GREEN LOGISTICS

Green Logistics

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Context of Climate Change

- Aim to keep global CO_2 level below 450 parts per million.
- Temperature rise over period to 2100 limited to 2°C
- Targets
  - EU Climate Change Target: 20% reduction in CO2 by 2020
  - UK Climate Change Target: 80% reduction in CO2 by 2050 (relative to 1990)

Green Logistics Project

- A research programme into the sustainability of logistics systems and supply chains
- A consortium of 6 UK universities
- Funded by EPSRC for 4 years (2006-2010)
- Supported and steered by a range of organisations including the Department for Transport and Transport for London

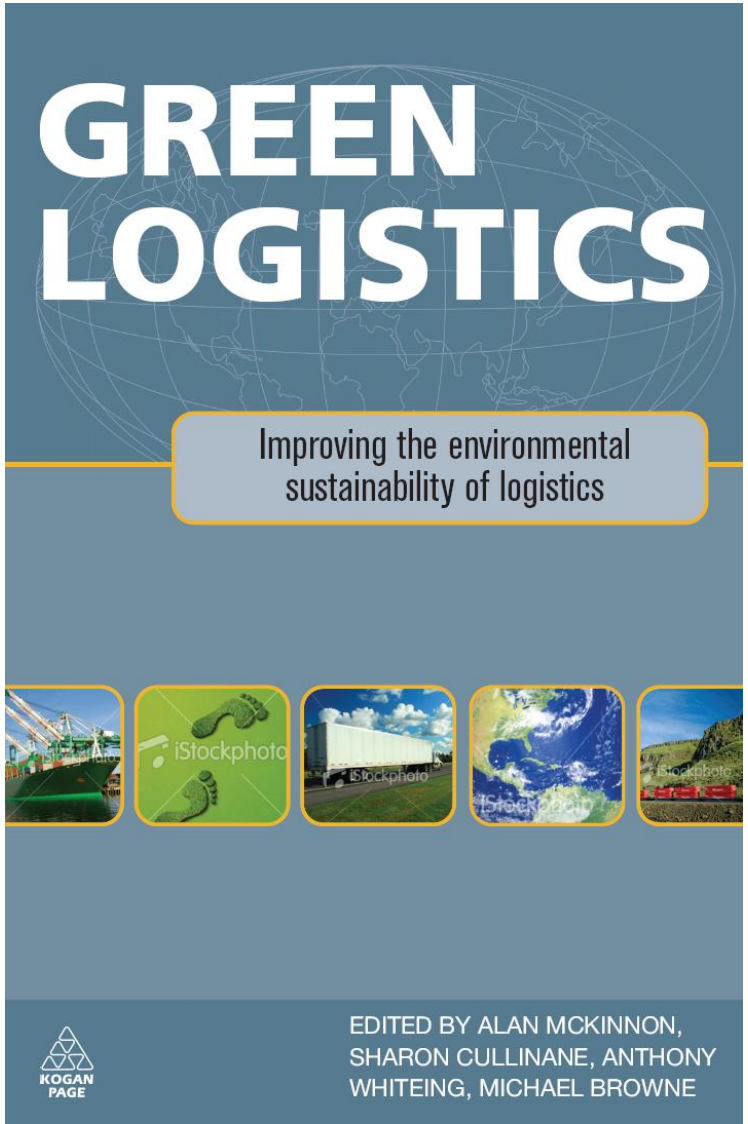
Research Partners

- University of Leeds, *Institute for Transport Studies*
- Cardiff University, *Logistics & Operations Management supported by Computer Science*
- Heriot-Watt University, *Logistics Research Centre*
- Lancaster University, *Management Science*
- University of Southampton, *Transportation Research Group*
- University of Westminster, *Transport Studies Group*

Website

- www.greenlogistics.org
- Information on all work modules
- Latest working papers

Book

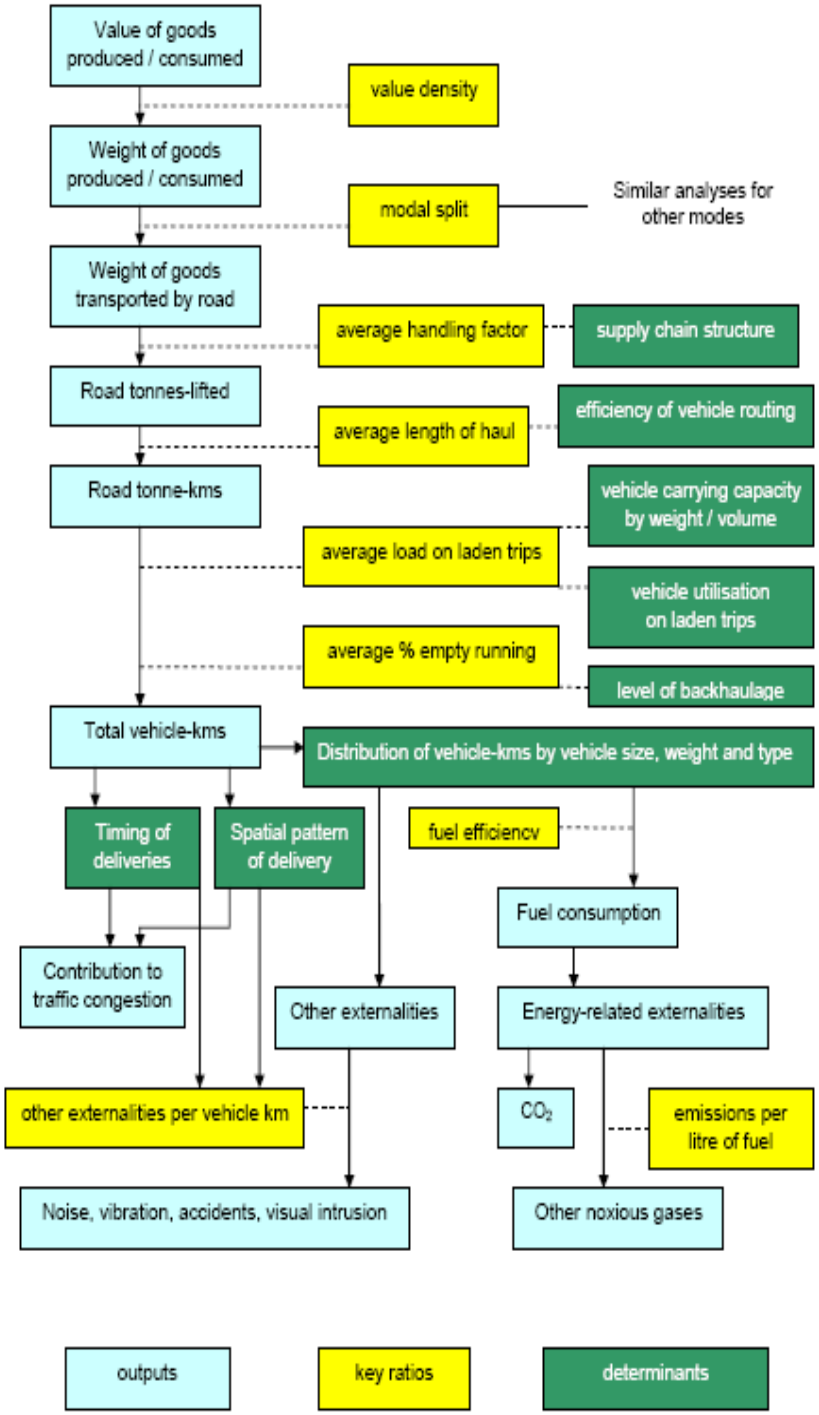


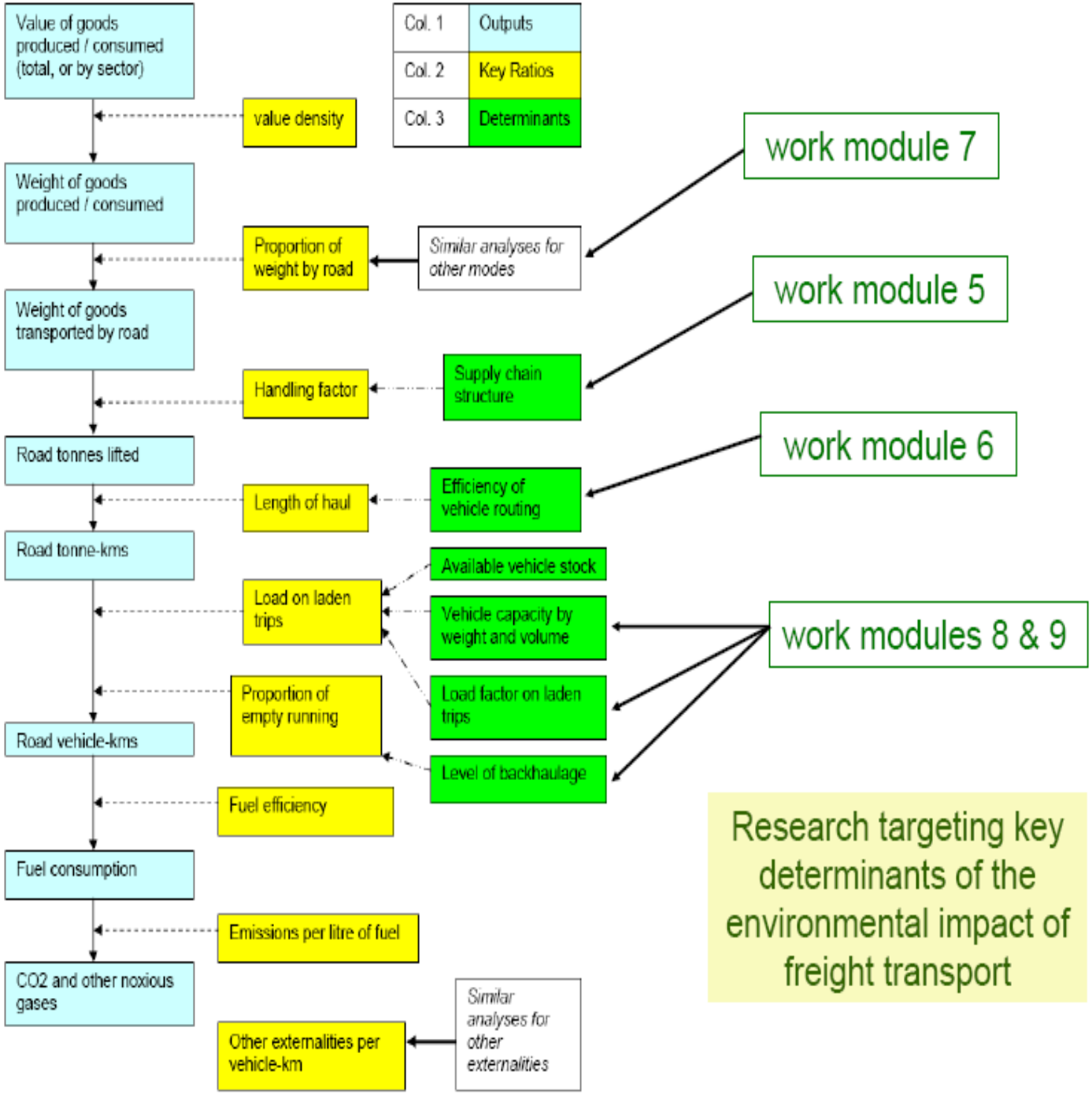
Published in March 2010

Conceptual Framework

business transactions

emissions




Value of goods produced / consumed (total, or by sector)
Weight of goods produced / consumed
Weight of goods transported by road
Road tonnes lifted
Road tonne-kms
Road vehicle-kms
Fuel consumption
CO2 and other noxious gases
value density
Proportion of weight by road
Handling factor
Length of haul
Load on laden trips
Proportion of empty running
Fuel efficiency
Emissions per litre of fuel
Other externalities per vehicle-km
Similar analyses for other modes
Similar analyses for other externalities
Supply chain structure
Efficiency of vehicle routing
Available vehicle stock
Vehicle capacity by weight and volume
Load factor on laden trips
Level of backhaulage
Col. 1
Outputs
Col. 2
Key Ratios
Col. 3
Determinants
work module 7
work module 5
work module 6
work modules 8 & 9
Research targeting key determinants of the environmental impact of freight transport

Understanding the "key ratios"

- The relationships between economic activity, freight transport activity and the consequent externalities are driven by a set of *key ratios*, which can be influenced by a range of technology changes and/or policy initiatives
- The project aims to develop a full understanding of these ratios and how they can be influenced to benefit the environment

The 9 "Green Levers"

Value density
Modal split
Average handling factor along supply chain
Average length of haul
Average load per laden journey
Empty running
Fuel efficiency
Emissions per litre of fuel
Other external effects per km travelled

Example of changes needed

Decarbonisation Scenario for UK Road Freight Sector in 2050*

Total tonne-kms stable at 2007 level

↓

Road share of freight tonne-kms reduced from 64% to 50%

↓

% of truck kilometres run empty reduced from 27% to 17%

↓

Average weight-based load factor up from 59% to 70%

↓

40% improvement in energy efficiency

↓

30% reduction in the carbon content of the truck energy

↓

75% reduction in CO_2 emissions

* changes relative to 2007

Future prospects

- A.C. McKinnon and M.I. Piecyk (2010): Logistics 2050. Moving Freight by Road in a Very Low Carbon World
- Conclusions – "The preliminary assessment of the potential for decarbonising the road freight sector suggests that a combination of a series of radical, but probably feasible, changes could cut CO_2 emissions by the 80% target adopted by the U.K. government for the economy as a whole for 2050 (relative to 1990). Of the two dozen scenarios tested the eight most optimistic would attain this level of reduction but require step changes in vehicle technology and corporate behaviour."

Example – Height restrictions

- EU is considering a max height limit of 4m for trailers.
- Report: "Britain without Double-deck Lorries"
- Prof Alan McKinnon, Logistics Research Centre, Heriot-Watt University, Edinburgh
- "In terms of its impact on CO_2 emissions, this would be equivalent to adding 151,000 new cars to Britain's roads."

E-business and the environment

- Is ordering over the internet more environmentally friendly than traditional shopping?

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E-business and the environment

- *The positive view*: Home shopping reduces (car) shopping travel and deliveries can be efficiently consolidated
- *The negative view*: Home deliveries are often inefficient, over long distances, put larger vehicles in suburban streets -and people will travel elsewhere in any case

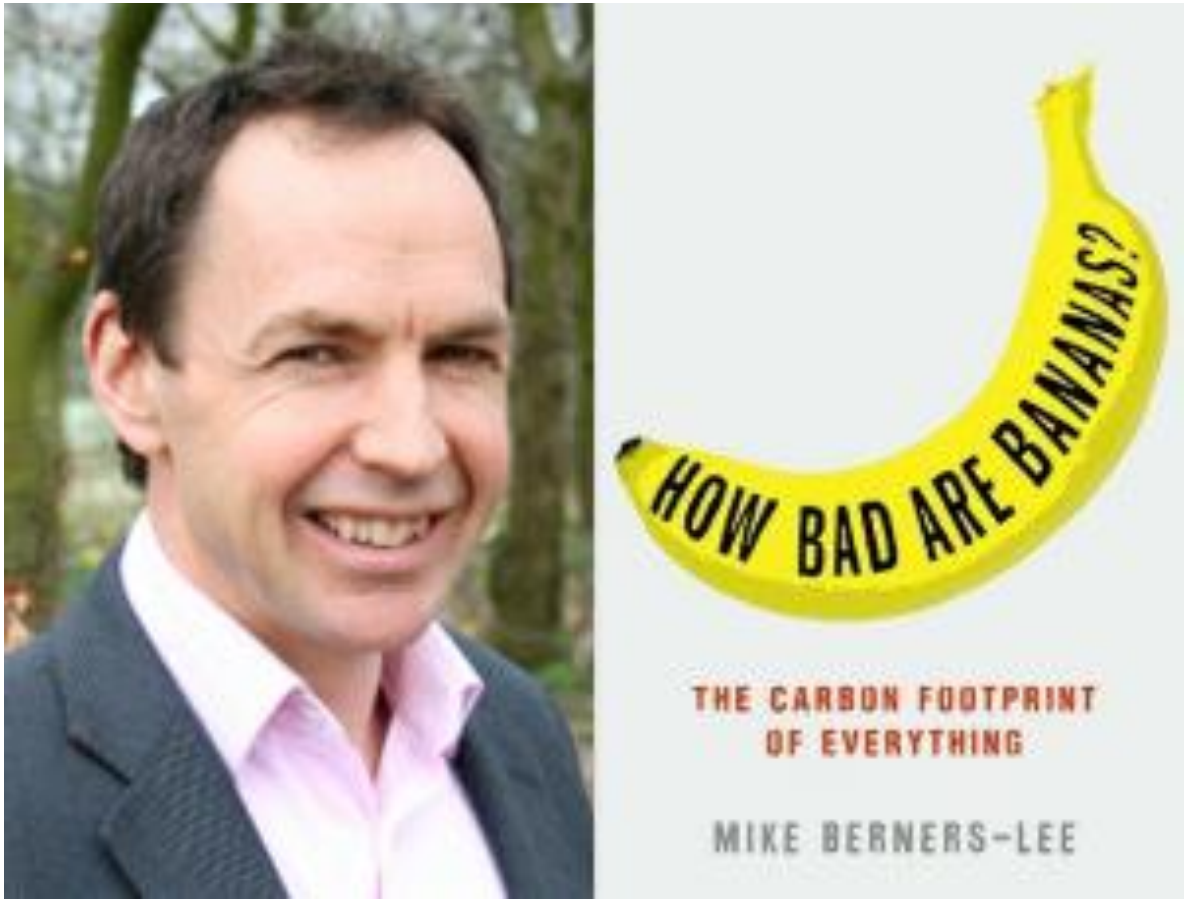
Is on-line shopping greener?

- *Carbon Auditing the 'Last Mile': Modelling the Environmental Impacts of Conventional and Online Non-food Shopping*
- March 2009
- J.B. Edwards, A.C. McKinnon and S.L. Cullinane
- "On average, when a customer shops by car and buys fewer than 24 items per trip (or fewer than 7 items in the case of bus users) the home delivery will emit less CO2 per item purchased"

What about electronic books?

- "I guesstimate that an e-reader has a footprint of around 50kg. If I'm right you'd have to get through at least a hundred paperbacks (bought new and then sent to recycling) before the paper saving outweighed the embodied emissions of the reader itself."
- Mike Berners-Lee "How bad are bananas? – The carbon footprint of everything"

Another new book



Estimating carbon footprints

- Under 10 grams
  - Sending a text message, drying your hands
- 100g to 1 kg
  - A nappy, a shower, a red rose
- 10kg to 100kg
  - A leg of lamb, year's typical use of a mobile phone
- 1 tonne to 10 tonnes
  - Flying from London to Hong Kong return

What are the load factors on container train services?

- *An assessment of the operational factors affecting rail freight sustainability in Britain*
- September 2009, Allan Woodburn
- "…environmental performance per unit of freight moved may be significantly influenced by the level of operational efficiency."

Examples of different load factors

Should domestic and commercial waste collection be combined?

- *Characteristics of retail waste logistics - A case study on Winchester High Street*
- May 2010, Sarah Maynard, Tom Cherrett
- "The ability of an existing domestic round to collect additional waste is dependent on spare capacity and time available… This has been examined in detail as part of a separate case study in Winchester."

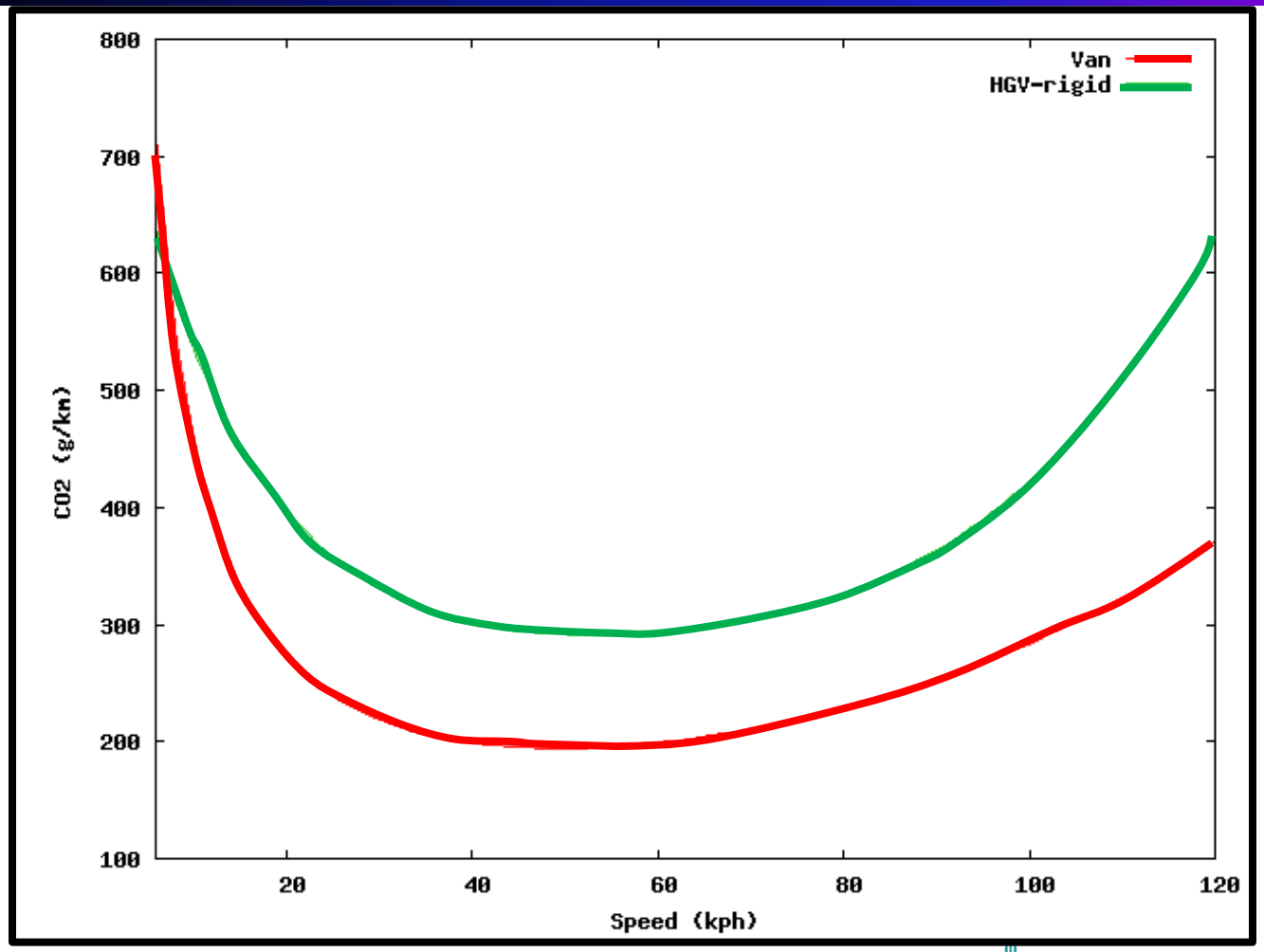
Using fuel more efficiently

- Those elements that influence fuel consumption are:
  - Travel related factors such as speed and acceleration rates
  - Road conditions such as congestion, inclines, bends, roundabouts and traffic lights
  - Vehicle characteristics such as engine size, fuel type, payload and age

For example…

The size, weight and shape of the load will affect the fuel consumption.

CO2 Emissions



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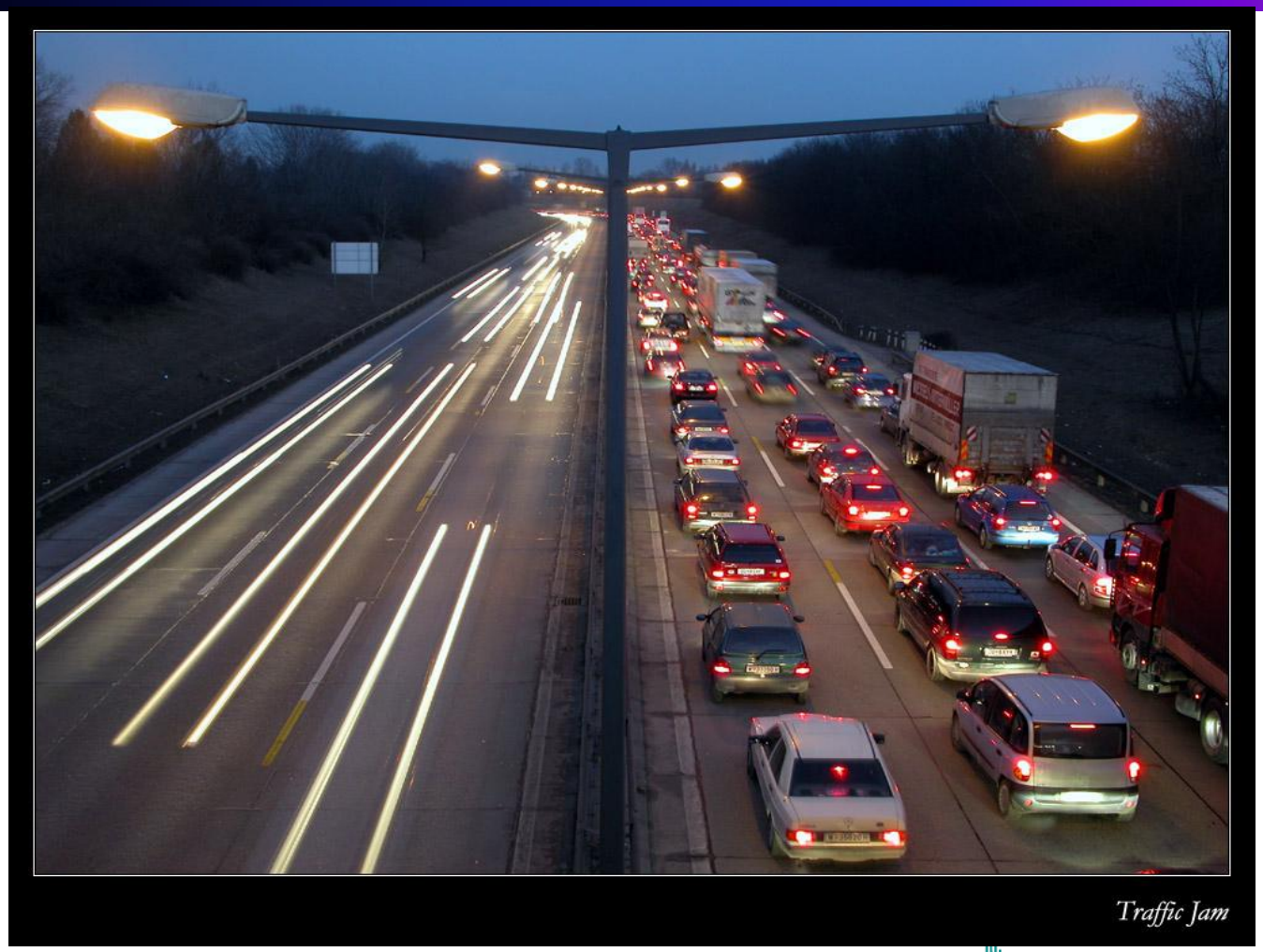
Can VR&S take account of congestion?

- *Vehicle routing and scheduling with time-varying data: A case study.*
- Maden W., Eglese R. and Black D. (2010) Journal of the Operational Research Society, Vol. 61(3), pp 515-522.

The problem



Data Source

A leading provider of traffic information and vehicle security services
http://www.itisholdings.com

- Largest commercial application of FVD ™
  - Real road speeds time matched and day matched

The LANTIME scheduler

- Given a set of customers and associated demands, central depot, vehicle fleet
- Objective: Min total time
- Constraints:
  - Vehicle capacity (weight and space)
  - Delivery time windows
  - Driving time for each route
- Using time-dependent data requires significant changes to the vehicle routing algorithms

Case Study

- Electrical Wholesale Distribution in the South West of England
- Type of vehicle - all 3.5 tonne GVW box vans. No restrictions on any roads.
- Weight/Cube - No restrictions
- Time Windows - none
- Time constraint – one shift per day

Vehicle Routes for one day

Uncongested routes

LANTIME routes

Result

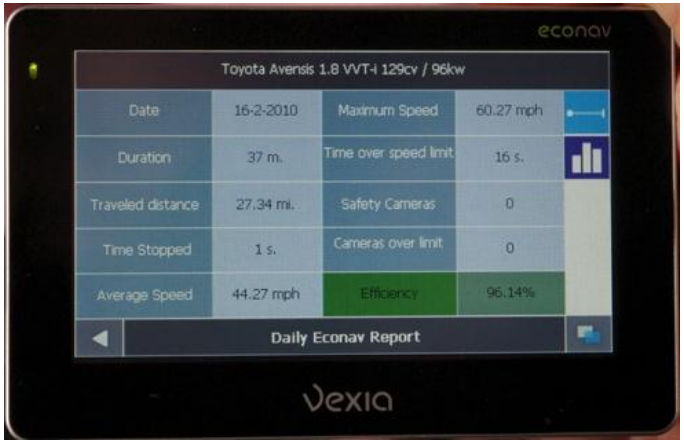
- In this case, a reduction in CO_2 emissions of about 7%.

Current Work

- Modifying for least polluting rather than least time
- Modifying to take account of congestion charging

Minimising pollution or fuel

- Fuel use and hence carbon footprint depends on speed.
- Treat speed as a decision variable in the network.
- Model using approximate dynamic programming and a column generation style heuristic.
- Implement using in-cab navigation systems



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Congestion charge

- General case is technically challenging
- Heuristics are being developed
- Future work to look at the design of a congestion charge scheme

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