SENCO

Including Non-Technical Measures for reducing air pollution in Integrated Assessment Modelling

Workshop Goteborg 7-8 December 2005

Mark Barrett

MarkBarrett@sencouk.co.uk

SENCO ***Sustainable Environment Consultants***

www.sencouk.co.uk

- Define NTMs
- Illustrate certain NTMs
- Modelled results of NTMs
- Modelling issues

Some references:

Report on consumption and NTMs

http://www.sencouk.co.uk/Consumption/Consumption.htm

Work in progress energy scenario including NTMs

http://www.sencouk.co.uk/Energy/Energy.htm

For comment and discussion only

The need for Non-Technical Measures

SENCO

- Assuming emission equity, global population of ten billion, GHG emission reductions of over 90% required in rich countries to stabilise climate.

- Conservation, energy efficiency and renewable energy sources are vital options, but these measures run into increasing marginal economic and environmental cost, and technical limits. This makes it difficult to reach reductions of over 90% with these means, at least with known technologies.

- Cost-effective limits to some emission control technologies being approached

- Some NTMs can reduce multi pollutants, penetrate quickly and have low cost

Non-Technical Measures: definition and examples

SENCO

Non-technical measures (NTMs) may be defined as measures where the behaviour of people changes such as to reduce a given environmental impact. This does not include the instruments for achieving behavioural change, such as fiscal or regulatory instruments.

NTMs may be put into four classes, as follows (with examples):

Reduce consumption

- change expenditure patterns to purchase commodities with less impact, e.g. buy a hi-fi rather than an air ticket
- reduce travel needs by living close to work or teleworking
- holiday locally rather than abroad

Substitution

- use telecommunications for business rather than air travel
- modal shift from car to bus, or truck to train
- wear warmer clothes to reduce thermostat setting

Technology choice

- purchase of small car rather than a large one

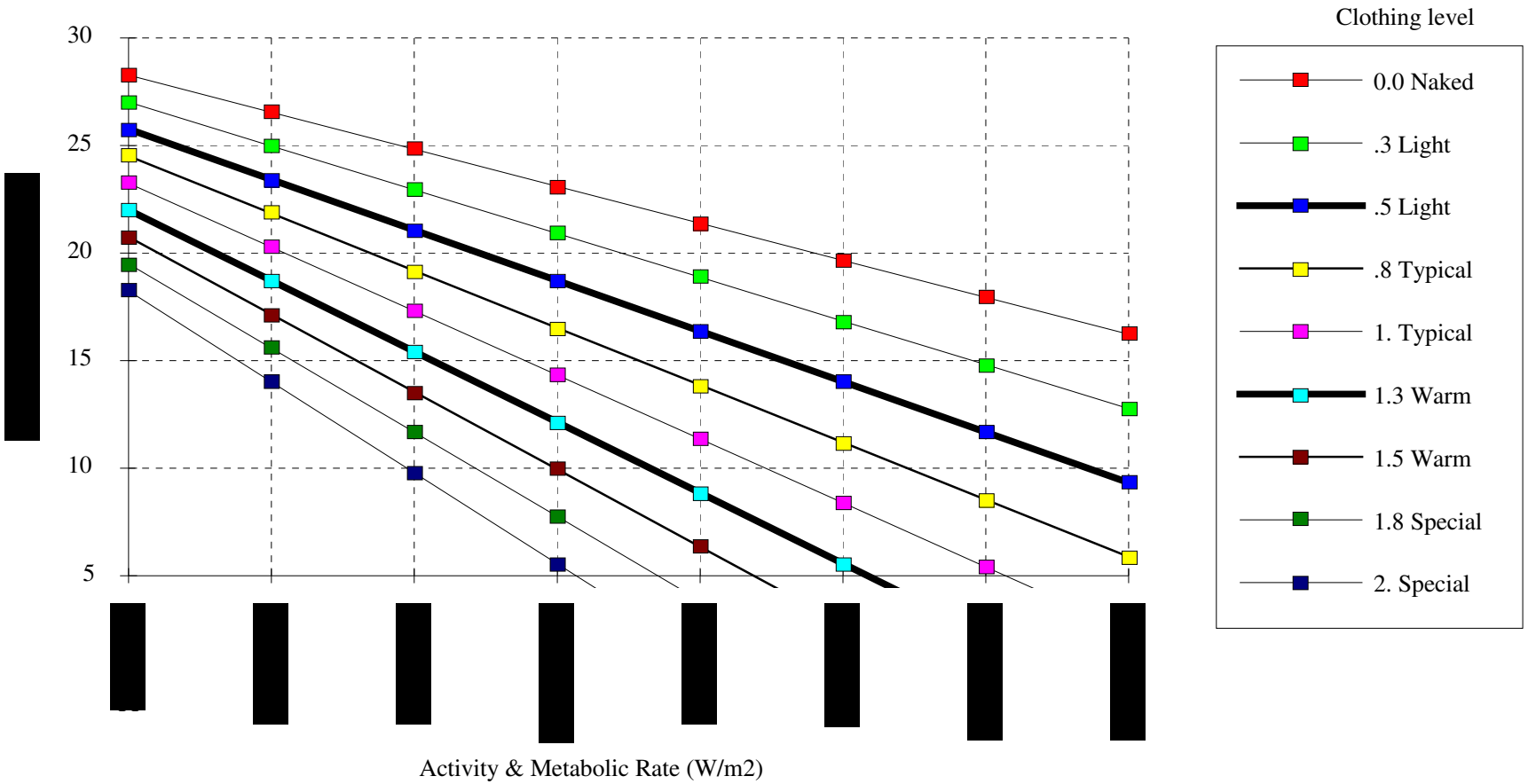
Technology use

- Transport
  - reduce vehicle speeds on motorways
  - increase vehicle load factor
- Buildings
  - control of lights and appliances

Comfort temperature, clothing and activity

SENCO

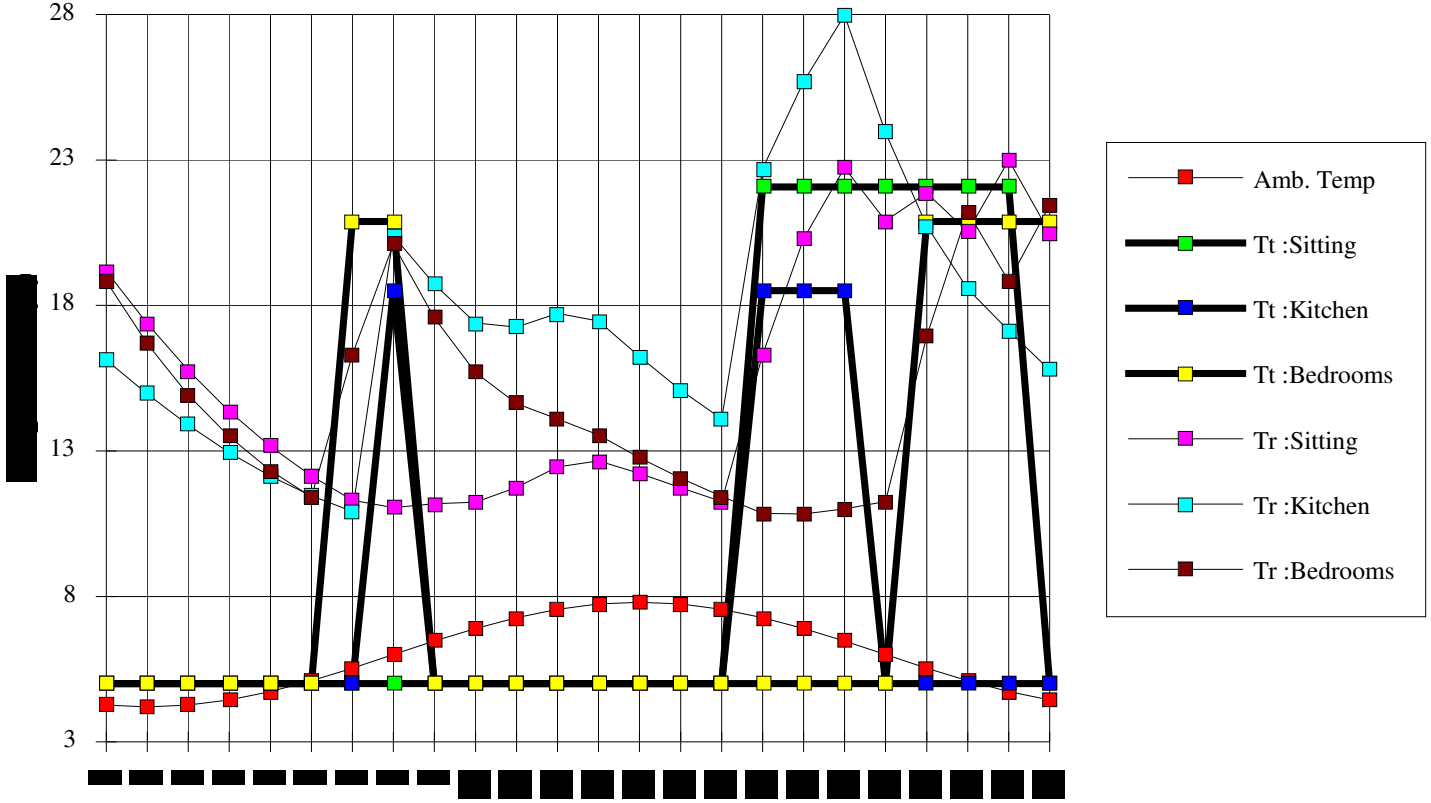
Appropriate clothing reduces energy demand and emissions



Building use

SENCO

Control of building energy systems reduces energy demand and emissions



Transport NTMs

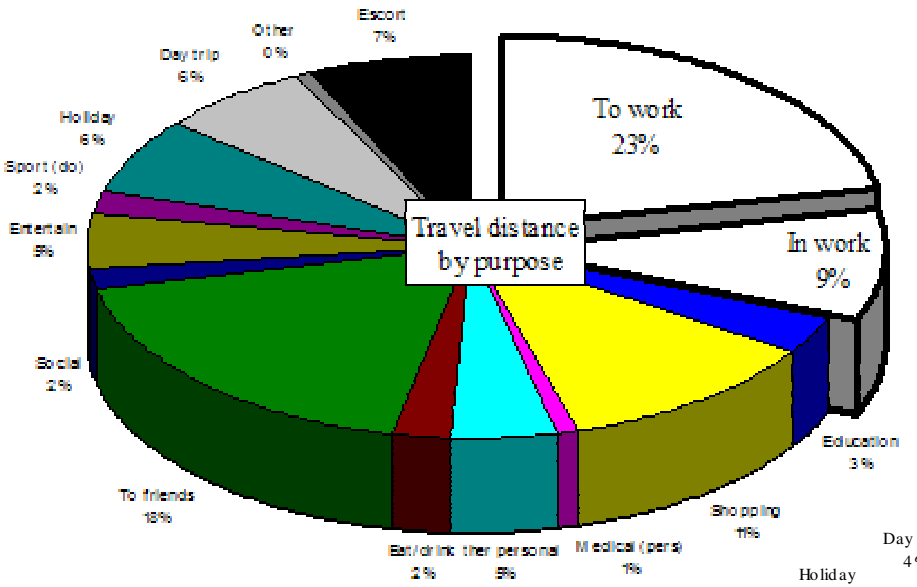
SENCO

In general energy use and carbon emissions resulting from transport depend on:

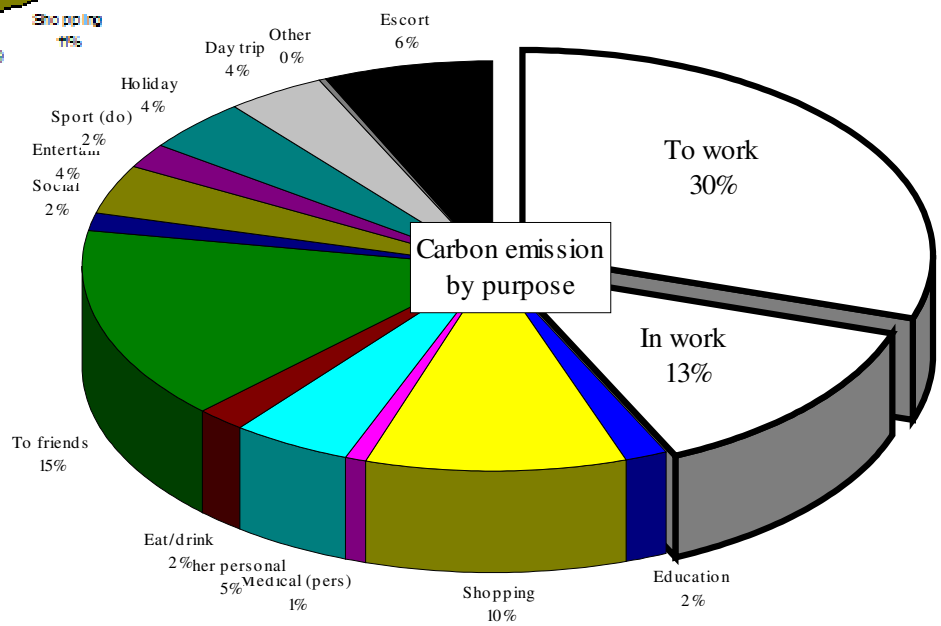
- **Demand**: the load distance and timing of travel
  - employment patterns
  - land use patterns
  - production patterns
- **Substitution**
  - trips shifted from cars to other modes;
    - primary change - vehicle performance
    - secondary system change - congestion
- **Choice of technology**
  - car size/power
  - technology type (liquid, electric fuelled)
- **Use of technology**
  - speed and acceleration
  - the proportion of vehicle load capacity utilised

SENCO

Passenger transport: distance and carbon emission by purpose

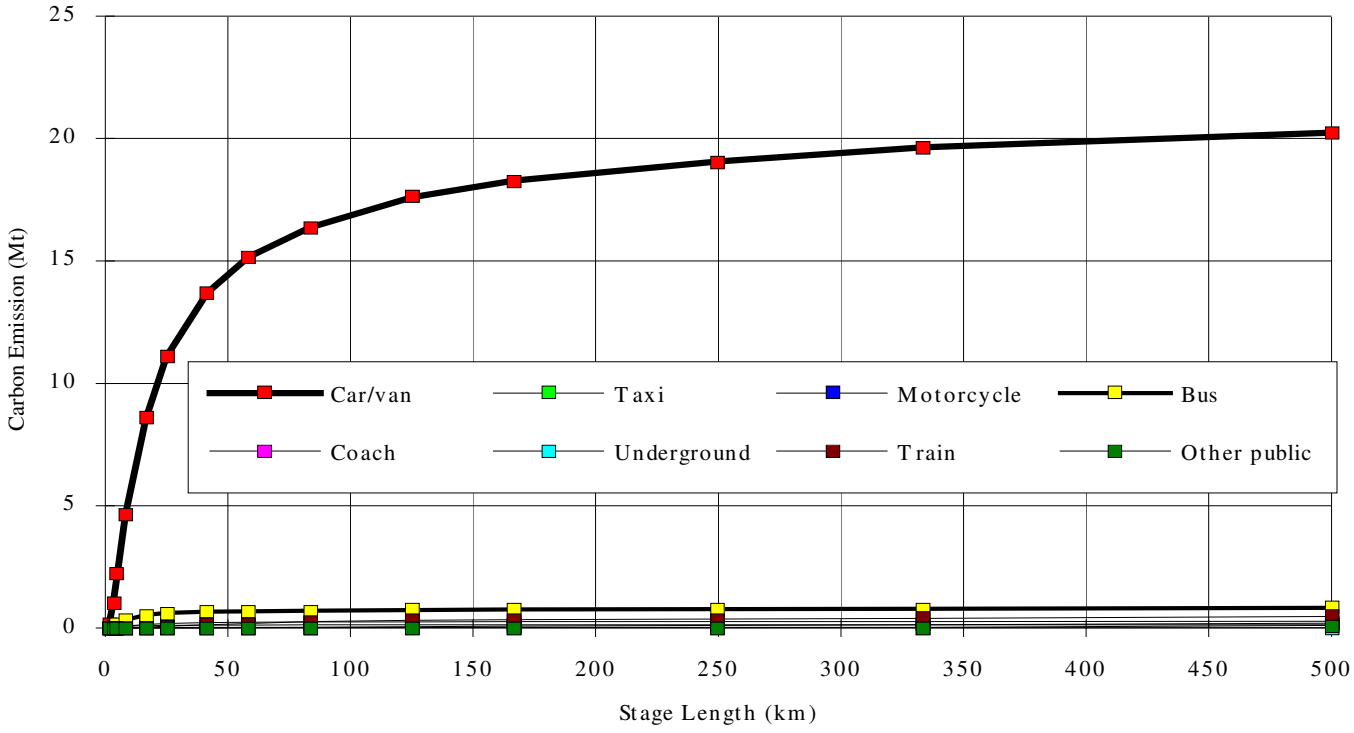


- Commuting and travel in work account for large fraction of emissions



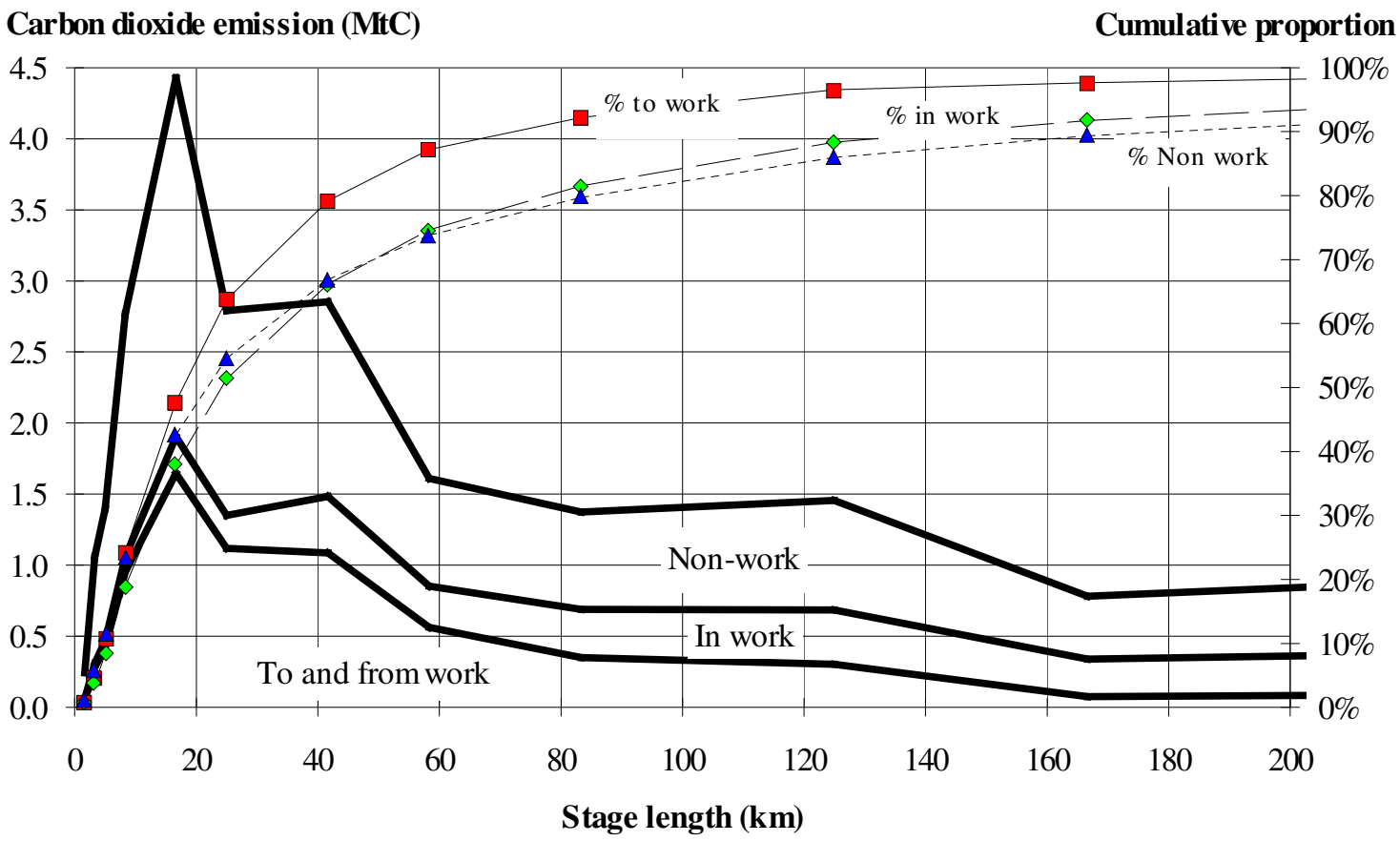
Passenger transport use by trip length

SENCO



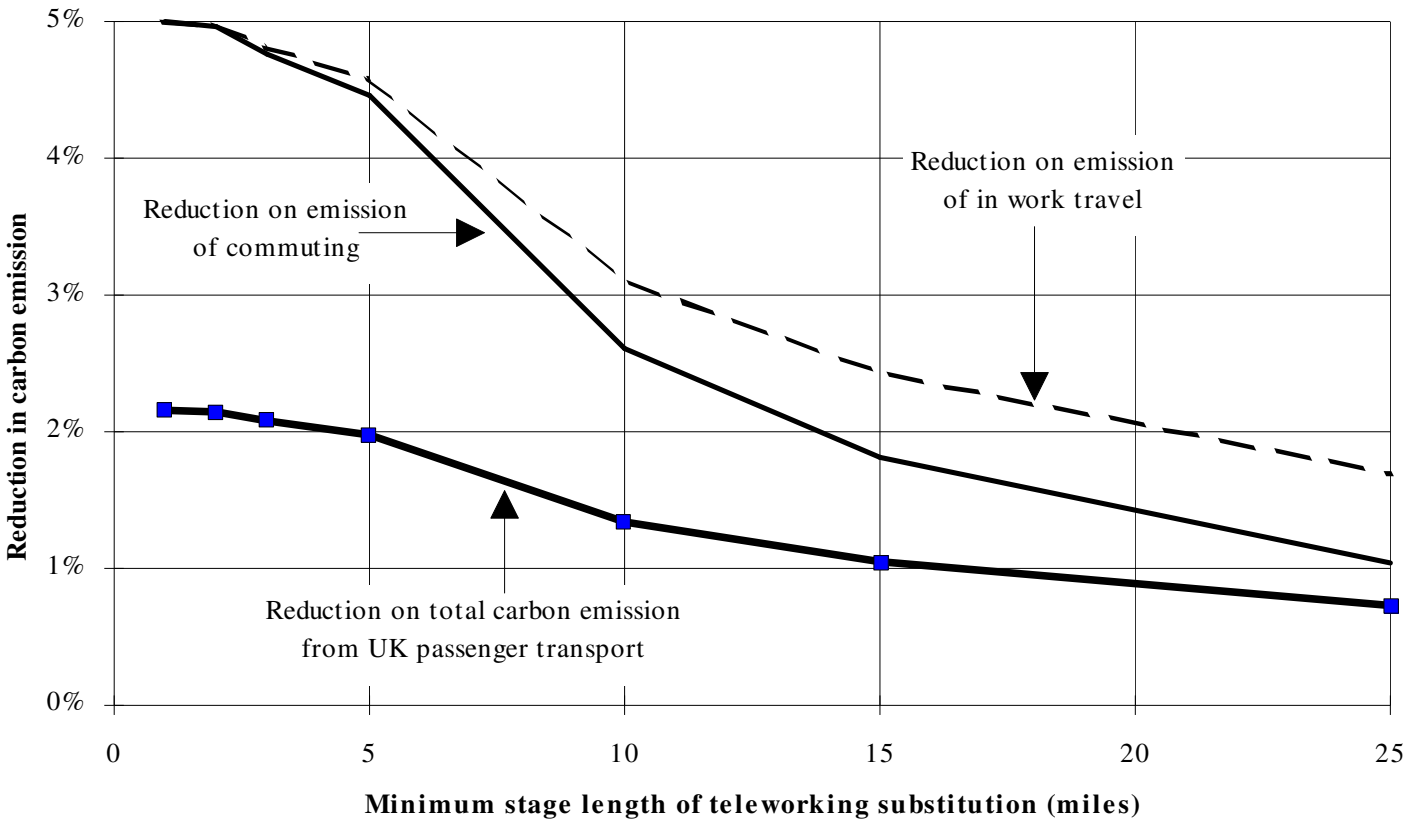
Passenger transport: carbon emission purpose and by trip length

SENCO



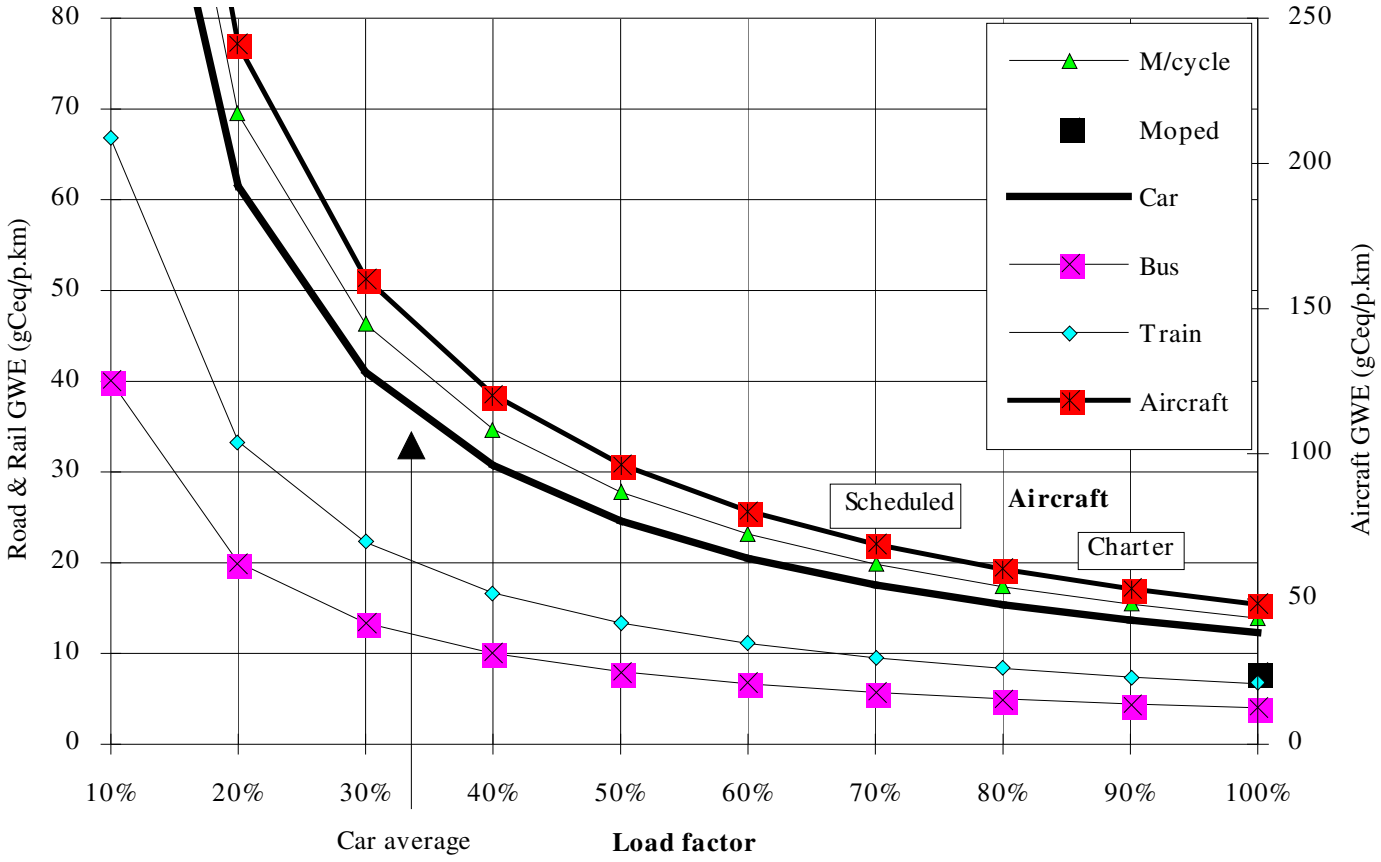
Passenger transport : potential effect of teleworking

SENCO



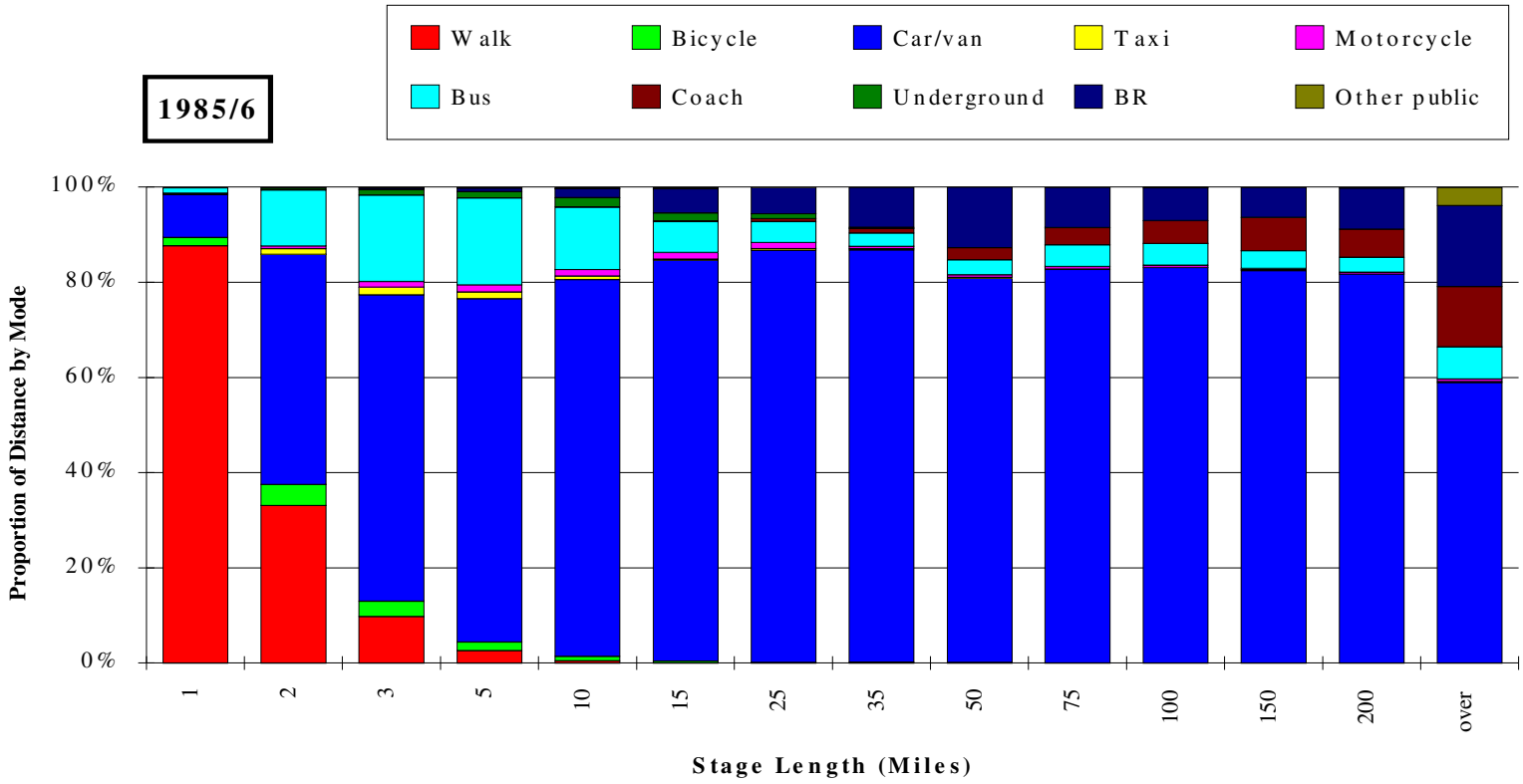
SENCO

Passenger transport: carbon emission by mode of travel



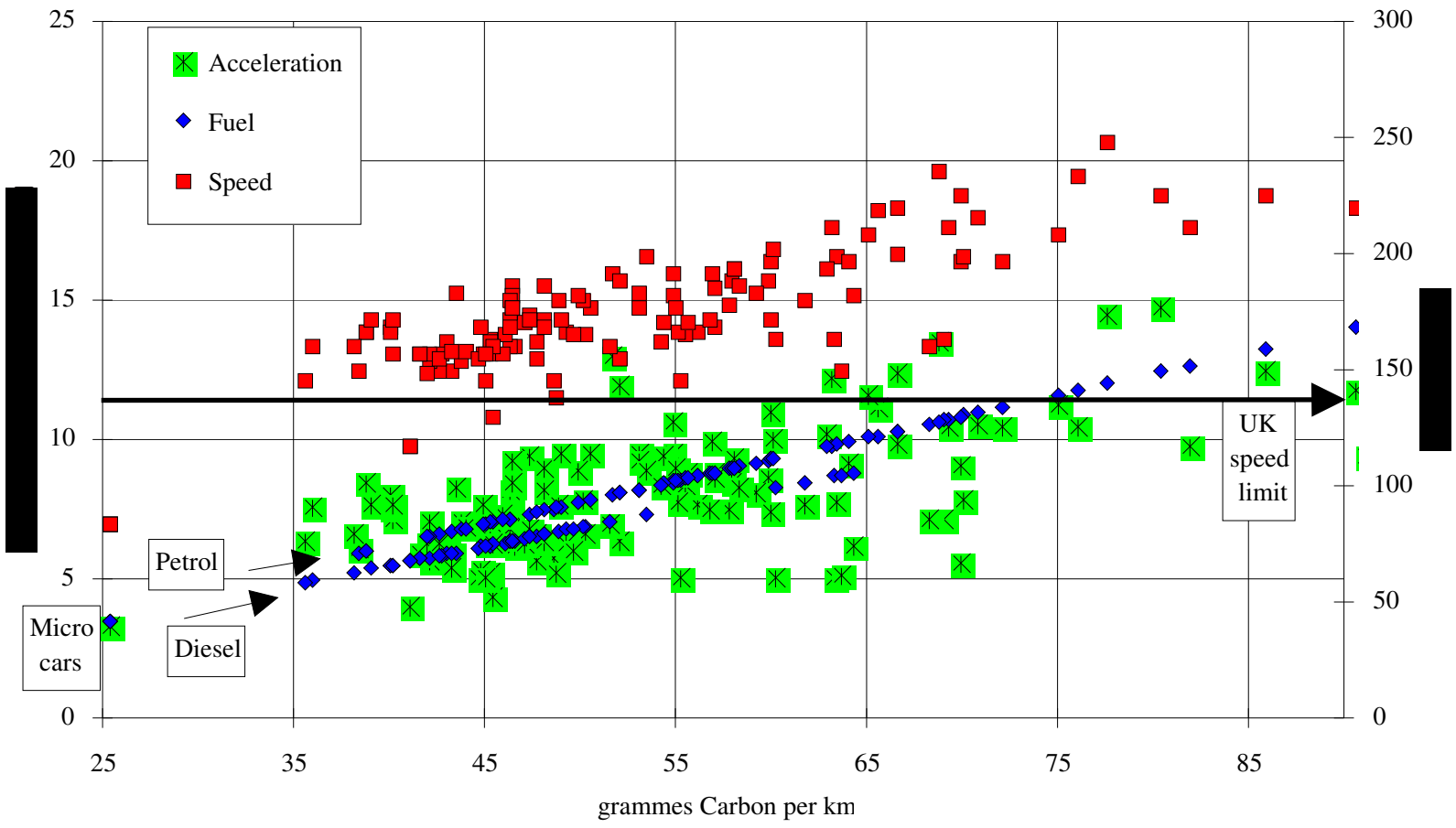
Passenger transport: mode of travel by distance

SENCO



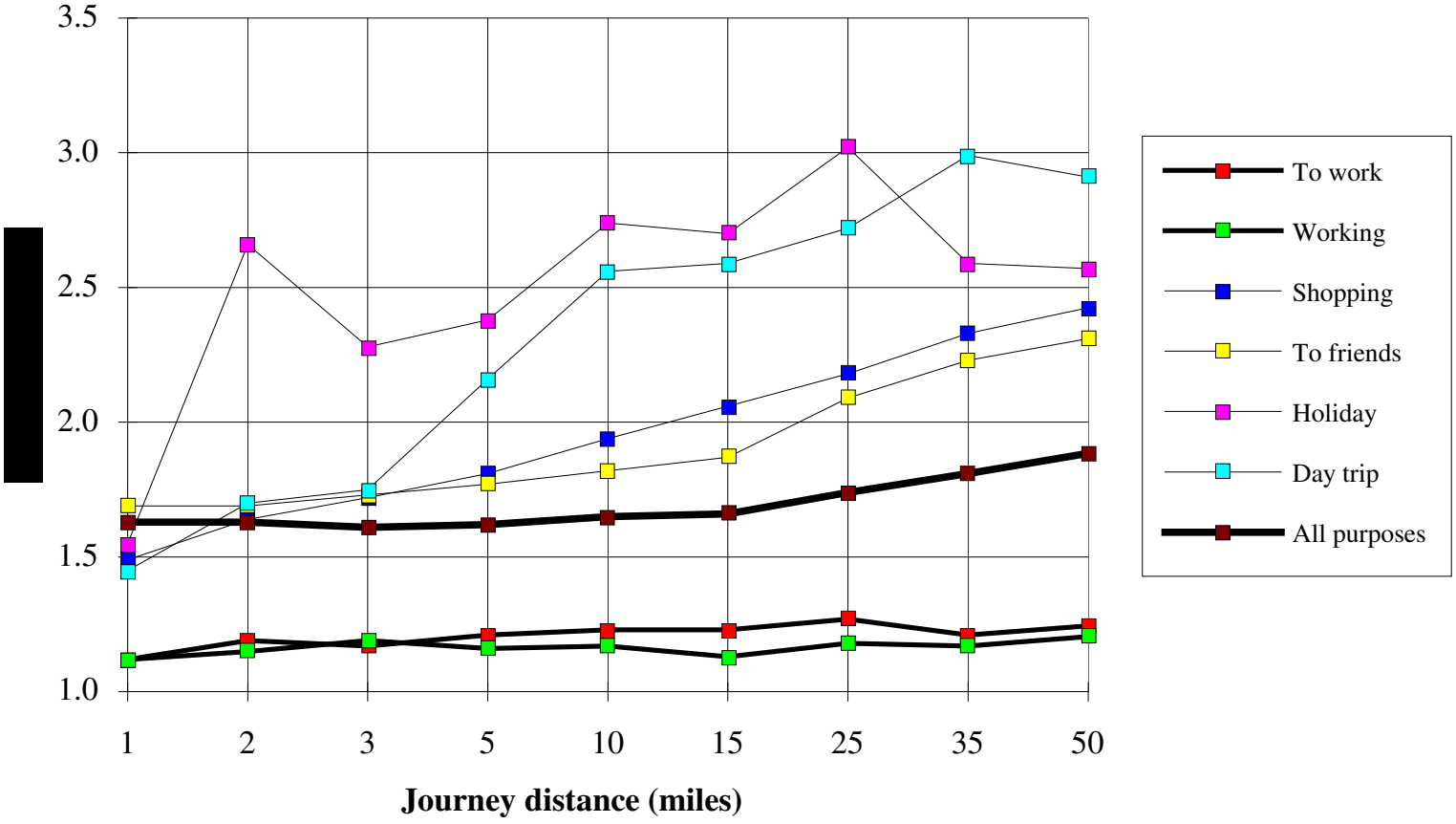
SENCO

Passenger transport: carbon emission by car performance



SENCO

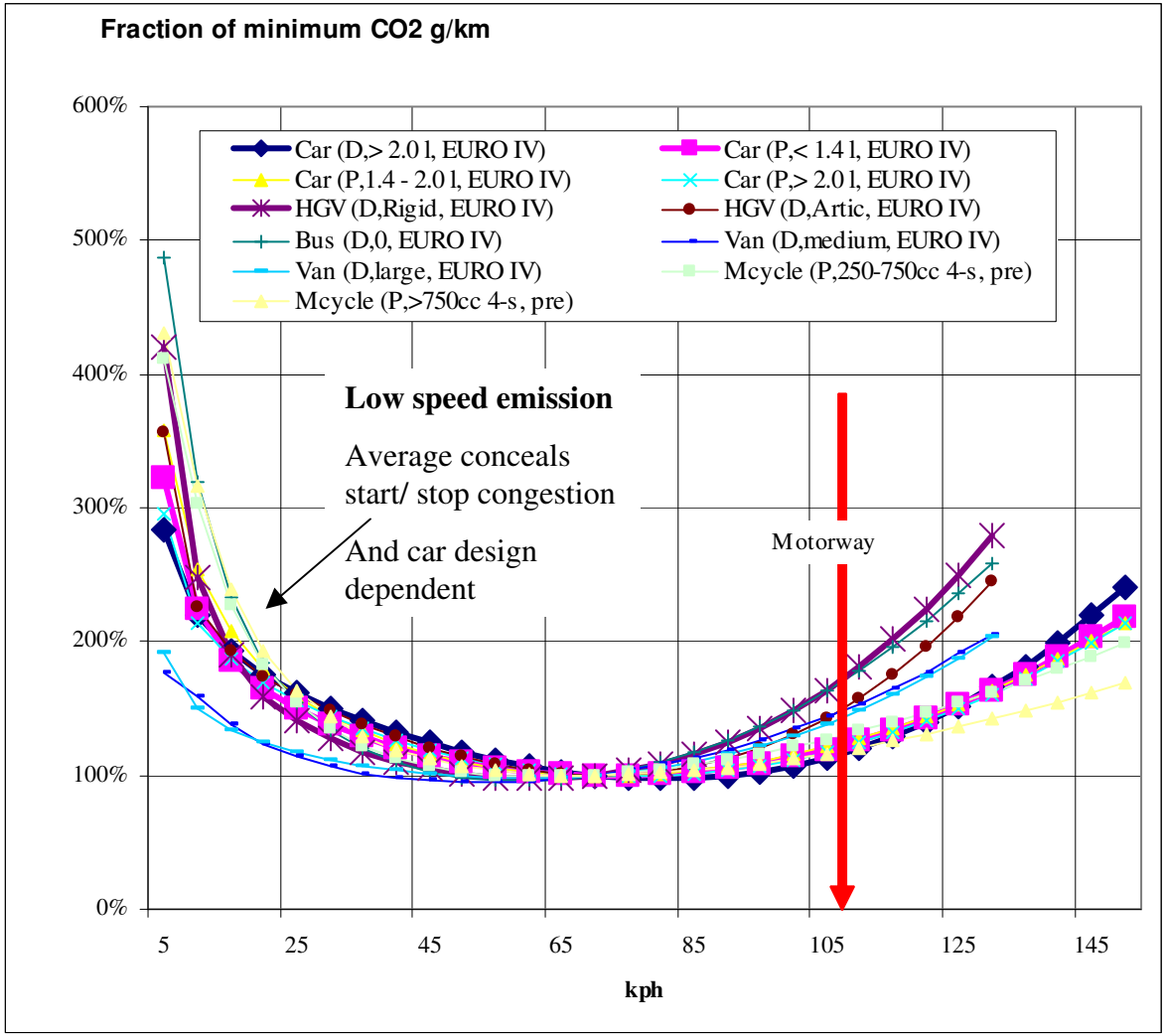
Passenger transport: car load factor by journey distance



Transport: road speed and CO2 emission

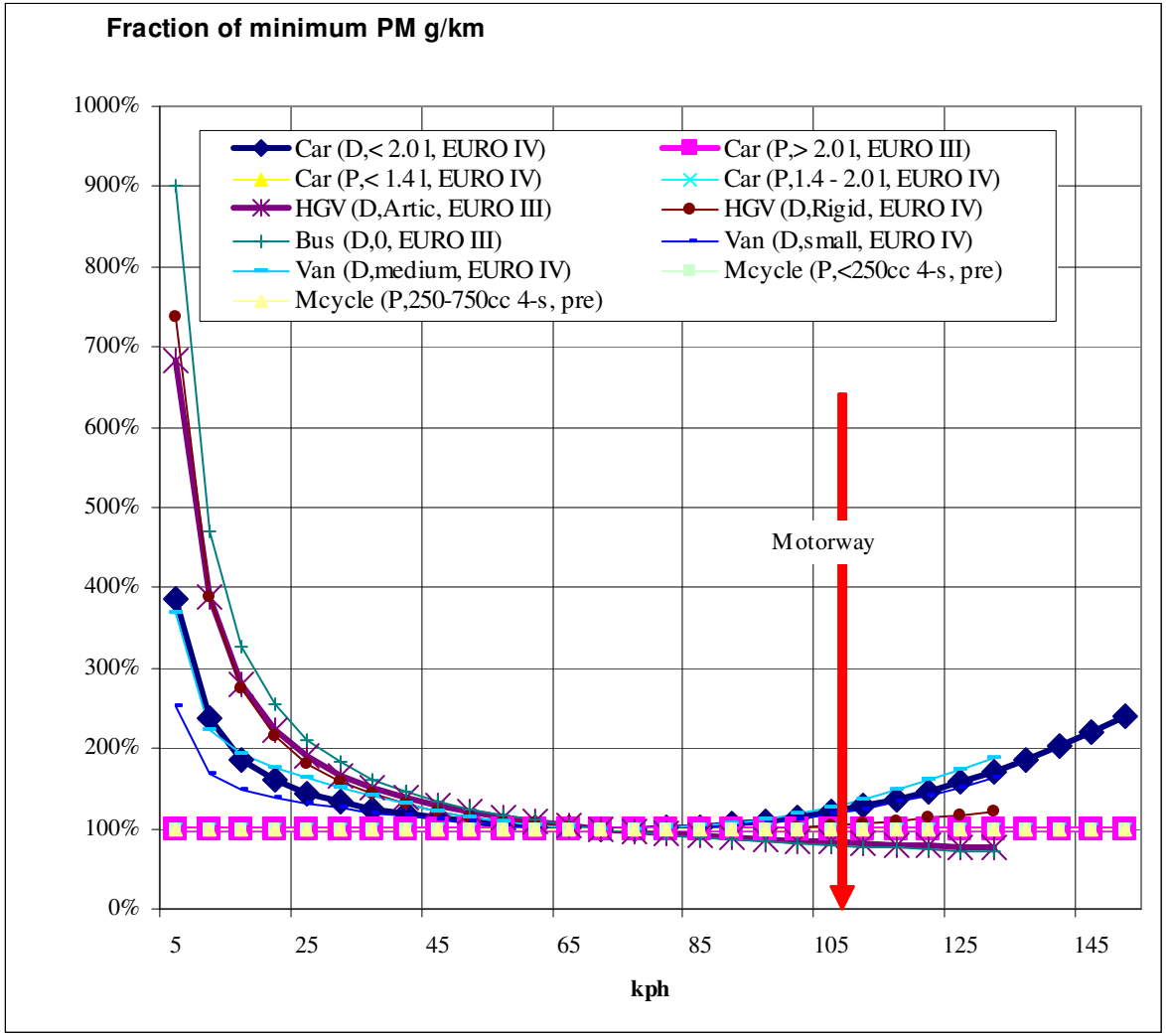
Note: Only applicable to current internal combustion vehicles. Curves for other pollutants generally similar, because emission strongly related to fuel consumption.

Characteristics of future vehicles (e.g. urban internal combustion and electric powered) would be different. Minimum emission would probably be at a lower speed, and the fuel consumption and emissions at low speeds would not show the same increase.



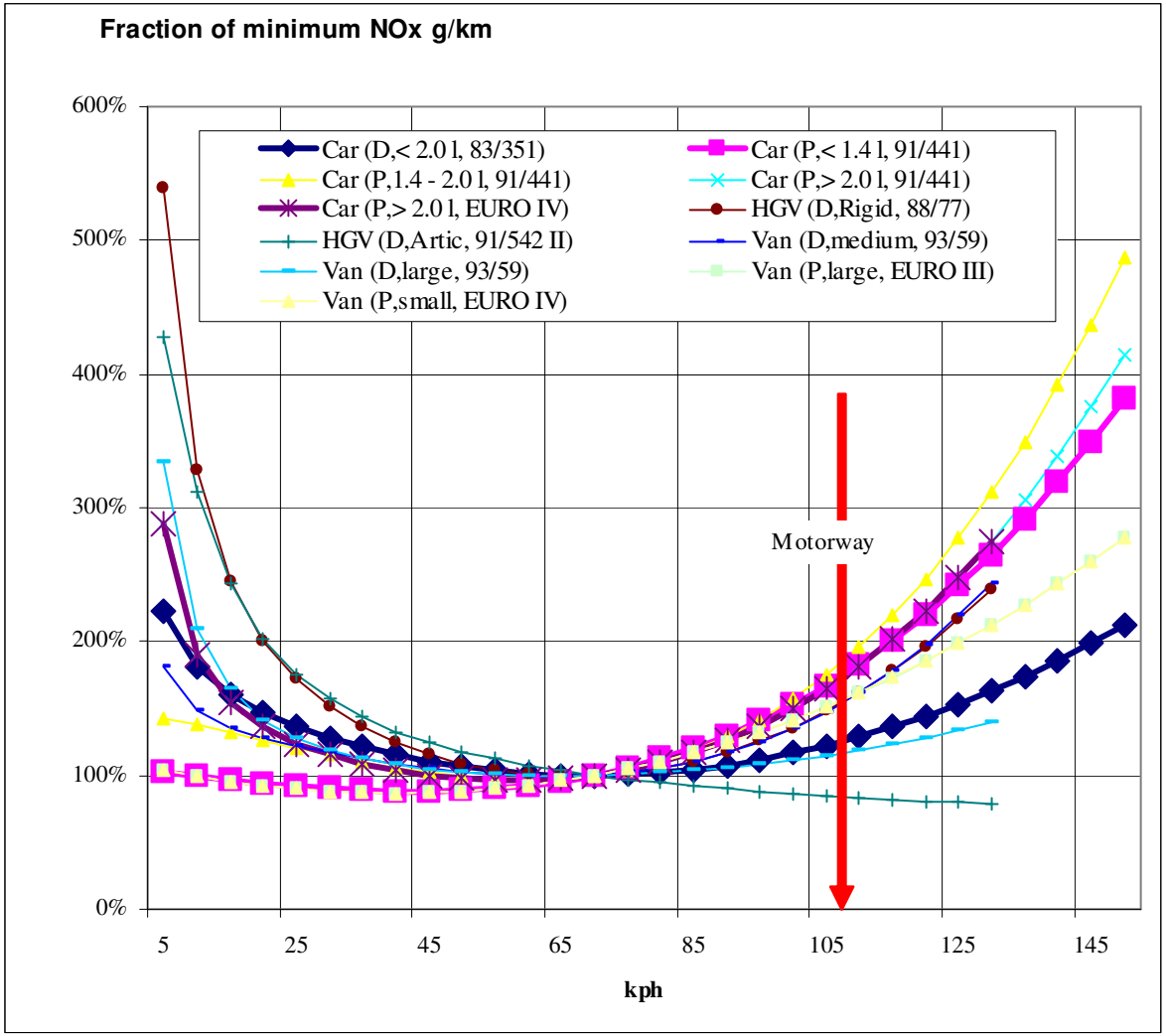
SENCO

Transport: road speed and PM emission



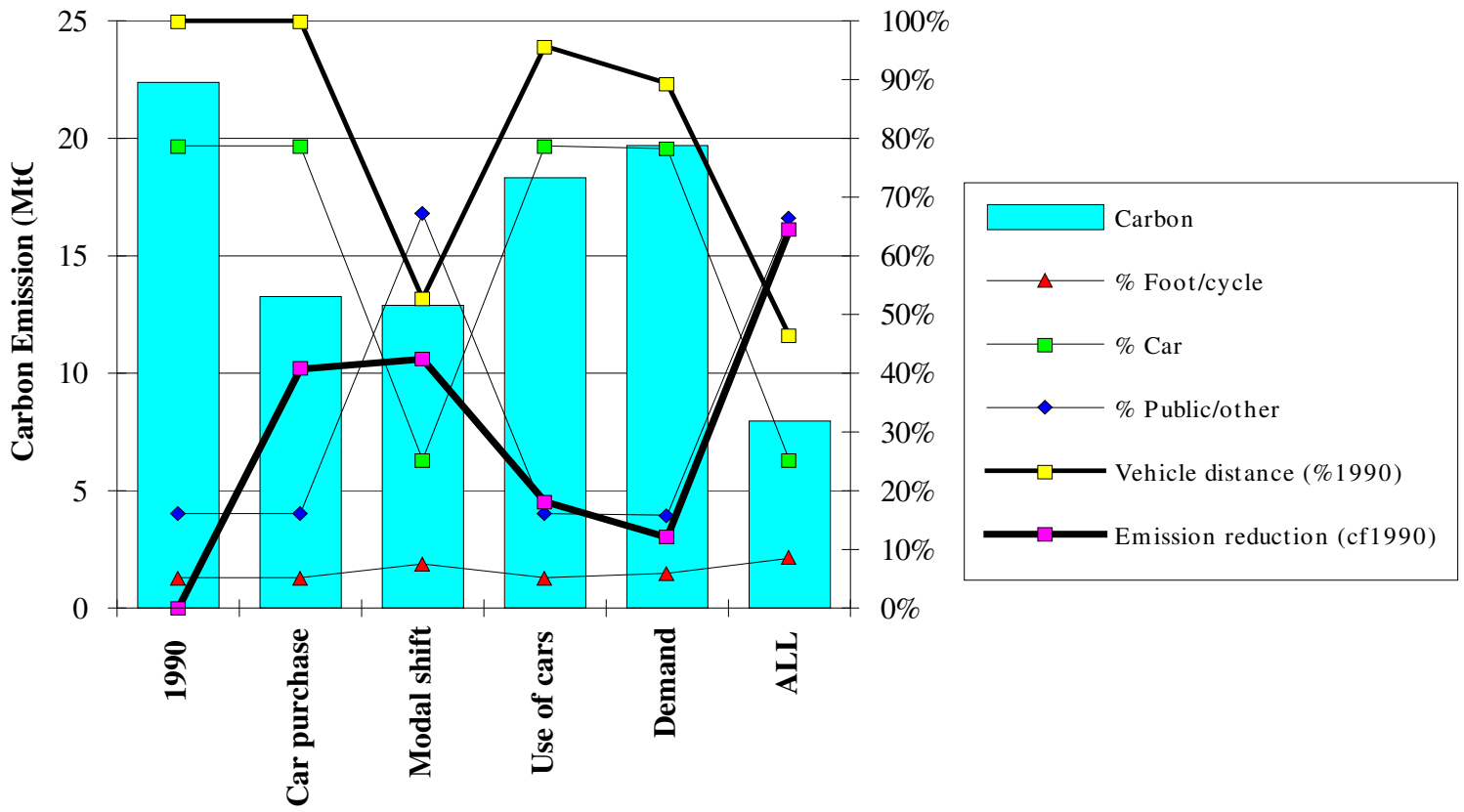
SENCO

Transport: road speed and NOx emission



SENCO

UK passenger transport: carbon emission saving with NTM



SEEScen: Society, Energy, Environment Scenario model

SENCO

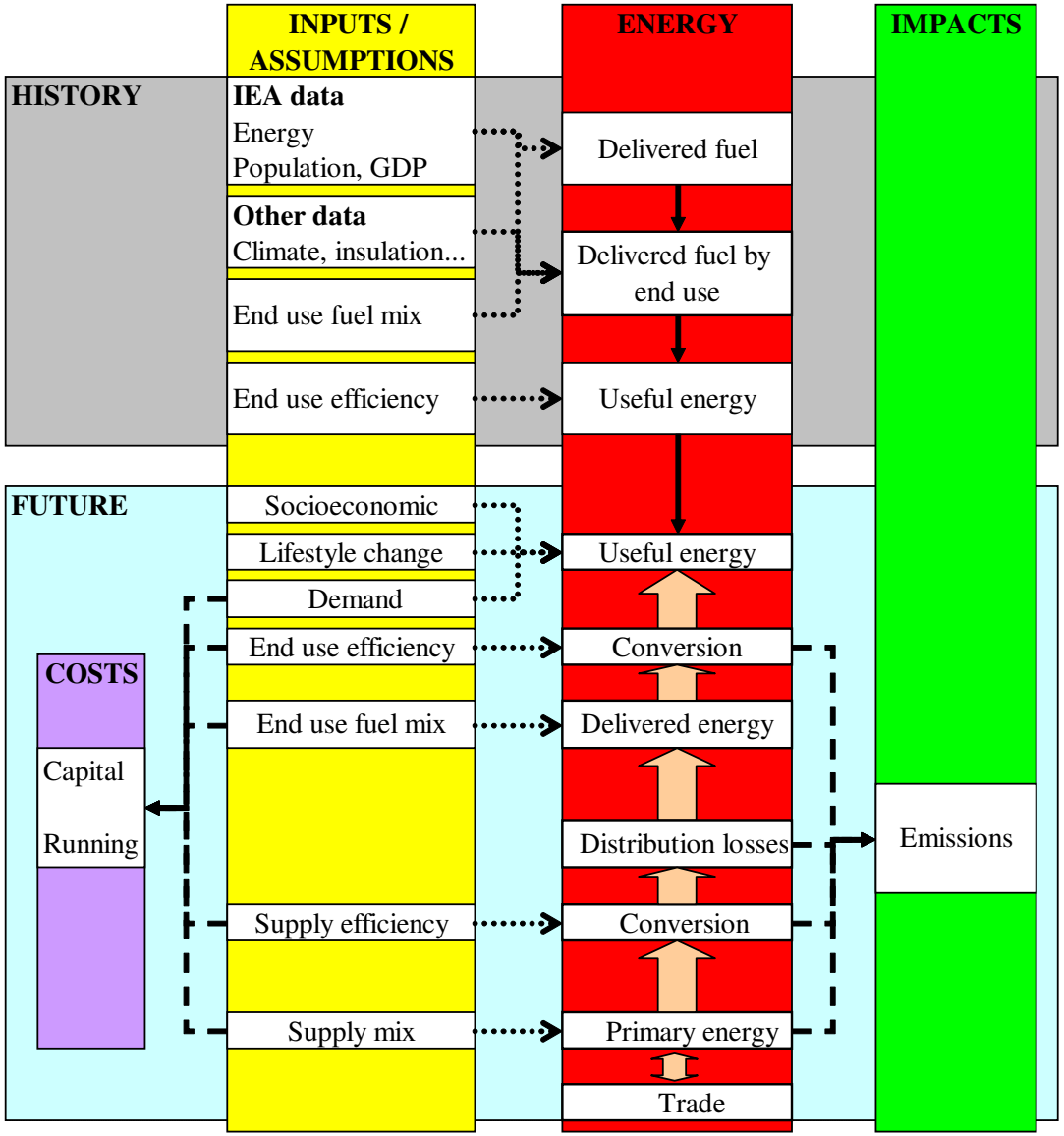
Applicable to any large country having IEA energy statistics

Method

- Simulates system over years, or hours
- Optimisation under development

Scenarios

- Base/Kyoto
- Carbon15
- LifeStyle
- Tech High
- Tech Lifestyle



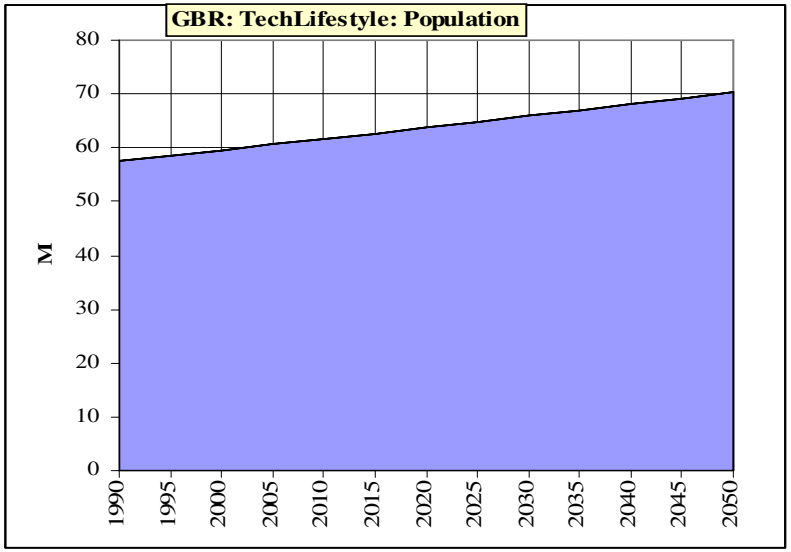
Consumption: SEEScen : Energy services and demand drivers

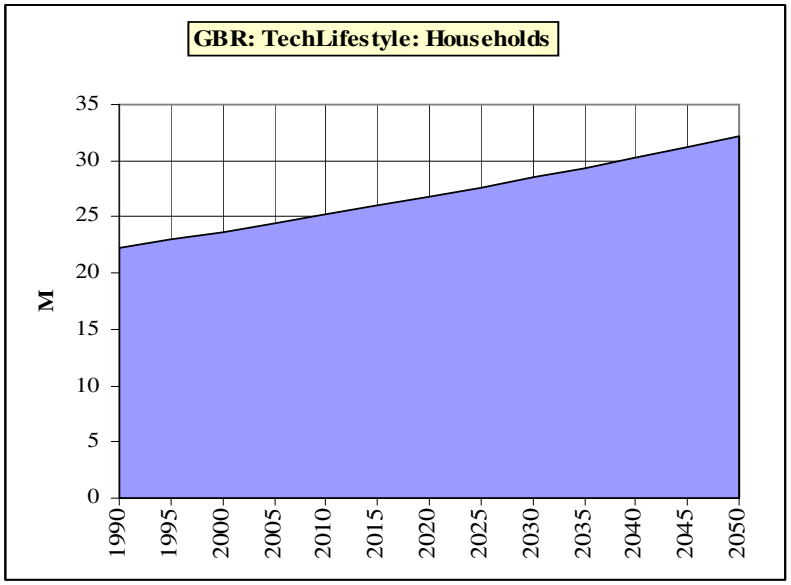
SENCO

- Demand for energy services determined by human needs, both basic and cultural
  - food
  - comfort, hygiene, health
  - culture

- Population increases
- Households increase faster because of smaller households

- Wealth increases, but energy consumption and impacts depend on choices of expenditure on goods and services somewhat arbitrary

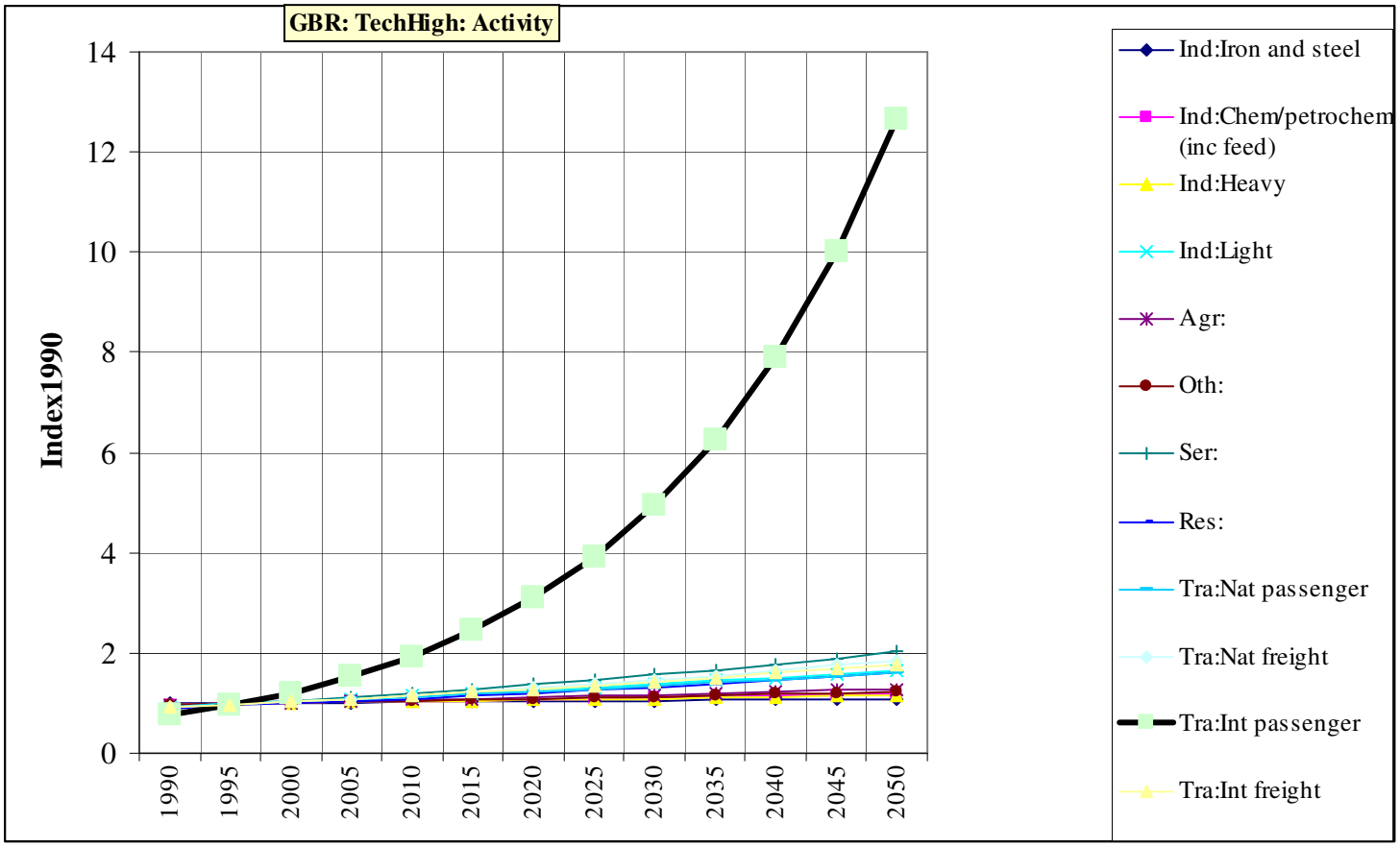




Consumption: SEEScen : Demand growth

SENCO

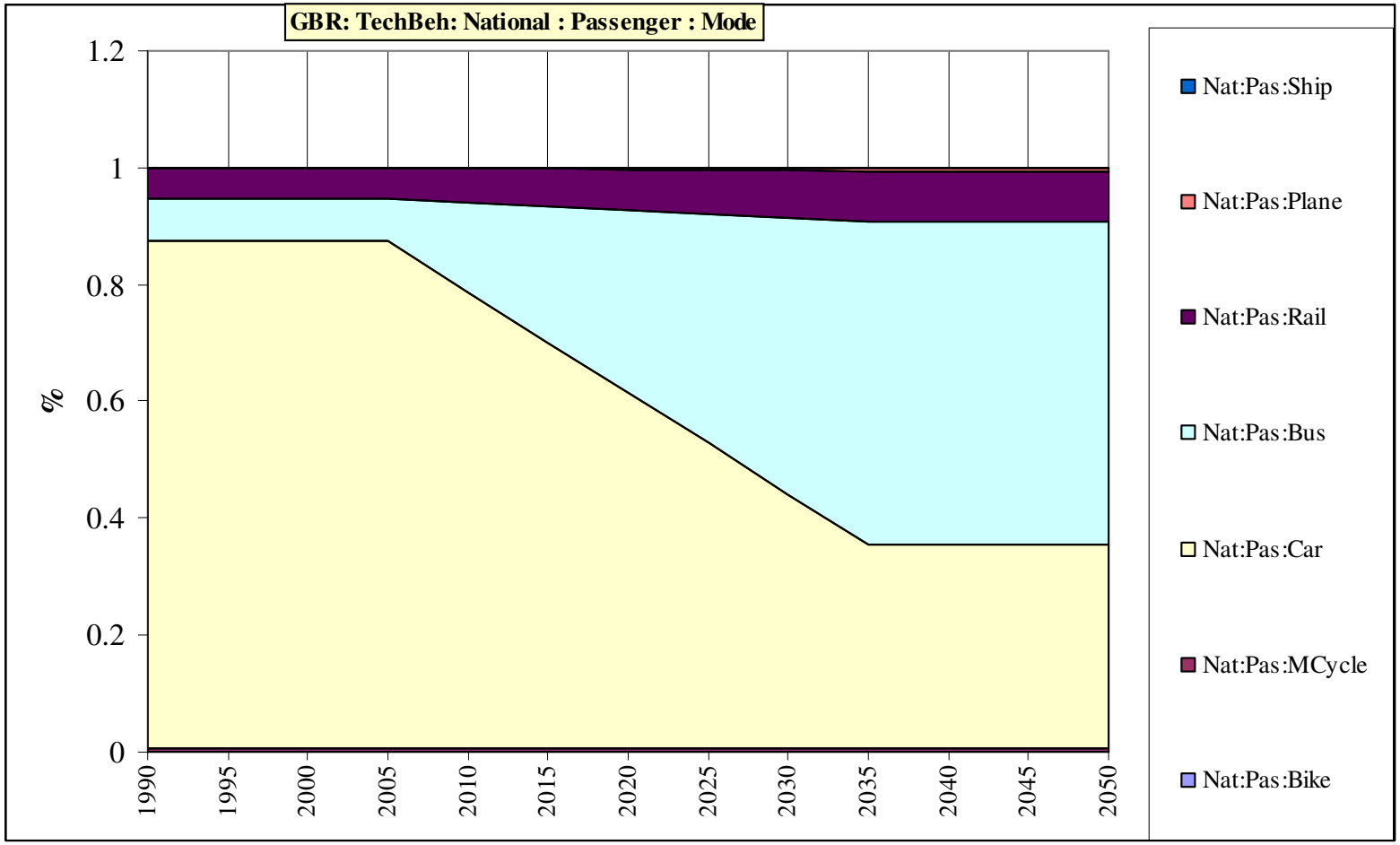
- Growth assumed in all sectors assumed to follow from drivers
- Fastest growth in international aviation



Transport, national: passenger mode

SENCO

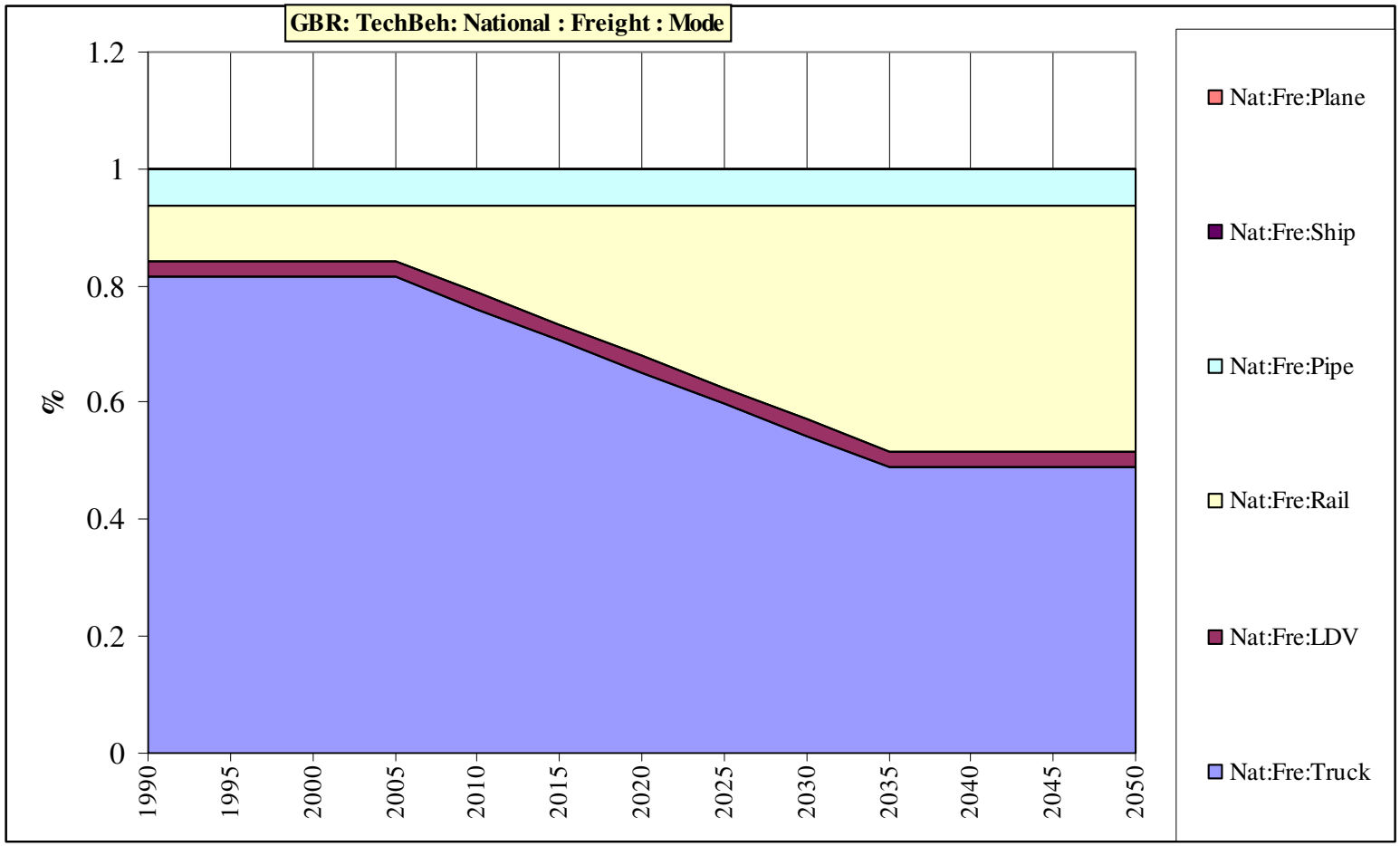
Shift from car to fuel efficient bus and train for commuting and longer journeys.



Transport: national : freight mode

SENCO

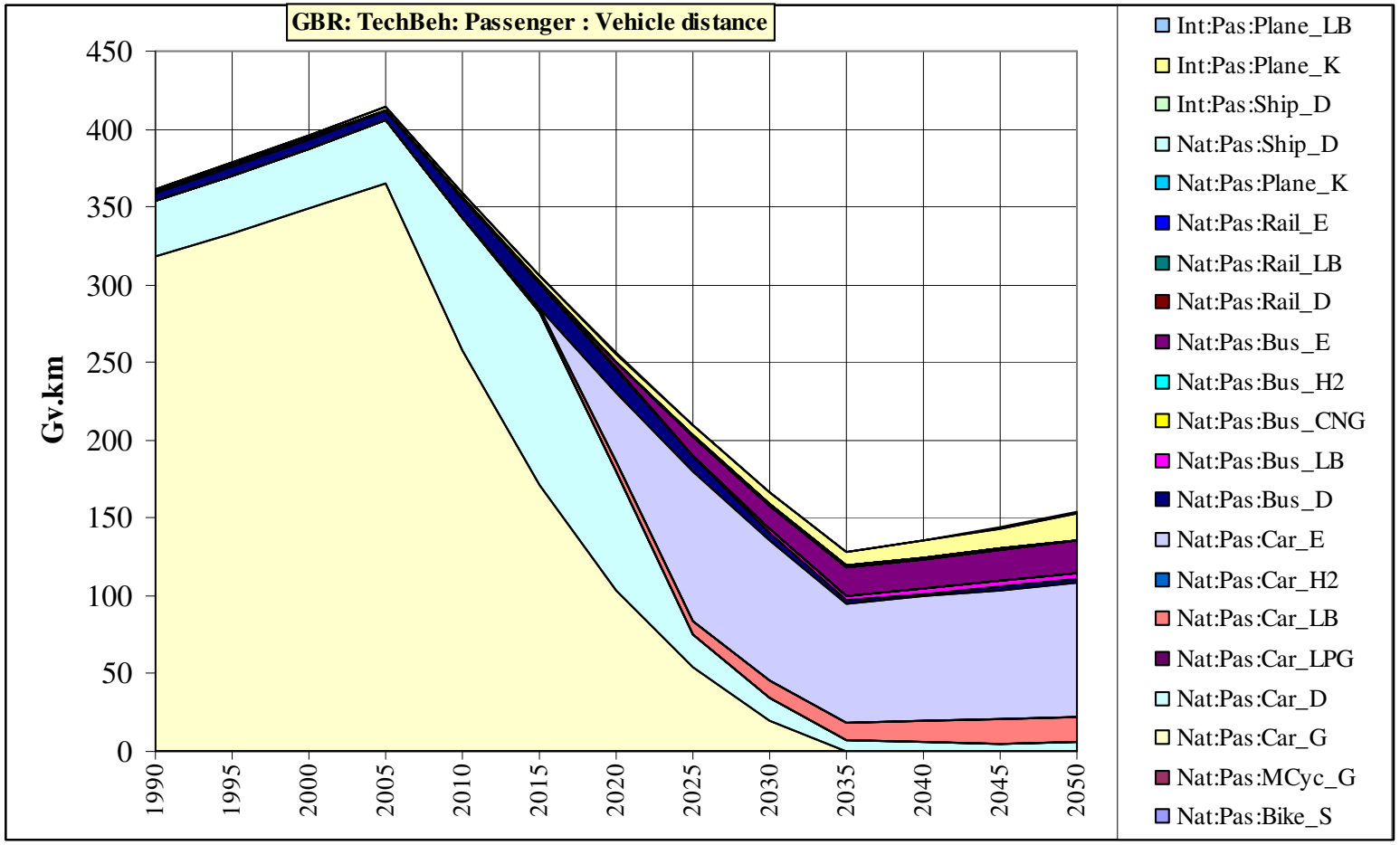
Shift from truck to rail. Currently, no assumed shift to inland and coastal shipping.



Transport: passenger vehicle distance

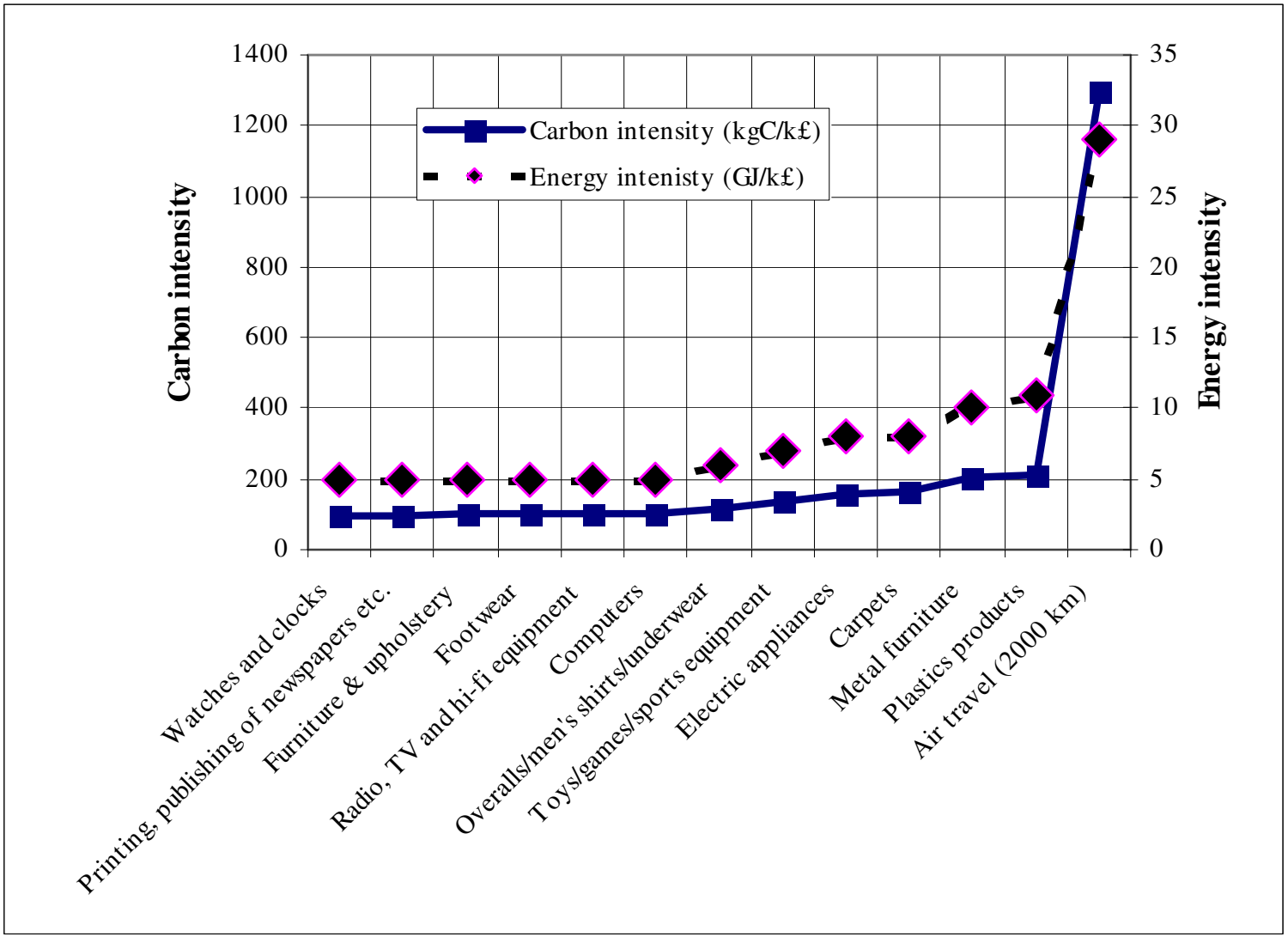
SENCO

A large reduction in road traffic reduces congestion which gives benefits of less energy, pollution and travel time.



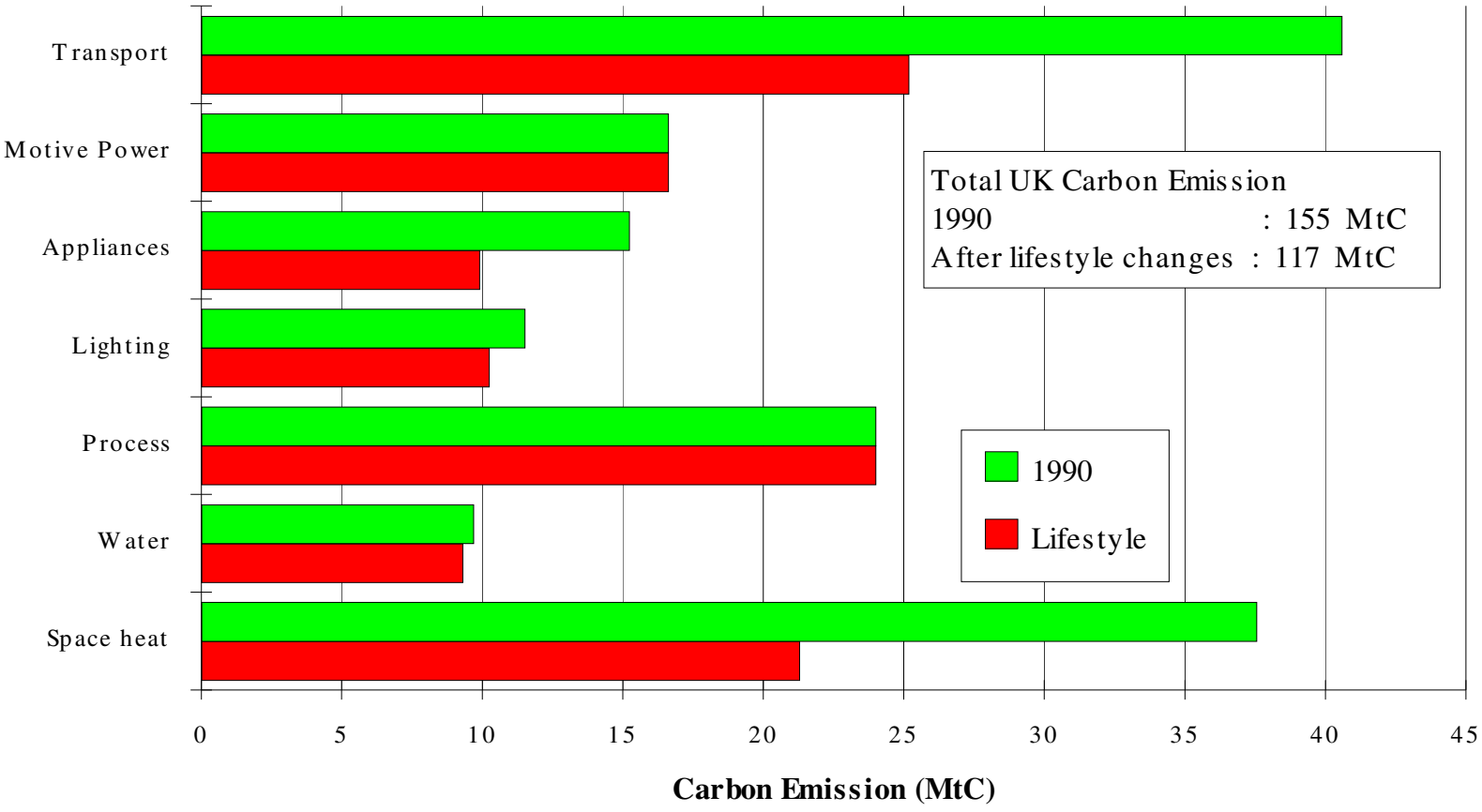
Consumption: carbon and energy intensity of commodities

SENCO



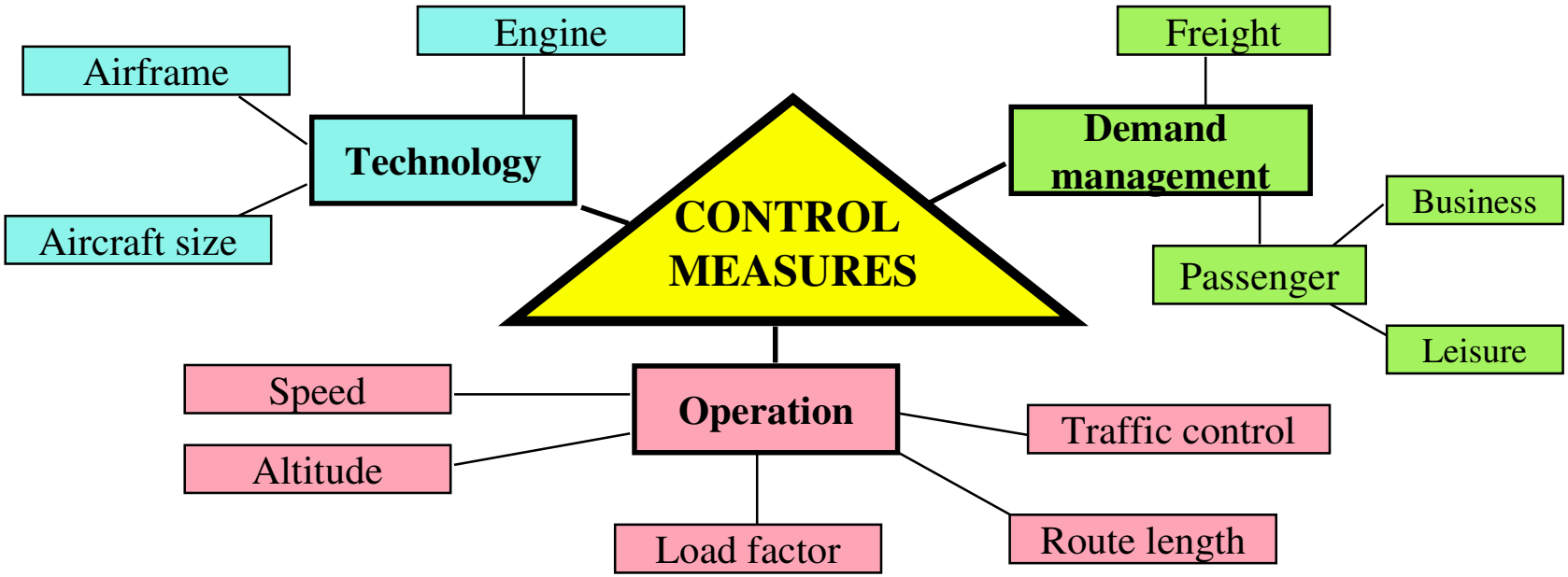
UK: Carbon reductions through NTMs

SENCO



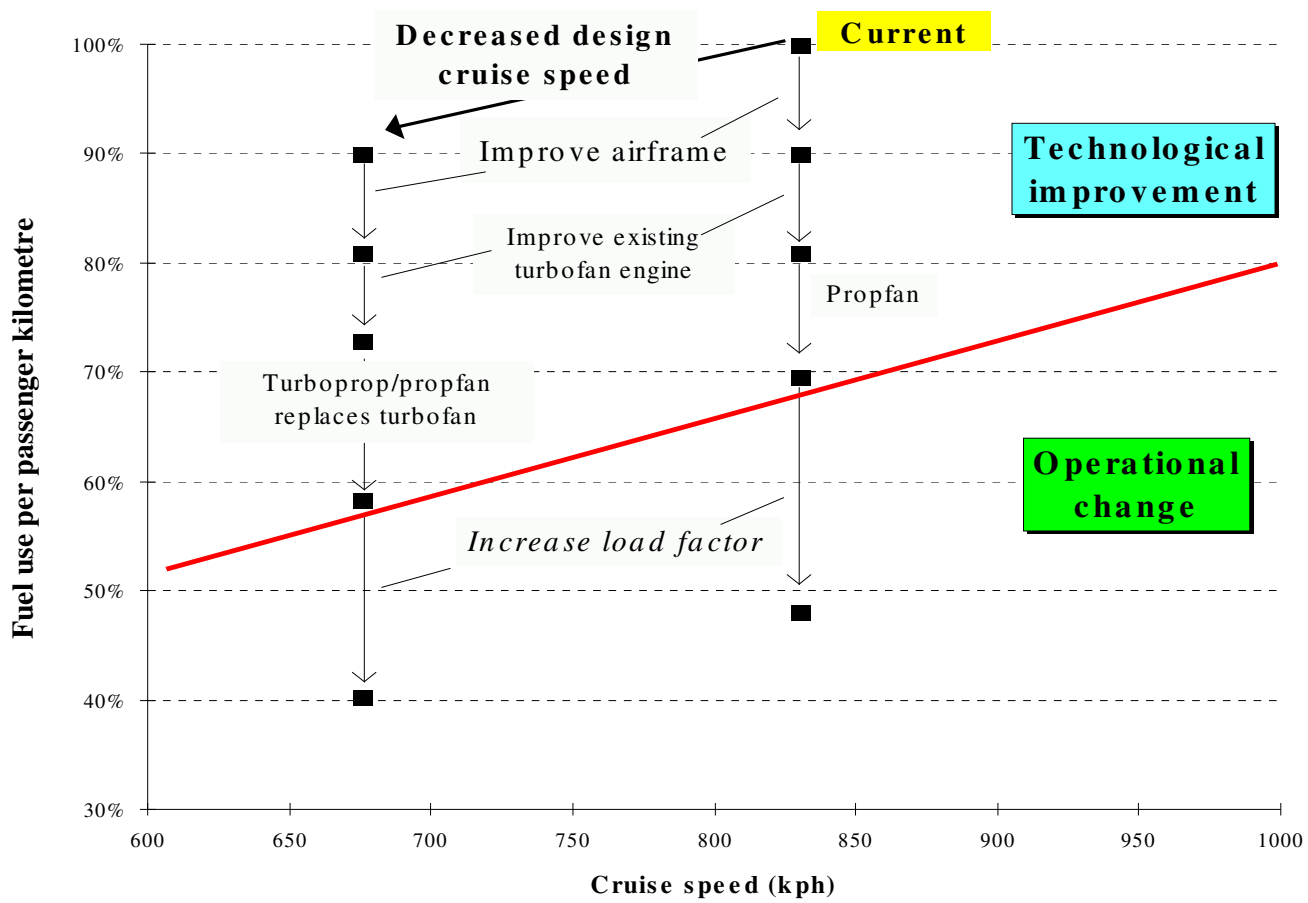
Aviation: control measures

SENCO



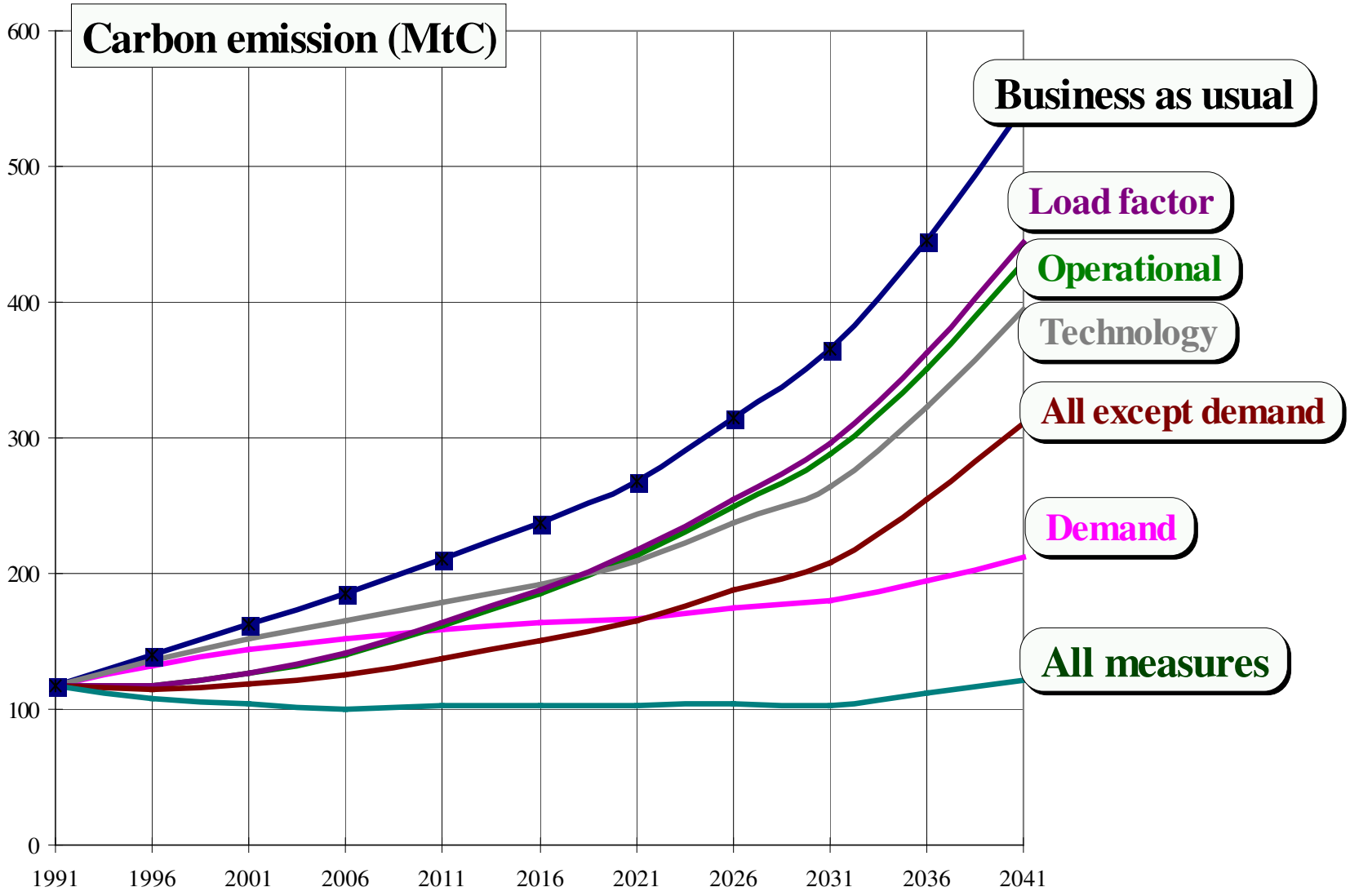
Aviation: effects of technical and operational measures

SENCO



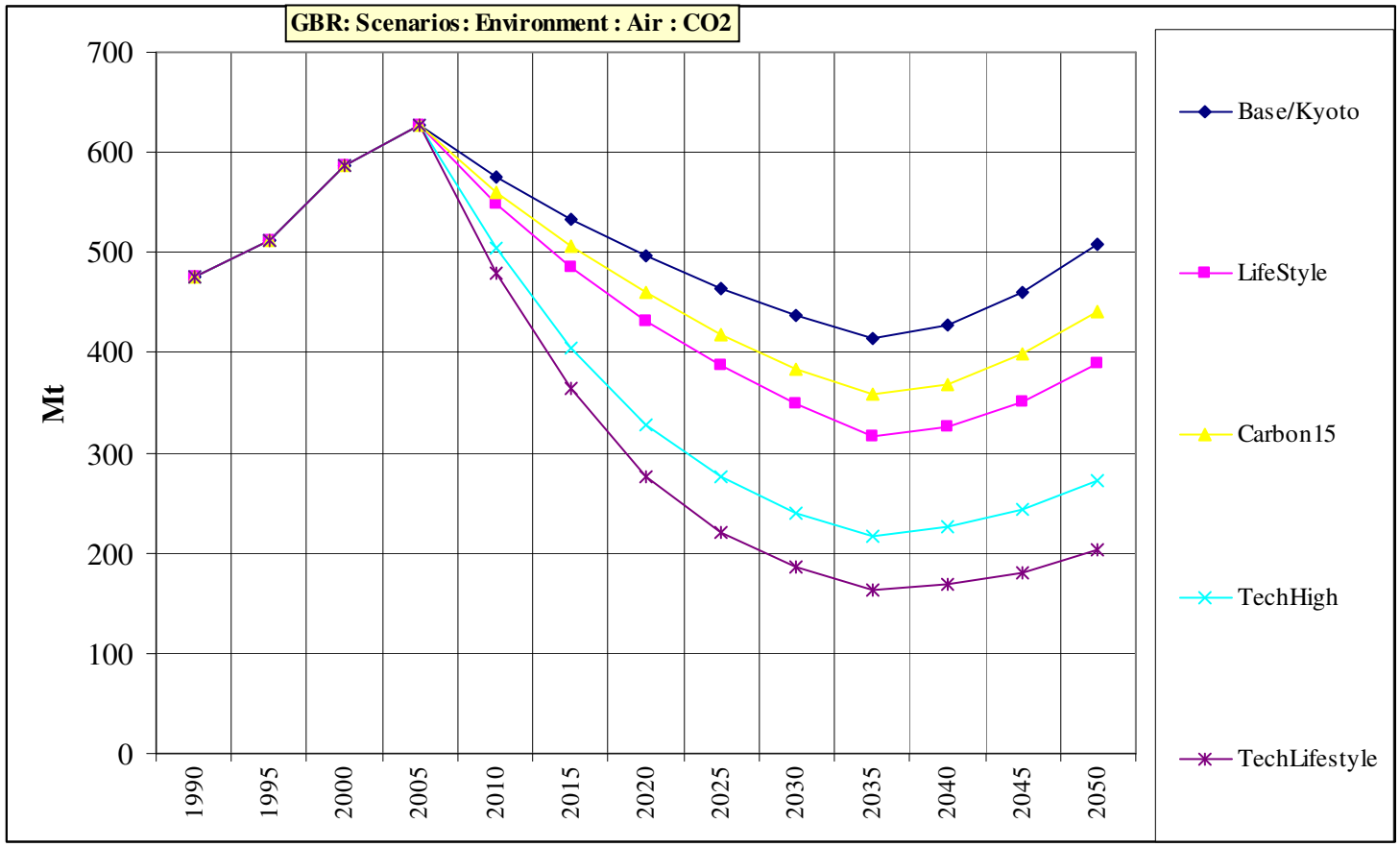
Aviation scenarios

SENCO



Environment: CO2 emission by scenario

SENCO



Non-Technical Measures: summary of use as policy options

NTMs have these advantages, they:

- can have a significant and rapid effect on emissions
- do not assume speculative technological development
- often do not have negative environmental side effects
- can have low or net negative direct costs

NTMs have disadvantages, they:

- require visible changes in behaviour that will generally be resisted by consumers, whereas most technical emission control measures (catalytic converters, loft insulation) are virtually invisible to the consumer
- TMs, if based on standards, have a fairly predictable easily calculated effect on future emissions. NTMs are more uncertain.
- have indirect costs that are difficult to quantify

Indirect cost calculation

- Net direct costs (capital and running) of NTMs often negative
  - small cars cost less than big ones
  - driving more slowly saves money

- Why don't people realise these savings?
  - they don't realise cost savings and therefore make economically sub-optimal choices?
  - they attach a value to car size and speed?

- How can this value be imputed?
  - from cost savings foregone
  - with willingness-to-pay (WTP)

Energy, emission and cost calculation

Changes to energy demand, whether by TM or NTM, cause multiple, interdependent changes to the energy supply system, so it is problematic to assign energy, cost and emission saving to any single measure.

- **Non-additive.**
  - E.g : choosing smaller cars reduces emission by x, and, independently, lowering motorway speed reduces emission by y, then the combined effect will be less than x+y.
- **Multiple effect.**
  - E.g : switching from petrol cars to diesel bus and train
    - reduces petrol car emissions and increases diesel bus and train emissions
    - reduces road congestion, and therefore emissions from all road vehicles
    - reducing liquid fuel consumption will reduce refinery emissions
- **Wider system impacts.**
  - Congestion of transport infrastructure
  - Electricity demand patter and generation mix

Modelling approach, conceptual and practical problems: model integration

SENCO

These interconnected aspects of NTMs have implications for modelling approaches.

- To integrate NTMs into a model depends on the structure of the model, the processes and linkages it incorporates, and its databases.
- No general model (RAINS/GAINS, PRIMES, SEEScen, ...) captures all of the detail required to assess NTMs; they have to be supported by sectoral models and other exogenous analysis.
- An approach:
  - Which sectors are most problematic for future emission control?
  - Estimate the potential of each NTM individually in terms of emission reduction, cost, political feasibility, etc.
  - Analyse multiple effects and interactions of NTMs.
  - Estimate the indirect costs (e.g. with WTP) and add to direct costs.
  - Fit the most promising NTMs into models so as to approximate the results of detailed analysis. Consistency must be ensured if there are multiple effects.

- In SEEScen, TMs and NTMs are assumed (mode, speed, load factor, etc.) and then the interdependent consequences are **simulated** with an interconnected system model. The direct costs of technologies, fuels and operation and maintenance are then calculated.

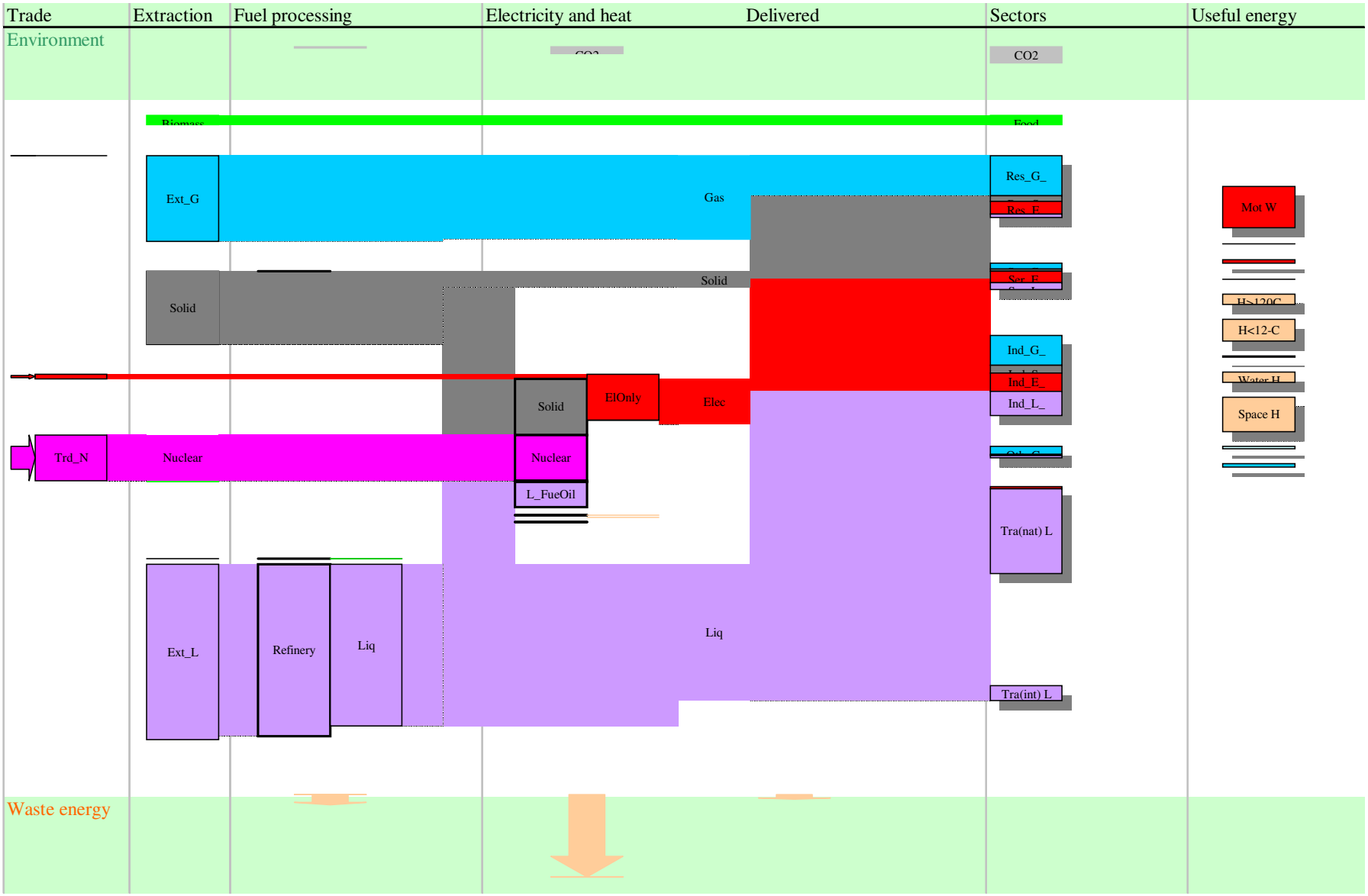
The effects of NTMs will depend on scenario context and country.

UK Energy flow chart: 1990

SENCO

GBR : TechBeh : Y1990

SENCO

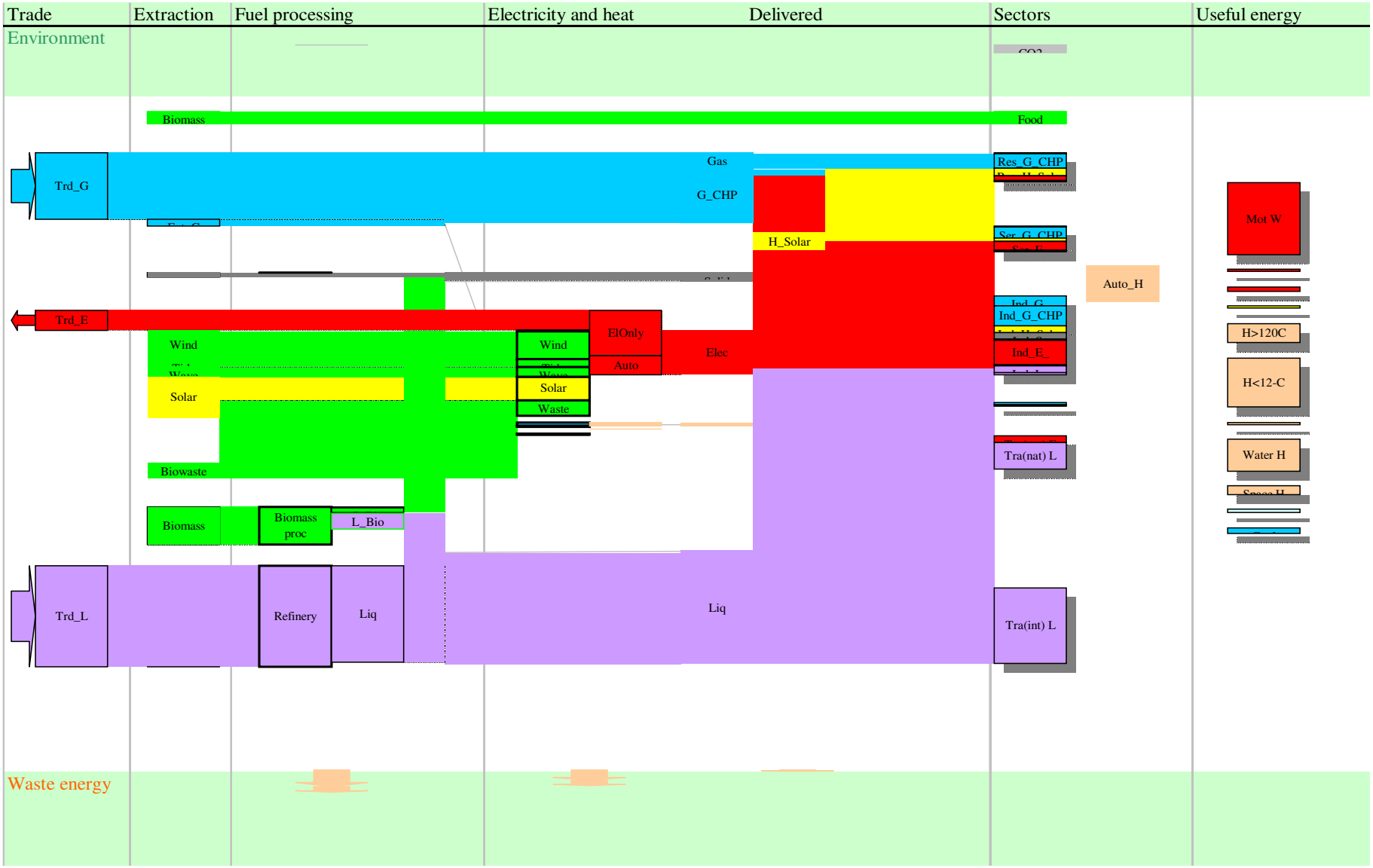


UK Energy flow chart: 2050

SENCO

GBR : TechBeh : Y2050

SENCO

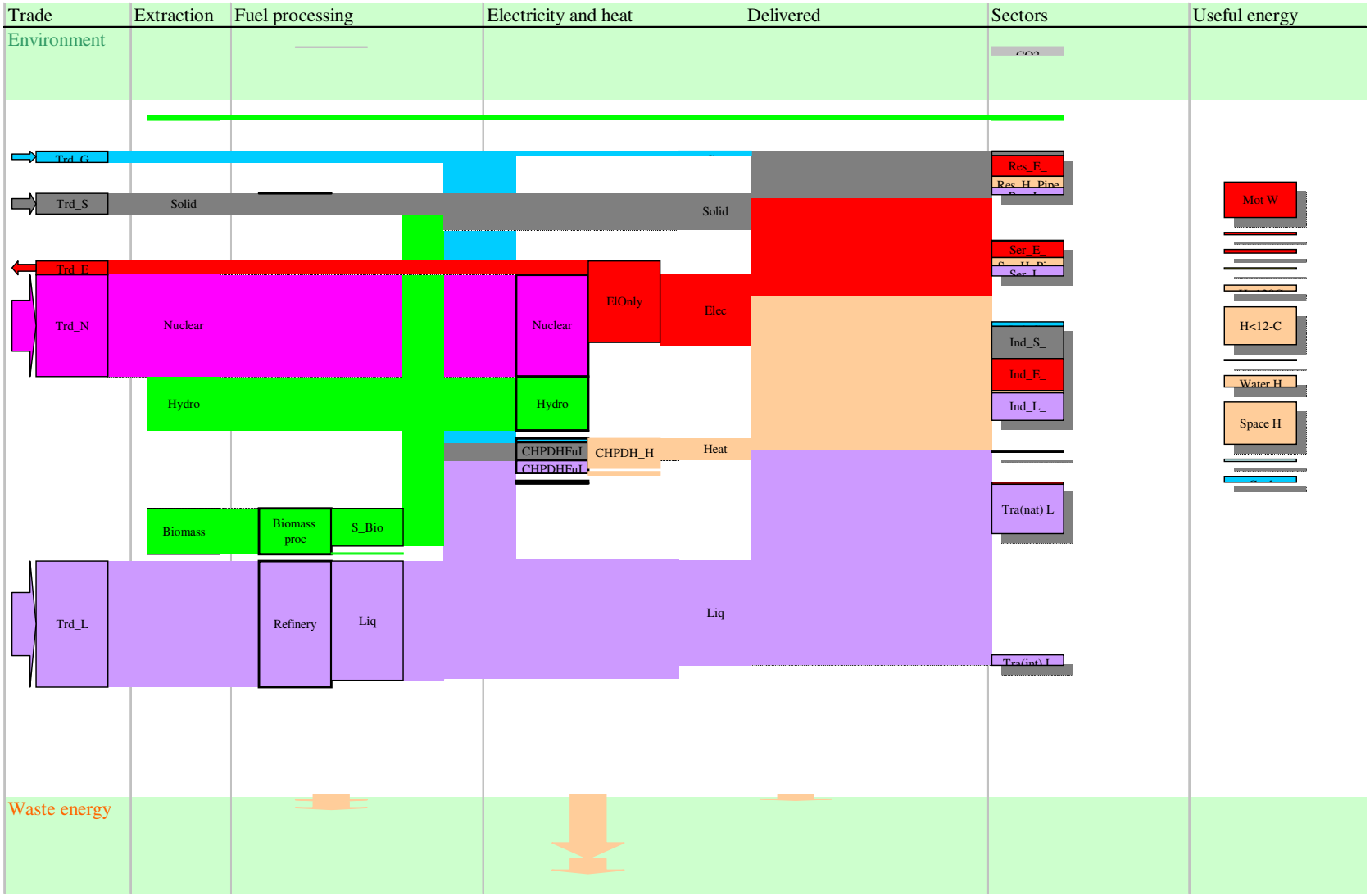


Sweden: energy flow chart: 2000 (approximate data)

SENCO

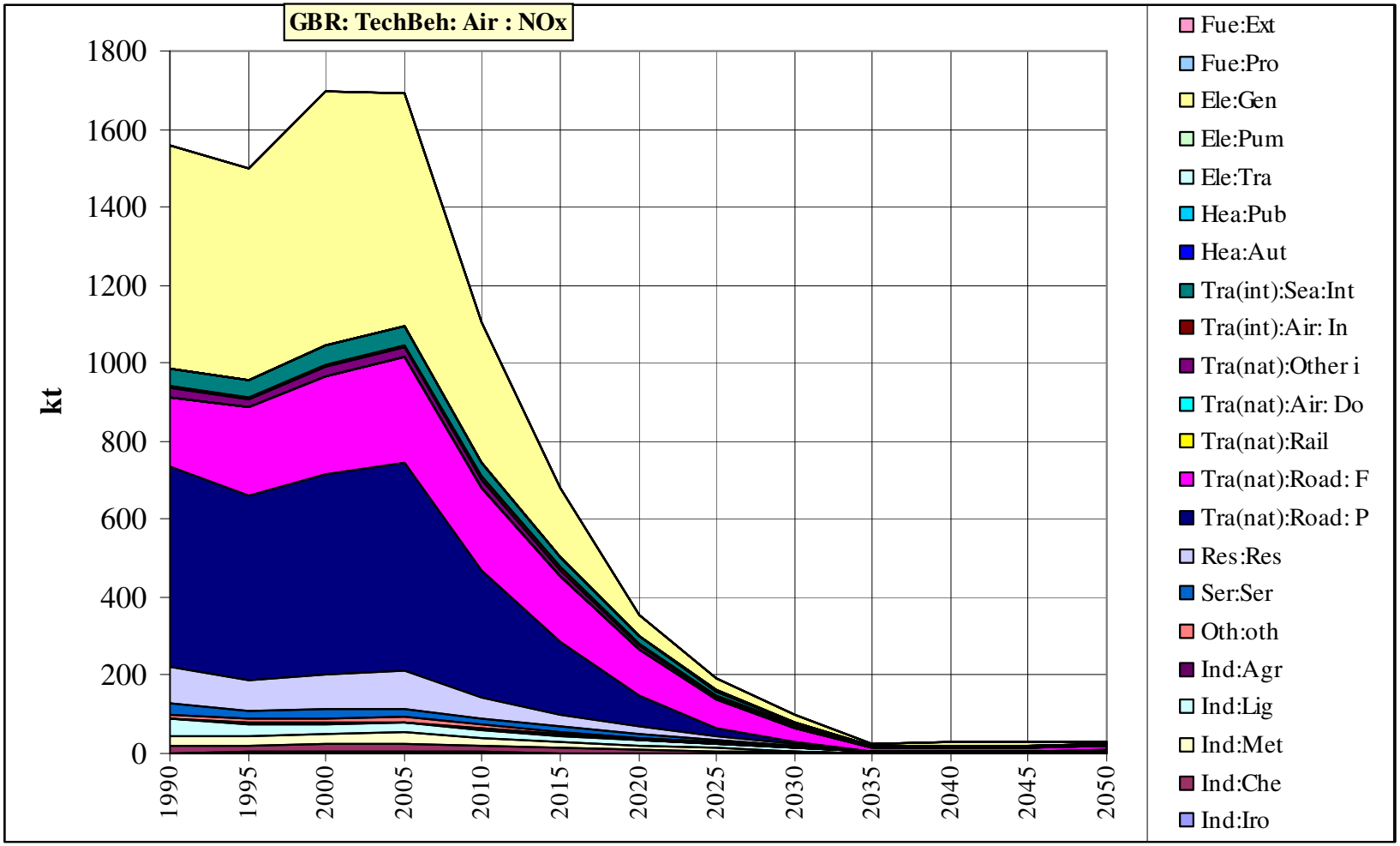
SENCO

SWE : TechBeh : Y2000



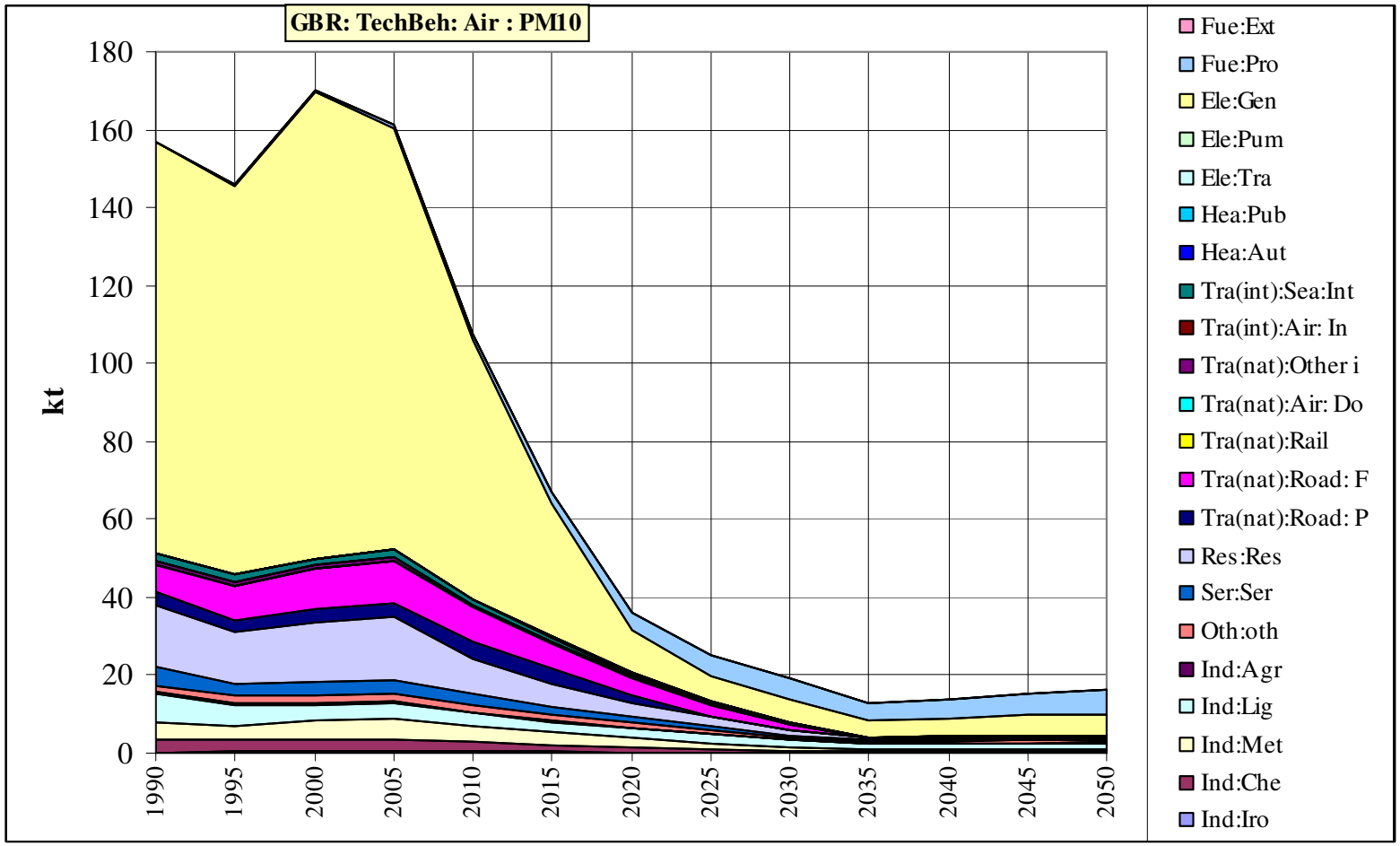
Environment: nitrogen oxides

SENCO



Environment: particulate matter

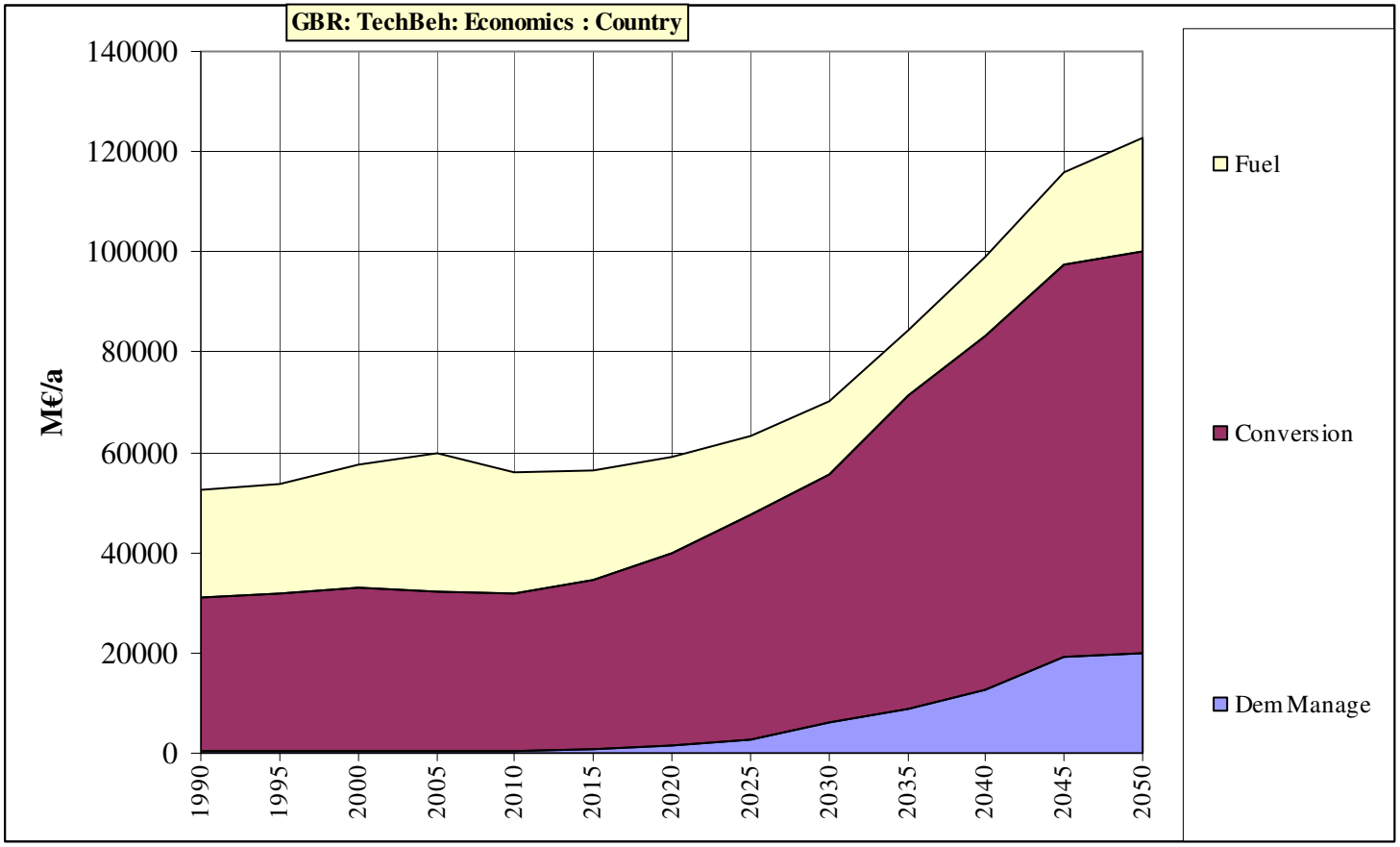
SENCO



Economics: TechBeh scenario annual costs of fuel, conversion and demand management

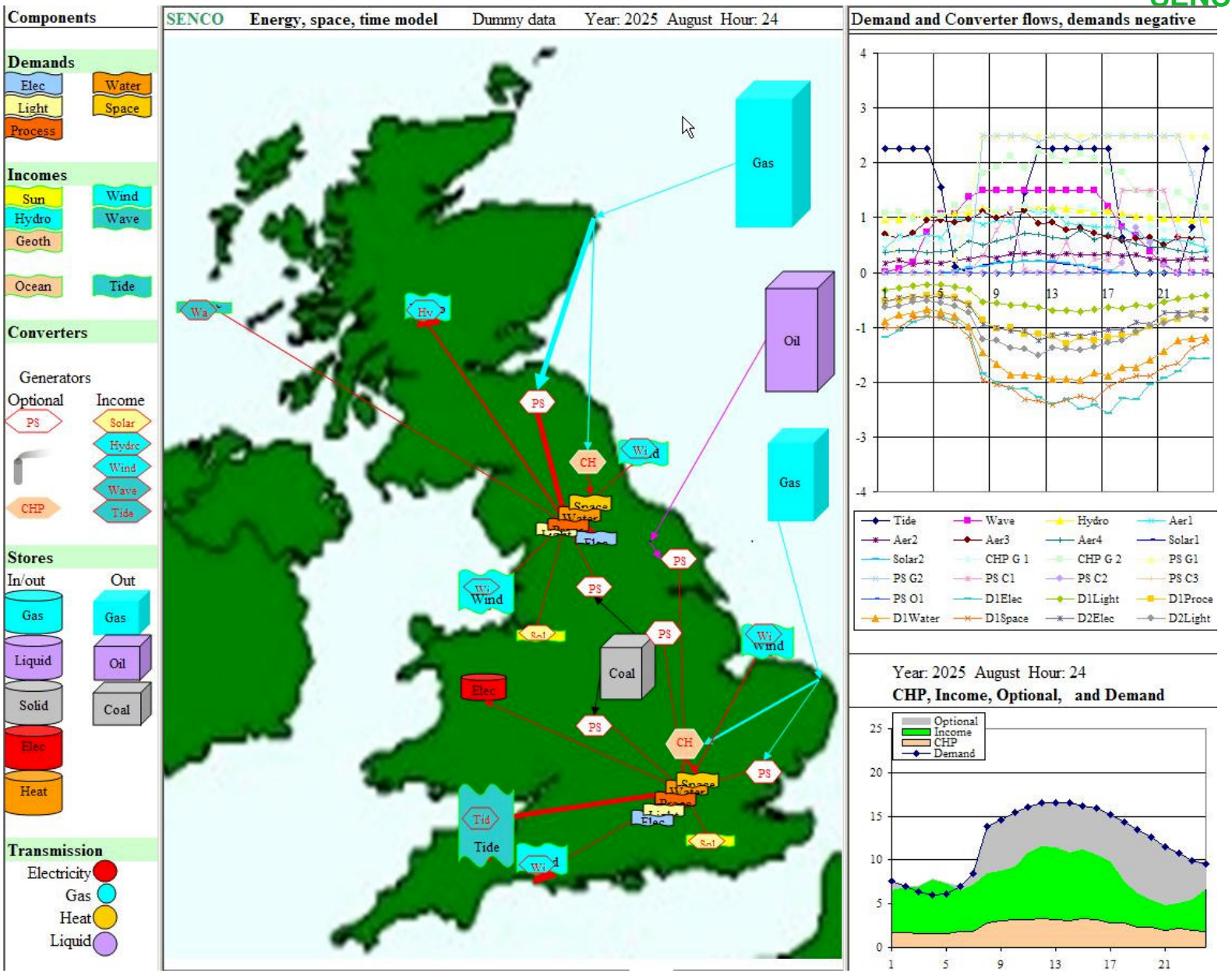
SENCO

The annuitised costs of each fuel, technology and demand management option are calculated for each of the end use and supply sectors. In the low demand scenario, the fraction of total cost due to converters (boilers, power stations, etc.) and demand management increases as compared to fuels.



UK energy, space and time illustrated with EST

SENCO

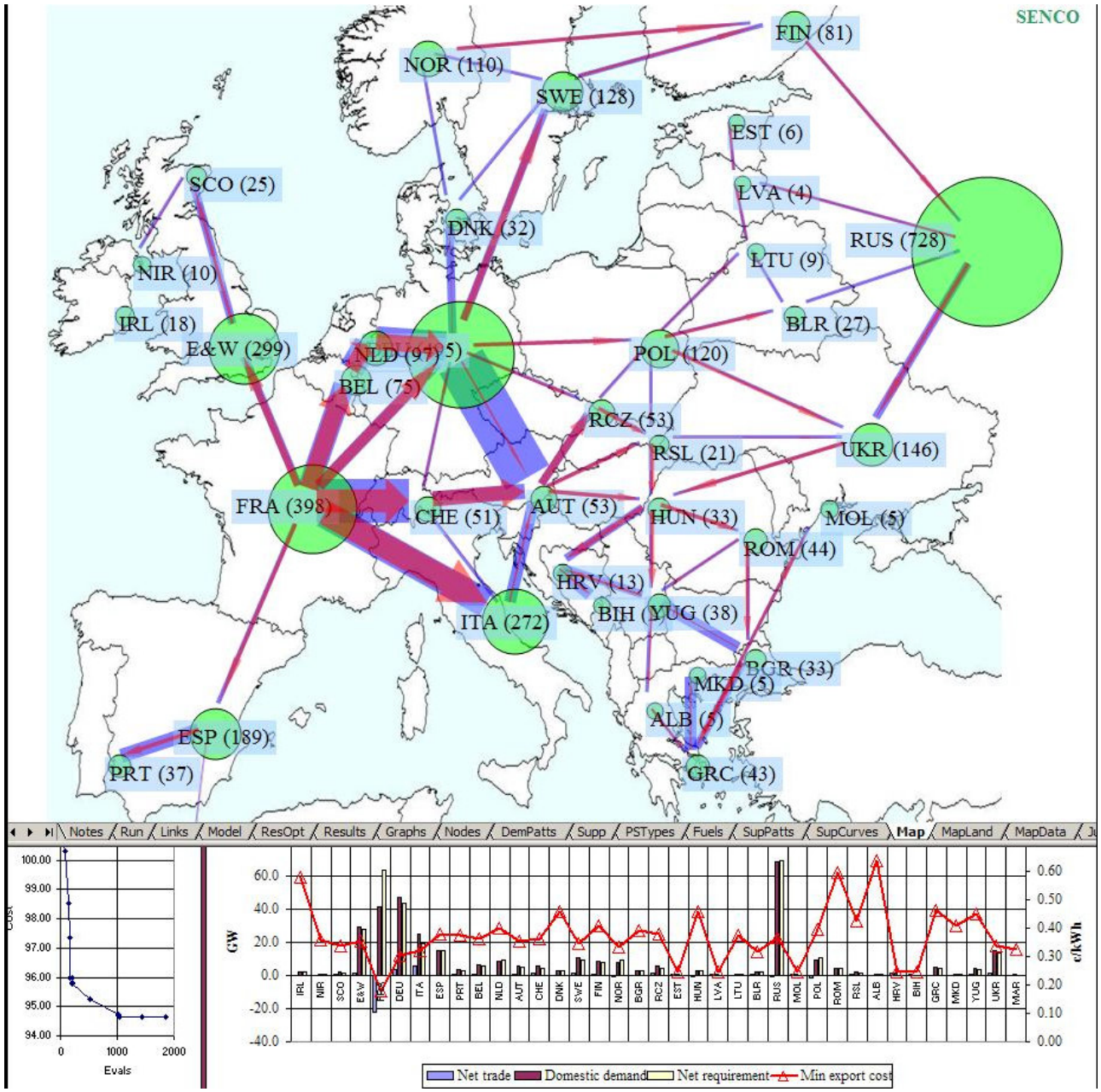


Electricity trade

- An extensive continental grid already exists
- Diversity of demand and supply variations across geographical regions
- What is the best balance between local and remote supply?

InterEnergy model

- Trade of energy over links of finite capacity
- Time varying demands and supply
- Minimise avoidable marginal cost
- Marginal cost curves for supply generated by model such as EleServe



Europe and western Asia – large point sources

SENCO

The environmental impact of energy is a global issue: what is the best strategy for reducing emissions within a larger region?