

## Unsustainable transport



Cambridge Energy Forum  
8 February 2007

Roger Kemp, Lancaster University

"When I turn on the TV, I see wall-to-wall Humvees, and I'm proud," said Sam Bernstein from Marin County, who drives a Hummer H2.

"They're not out there in Audi A4's," he said of the troops. "I'm proud of my country, and I'm proud to be driving a product that is making a significant contribution."

*Website: Education for Peace in Iraq Center*

"The H2 is a gas guzzler. So while our brothers and sisters are off in the Middle East risking their lives to secure America's fossil fuel future, H2 drivers are pissing away our "spoils of victory" during each trip to the grocery store.

*Website: Fuck you and your H2*



## Economic significance of transport

- UK business invests £85bn p.a. in supply chains.
- 3,400 people die on the roads p.a.
- Road congestion costs €20bn p.a. \* (1.5% GDP)
- Transport industry a major source of wealth/employment
- ¾ of households own at least one car – largest single investment after the house
- Travel can take ~30% of someone's active hours

\* CBI estimate

## Trends in energy use (excluding international travel)

Final energy consumption, 1970 to 2002

Millions of tonnes of oil equivalent

Year	Domestic	Services	Transport	Industry
1970	18	35	28	60
1975	18	35	30	55
1980	18	38	35	55
1985	18	40	40	40
1990	18	42	45	38
1995	18	45	50	35
2002	18	48	55	35

UK energy use up 6% in last decade  
 Transport use, excluding international air routes, up 15%  
 Transport's share up 33% → 35%  
 Transport's share of petroleum up 54% → 65%

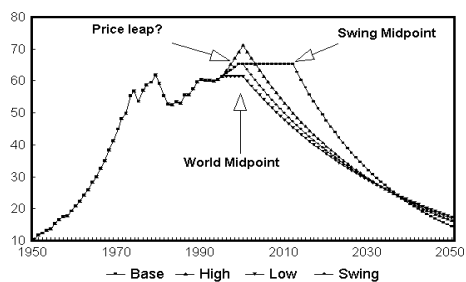
## Oil reserves (billion barrels)



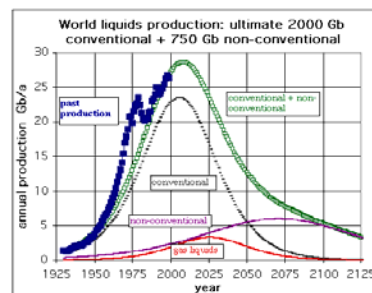
Country	OGJ	WO	Country	OGJ	WO
Saudi Arabia	262	262	Libya	30	30
Canada	180*	5	Nigeria	24	32
Iraq	113	115	USA	23	23
UAE	98	63	China	18	24
Kuwait	97	99	Qatar	15	20
Iran	90	100	Mexico	13	17
Venezuela	78	53	Norway	10	9
Russia	60	59	Algeria	9	13

OGJ = Oil & Gas Journal, WO = World Oil estimates \* primarily oil shale

## Oil exhaustion scenarios

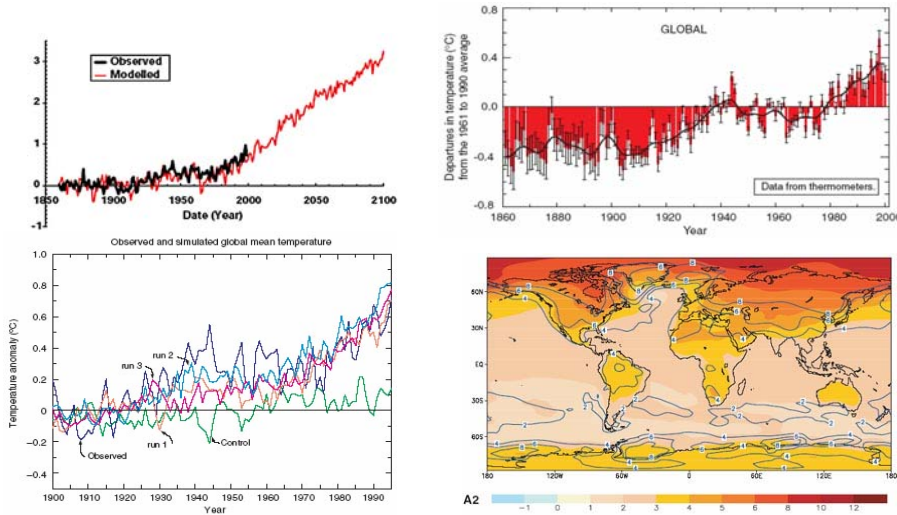


Colin Campbell, 1996  
<http://www.oilcrisis.com/midpoint.htm>



Jean Leherrère  
<http://www.oilcrisis.com/midpoint.htm>

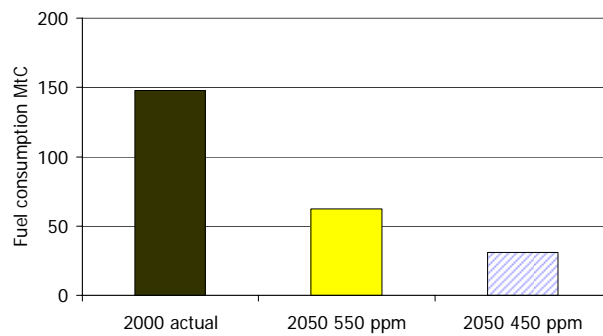
# Climate change



# Reduction in fuel use

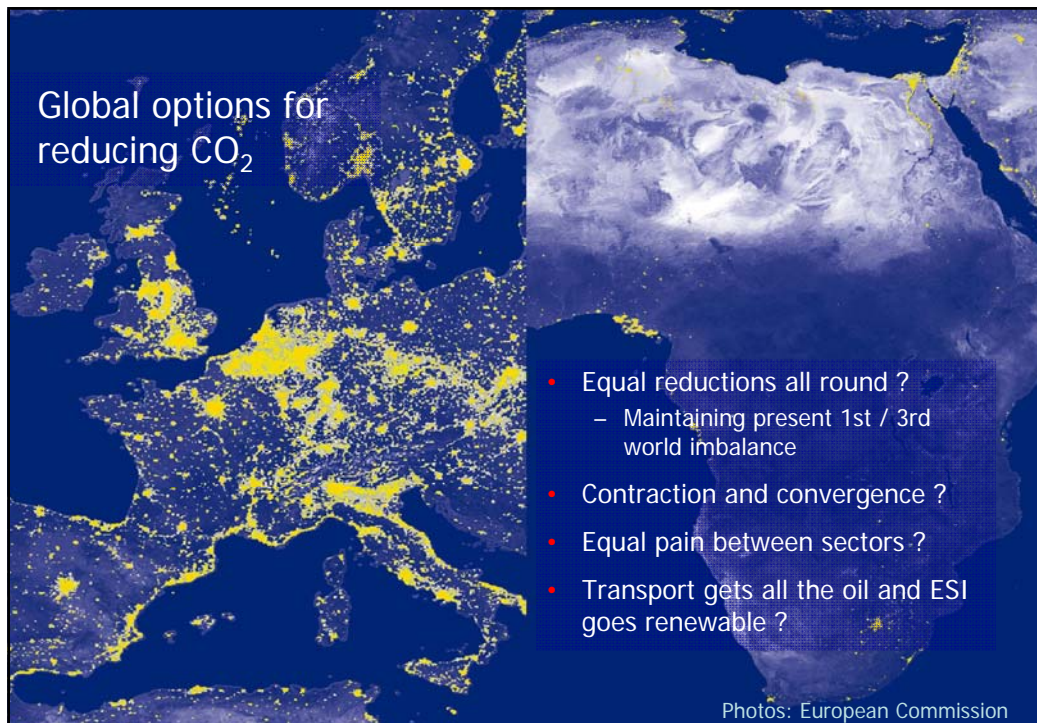


Assumes principle of "equal pain"



- To achieve 550 ppm CO<sub>2</sub> requires 55% reduction
- To achieve 450 ppm CO<sub>2</sub> requires 79% reduction

Source: Leeds ITS



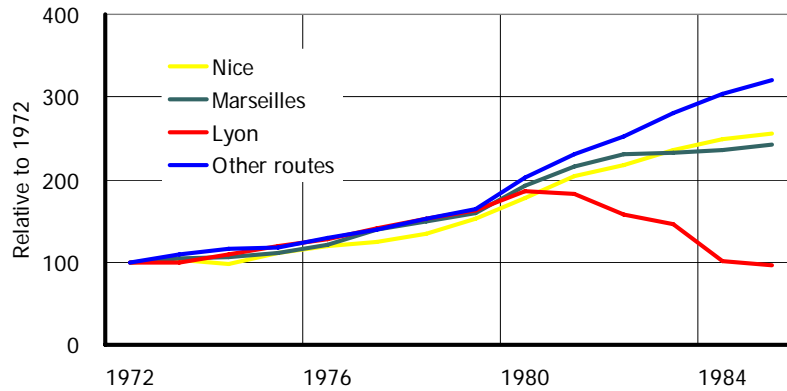
## Reducing CO<sub>2</sub> in the transport sector



- Increasing efficiency of transport systems to use significantly less fuel per passenger-km or tonne-km
- Reducing the overall amount of personal travel and movement of goods
- Transferring passengers and freight from high-consumption modes (roads & air ?) to low-consumption modes (rail ?)
- Obtaining energy from non-carbon sources

## Modal transfer

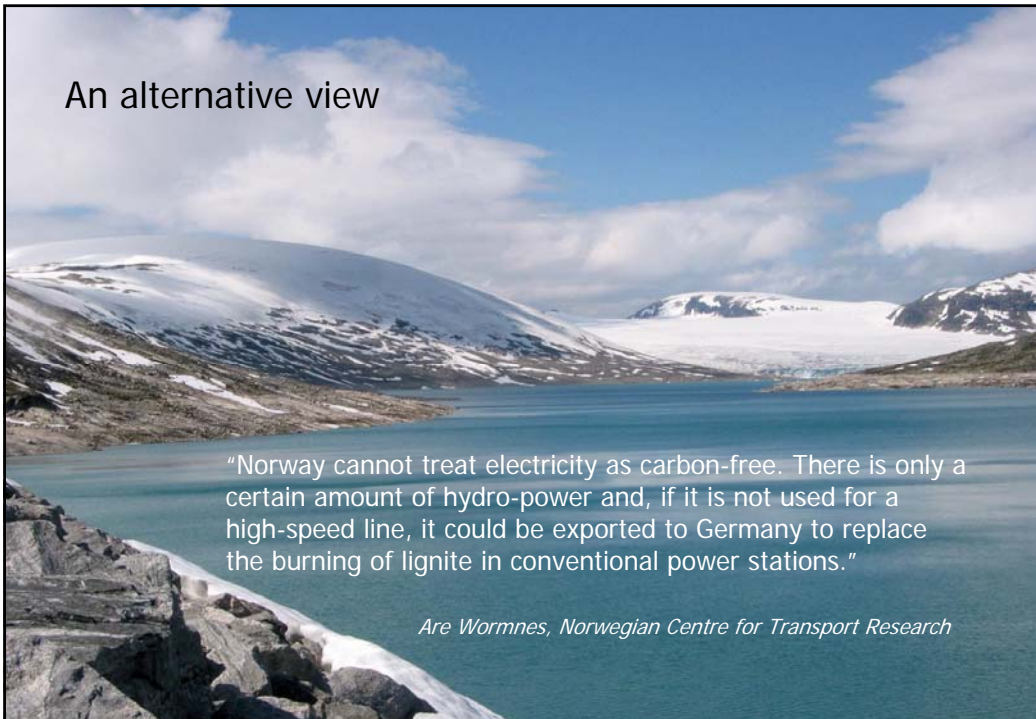
Effect of TGV-PSE on domestic air services

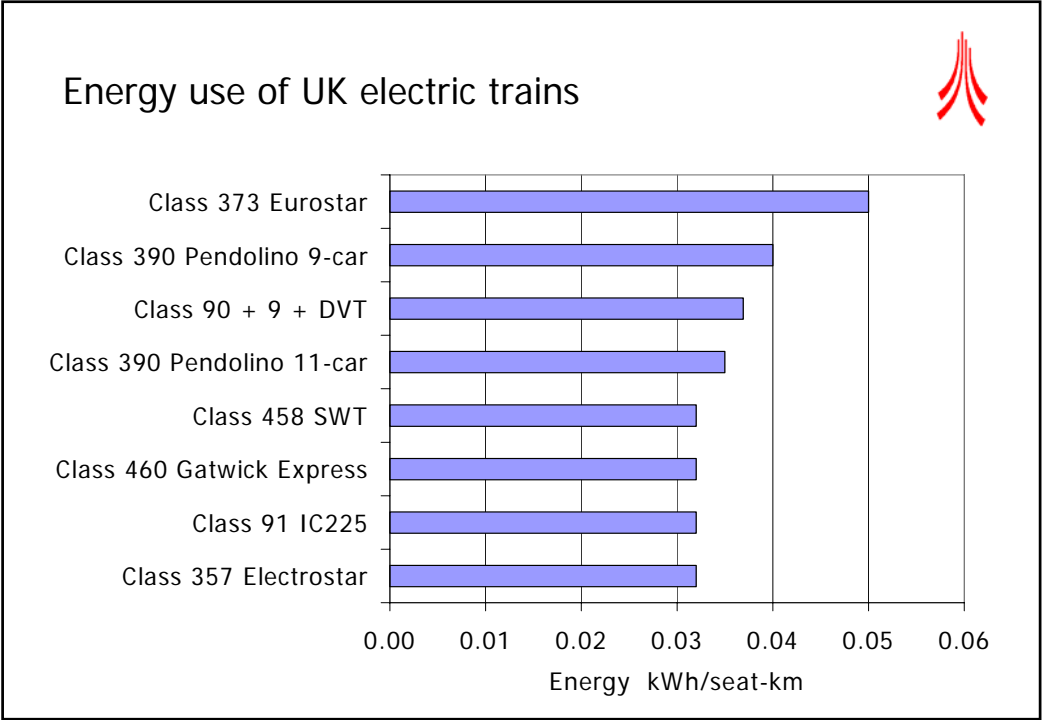
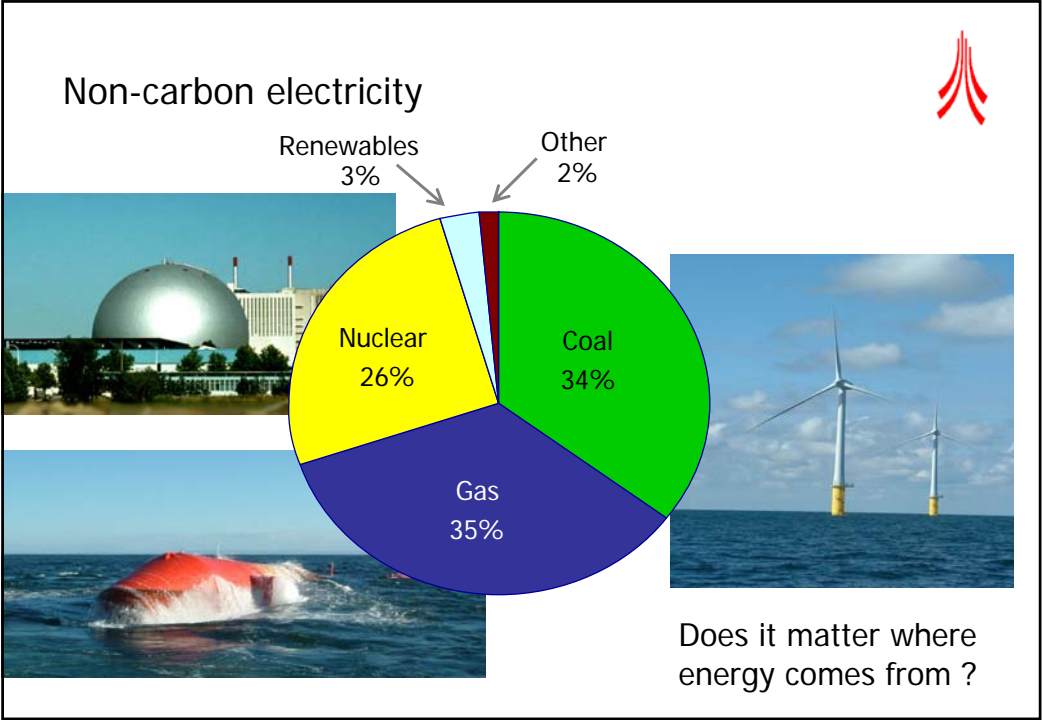


It can be argued that TGV cut CO<sub>2</sub> in France, due to nuclear generation  
Would the same be true in Britain ?

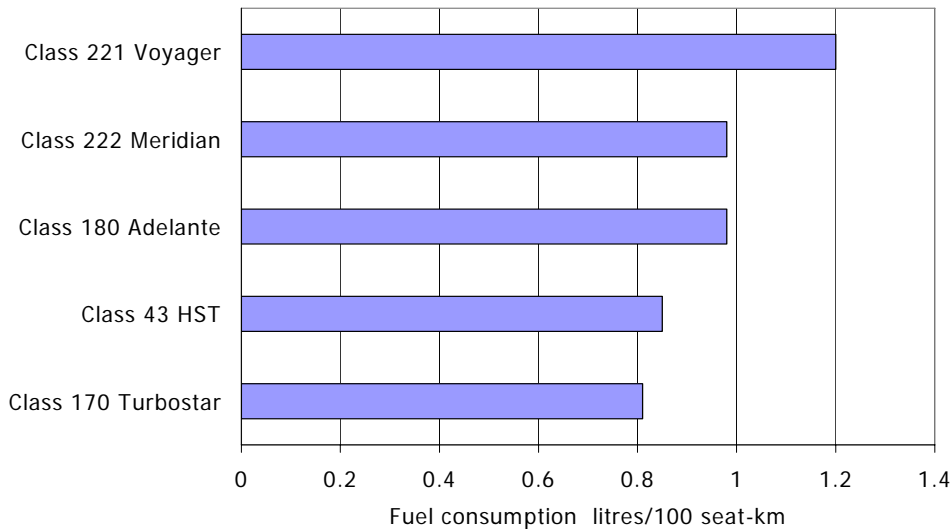
Source: Berlioz & Leboeuf (1986)

## An alternative view

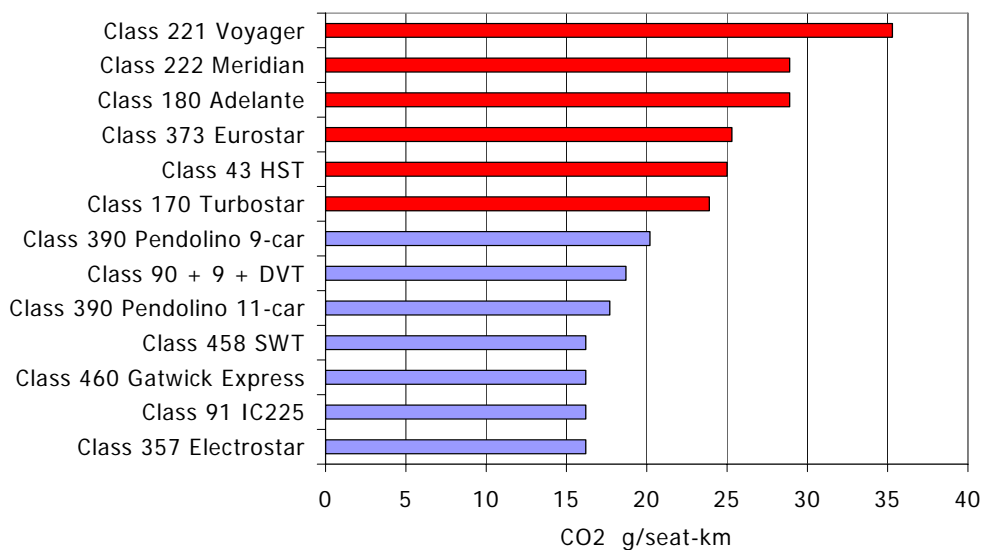




## Fuel consumption of UK diesel trains



## CO<sub>2</sub> emissions of electric and diesel trains



## Load factor

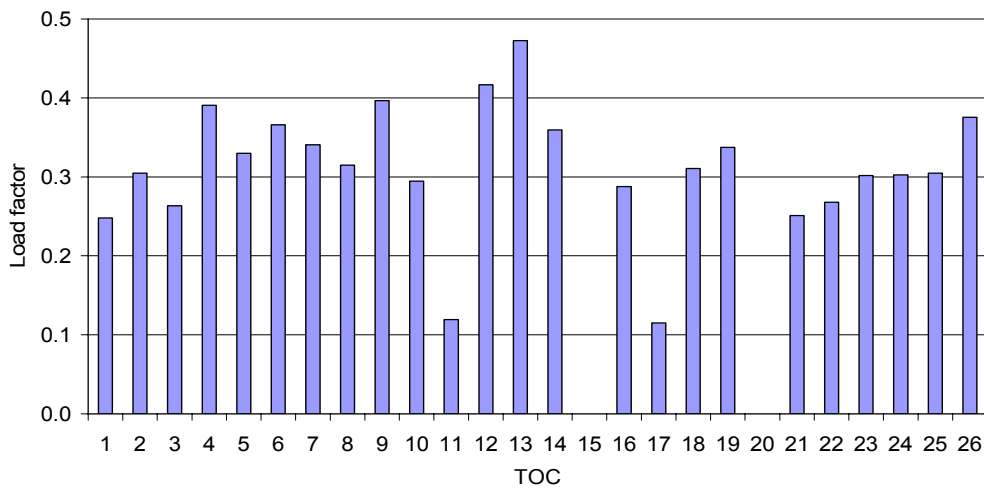


- Most vehicles (trains, cars, planes, ships) use much the same amount of fuel however many people are travelling
- Average load factor on trains 30%
  - varies between 20% and 50% depending on TOC
  - full leaving London, empty north of Lancaster
- Average number of people in a car 1.8
  - What is the load factor when a parent is taking a child to school by car?

## Load factors



Train load factor 2005-06

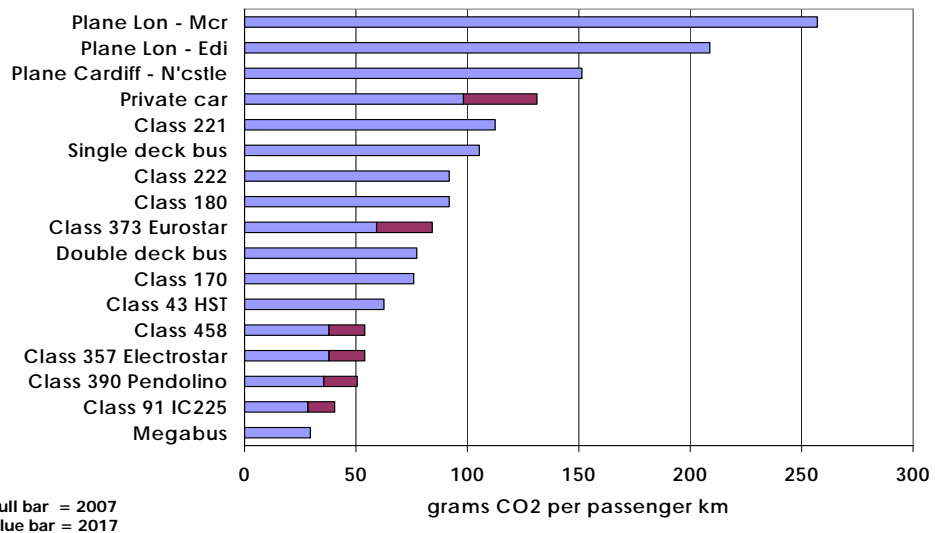


NB: TOCs 11 and 17 are misrepresented due to other sources of passengers

On average buses carry 9 passengers and achieve 5.6 miles/gallon



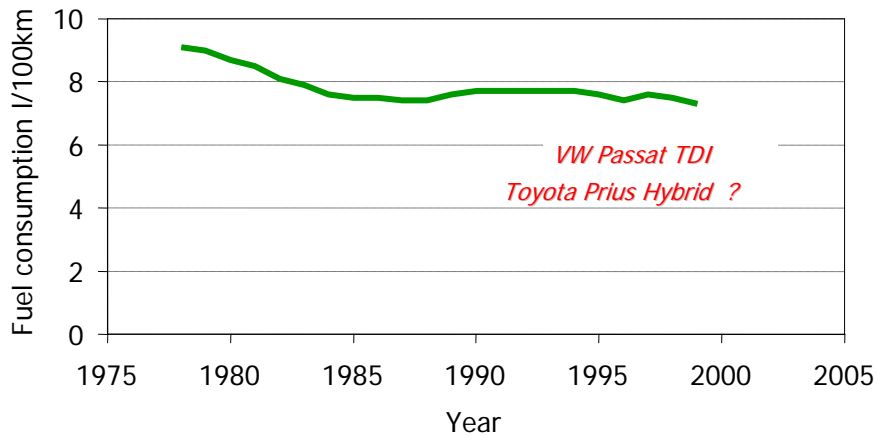
### Carbon emissions of transport



## Car fuel consumption

Average of new cars, excluding SUVs

*Toyota Land Cruiser*



Source: DfT

## Non-carbon fuel



- Requires widespread planting of biomass crops
  - competing with food
  - destruction of amenity
- Environmental impact
  - High water demand
  - Possible fertiliser use
  - Voluminous by-product disposal

## Hydrogen fuel cells



- Are hydrogen vehicles a way of reducing global warming  
... or insulating the USA from the reality of the Middle East?
- Where will the hydrogen come from?
  - Hydrocarbons ?
  - Electrolysis ?

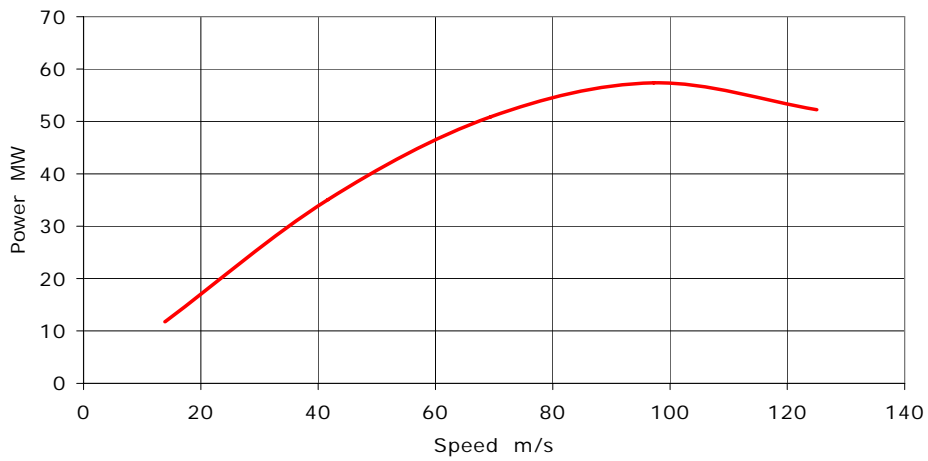
## Flying at 0.01 metres and 500 km/h



## Power demand of 10-car maglev

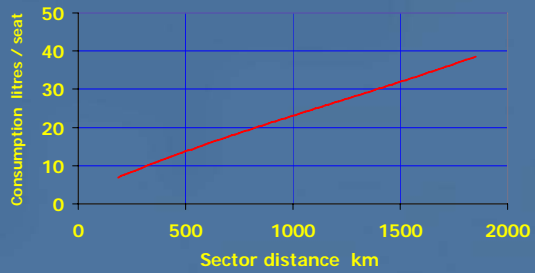


Power drawn from grid when accelerating



## Airbus consumption vs. sector length

A321-100 single class seating



Source: Airbus

## A high-speed line?



### For

- Rail uses less energy per seat
- Rail uses electricity not liquid fuel
- Rail emissions are at ground level



### Against

- Present traffic levels could not fill a high-speed line
- Planes in UK operate at higher load factors



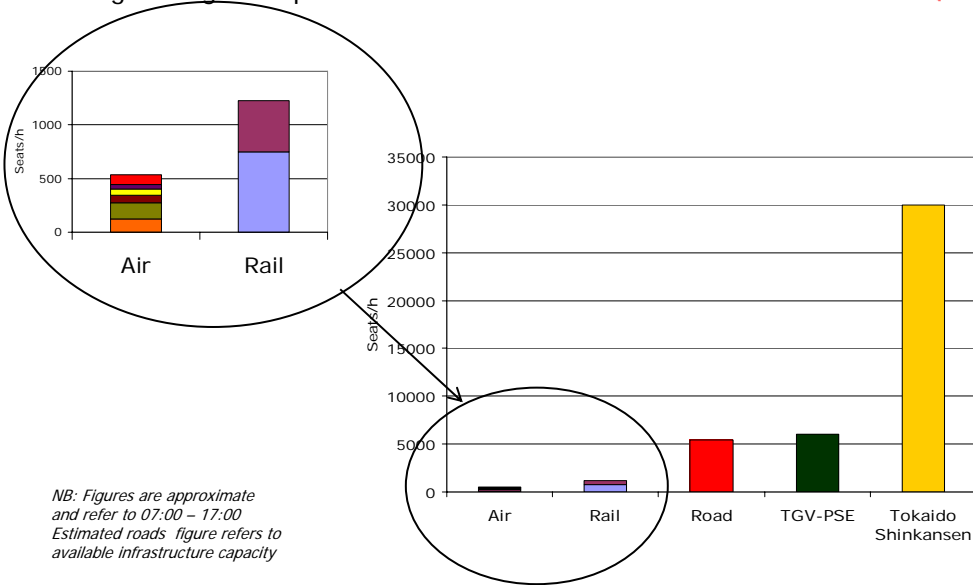
## Diversity of destinations



Where to check in			
		Desk	
16:15	Belfast City	BE686	Delayed 16:45
16:25	Stansted	EZY238	Departed
16:40	Dublin	FR817	Closed
17:05	Belfast Int'l	EZY488	Closed
17:10	Kirkwall	BA8899	Closed
17:10	Luton	EZY056	15 Closed
17:15	Heathrow	BA1455	45 Open
17:15	Paris CDG	BA7935	45 Open
17:30	Manchester	L5785	8-9 Open
17:30	Birmingham	BA1829	45 Open
17:50	Gatwick	BA2943	45 Open
17:50	London City	CB726	5 Open

16:42

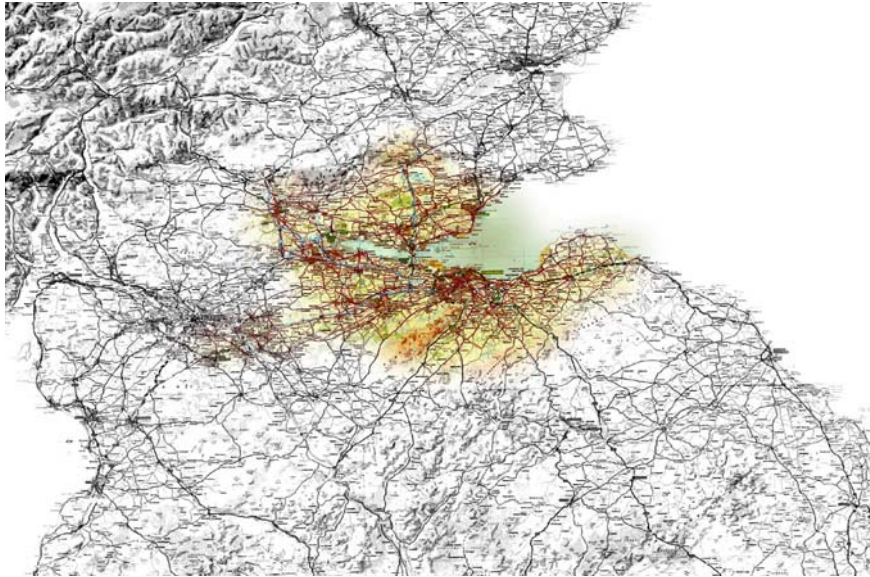
## Modal split of available seats Edinburgh – English airports



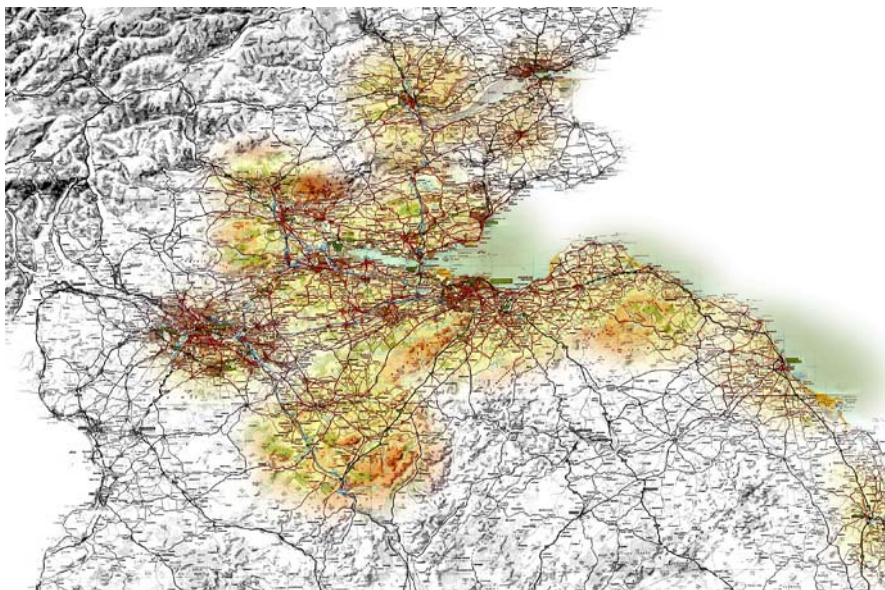
## Commuting by bus



### Commuting by car



### Commuting by HS train & car



## Air – rail modal shift Scotland - London



- HS rail is always less environmentally damaging than air
  - Particularly if it uses non-carbon electricity
  - Measured on CO<sub>2</sub> emissions per seat
- Air – rail substitution by itself would not provide sufficient passengers for a HS line
  - It would be almost impossible to prevent a new HS line creating environmentally damaging travel growth (e.g. commuting)
  - Transfer of passengers from conventional rail to HS rail is environmentally damaging, unless using non-carbon energy
  - A privately financed HS line is only likely to be viable if operators have a free hand to maximise travel growth
- Net effect of a new HS line or Maglev could be to increase overall CO<sub>2</sub> emissions, despite transfer from air to rail

**Ferry** 2000 passengers (with cars)

50,000 kW, 50 km/h

**Train** 500 passengers

4,000 kW, 200 km/h

**Plane** 200 passengers

20,000 kW, 800 km/h



## London – Hyderabad : options



- Plane (A380, B747)
- The Orient Express with sleeping/dining cars
- Ocean liner
- Overland bus/train (with hotel stops)

## Conclusions

- Travel, other than on foot or by bike, is environmentally undesirable
- Operating full vehicles is generally more important than the vehicle type
- Air travel will always be bad for the environment
- But the alternatives can be worse!

