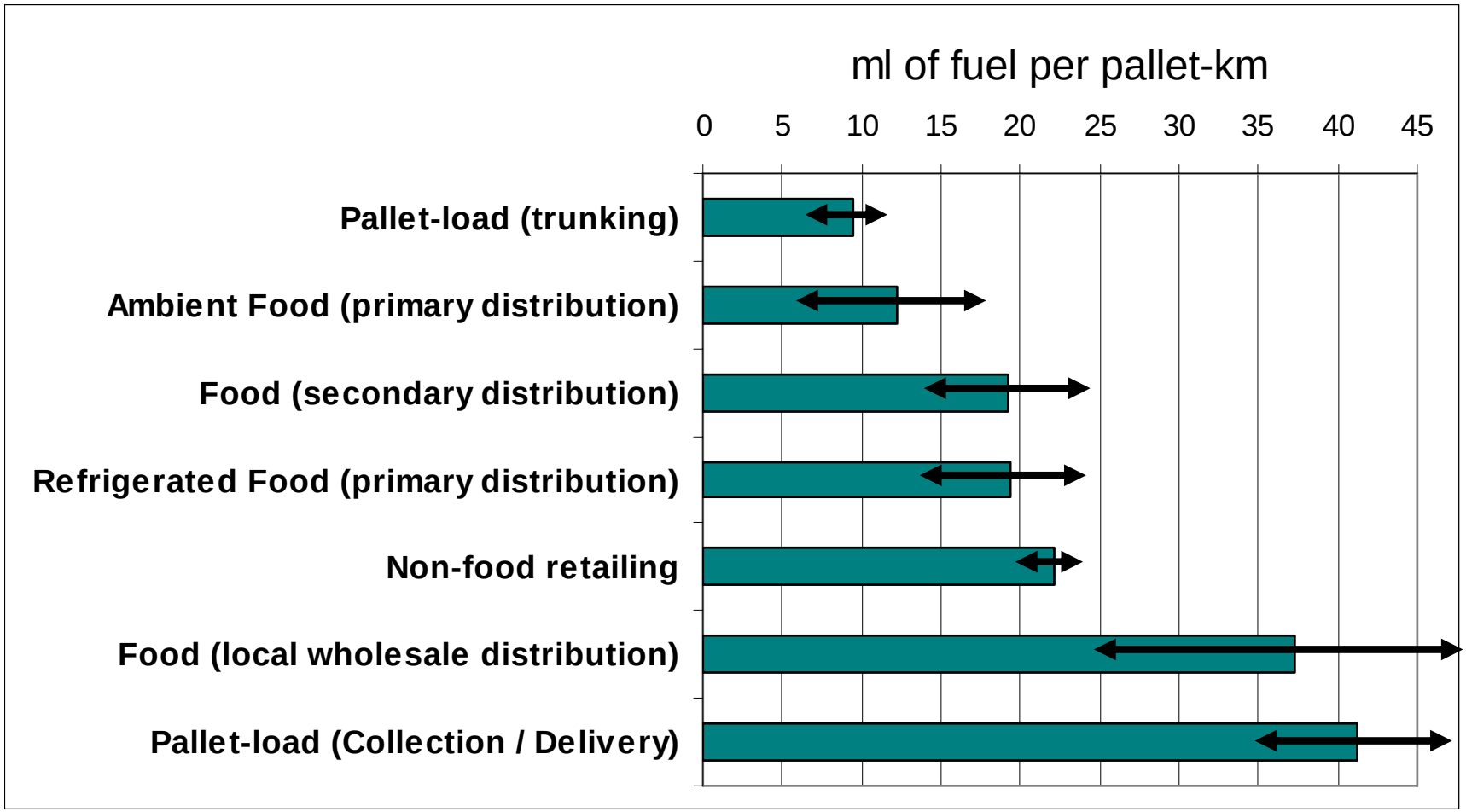
Increasing proportion of vehicles with onboard tracking and monitoring systems

Data downloaded from company IT systems

Transport KPI Surveys: *summary statistics*

Sector	Date	Fleets	Articulated vehicles	Rigid vehicles	Total	Trips	Distance Travelled (km)
Refrigerated food	1997	11	795	0	795	2981	519963
Food	1998	36	1393	182	1575	4024	1161911
Automotive	2001	7	143	50	193	679	179428
Food	2002	53	1446	546	1992	6068	1454221
Non-food retailing	2002	26	705	145	850	2496	744087
Pallet-load networks	2004	17	34	105	139	295	65880
Next day parcel delivery	2005	12	42	107	149	863	111464
Building Merchants	2006	35	3	113	116	379	23120
Food and drink	2006	113	4,696	1,600	6,296	8,000	1,300,000
Totals		**310**	**9257**	**2848**	**12105**	**25785**	**5,560,074**

Energy Intensity of Distribution Operations by Sector



↔ 1 standard deviation around mean

Transport KPI Surveys: *Problems and Limitations*

- Difficulty of securing adequate company involvement
  - *beneficial to have trade association support + industry champions*
  - *participation of major / high-profile companies*
- Non-random sampling – self-selection may bias results
  - *exercise caution in statistical analysis and generalisation*
- Limited coverage: *sectoral focus*
- Limited analysis of the causes of observed differences in performance
  - *inadequate resourcing of diagnosis and explanation*

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