UCL Energy Institute

Urban transport modal shift: an energy systems approach

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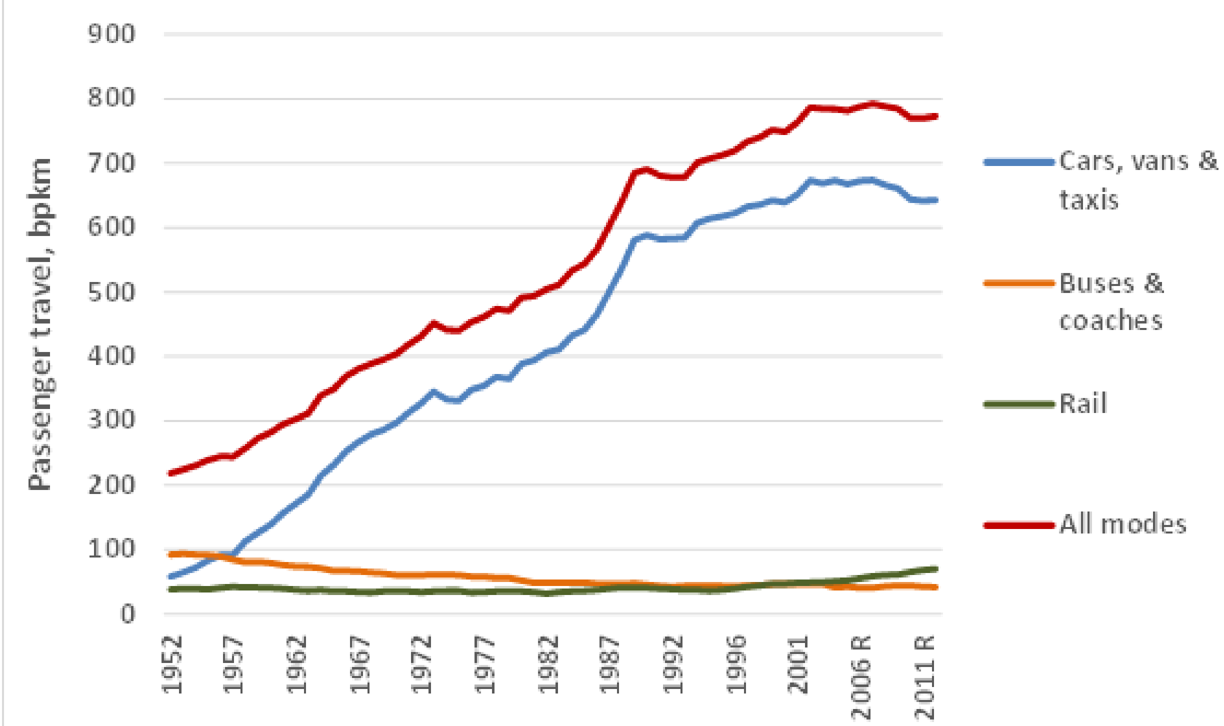
Passenger transport growth in the UK

- Growth in passenger km increased 4-fold in UK since 1950, driven by increased ownership and use of cars
- No question of positive benefits…….but also negative environmental impacts



Source: Transport Statistics Great Britain 2013

Going beyond technology: the need for behavioural representation

- A move to more sustainable transport systems will depend on consumer choices
- Schäfer (2012) highlights a deficit of behavioural representation in many E3-type models
  - Elastic transportation demand
  - Endogenous mode choice
  - Choice of no physical travel
  - Accounting for infrastructure capacity
  - Segmenting urban and intercity transport
- Daly et al. (2014) demonstrate an approach to incorporating modal shift in a TIMES model; this paper builds on that approach

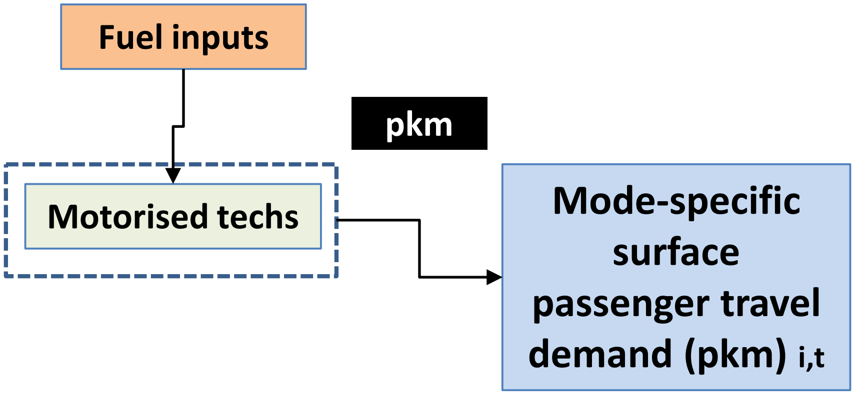
How to represent urban modal shift?

- We want to consider the following –

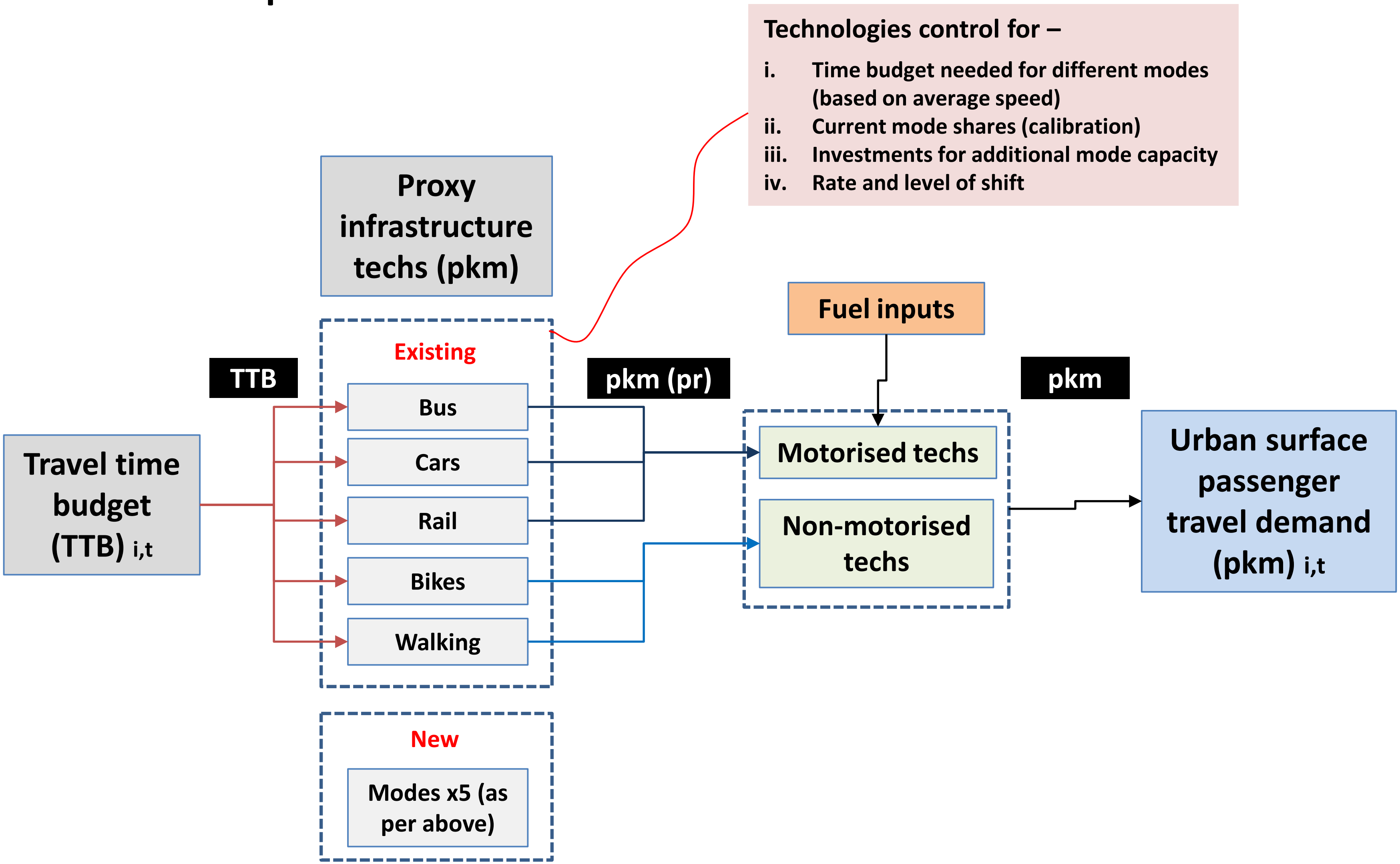
1. **Demand:** focus on shorter trips in urban areas where application most relevant
2. **Mode speed**: consumers appear to have a travel time budget of ~1 hour per day; therefore mode speed matters
3. **Rate and level of shift**: there are constraints on timescale of shifts, and maximum levels
4. **Costs of shift**: different infrastructure costs need to be considered if we are exploring policy-optimal solutions

- So how can this be implemented in a bottom-up, optimisation model?

Standard model implementation



MS model implementation

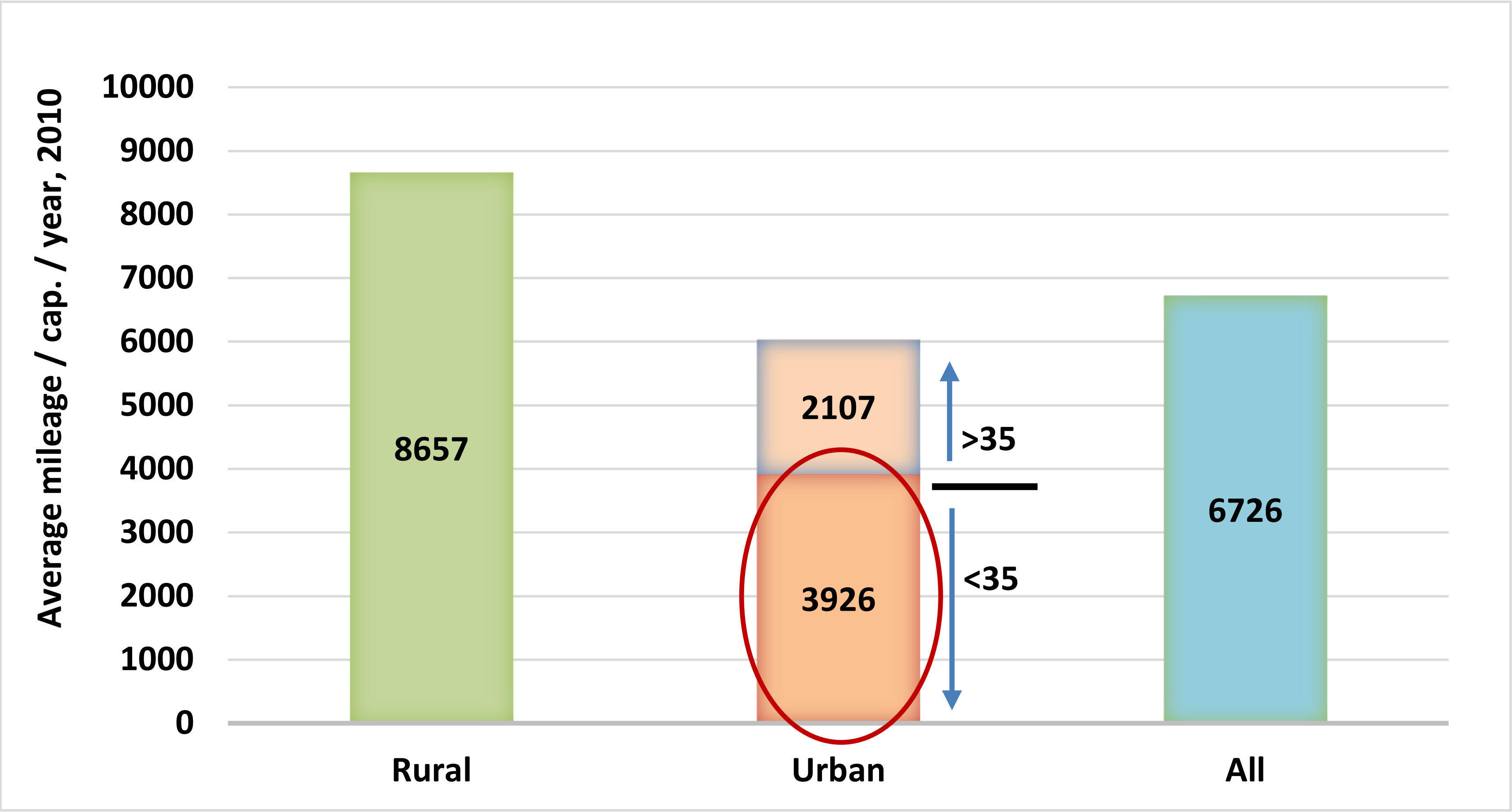


How to represent urban modal shift?

- Four factors to consider -

  1. **Demand**
  2. **Mode speed**
  3. **Rate and level of shift**
  4. **Costs of shift**

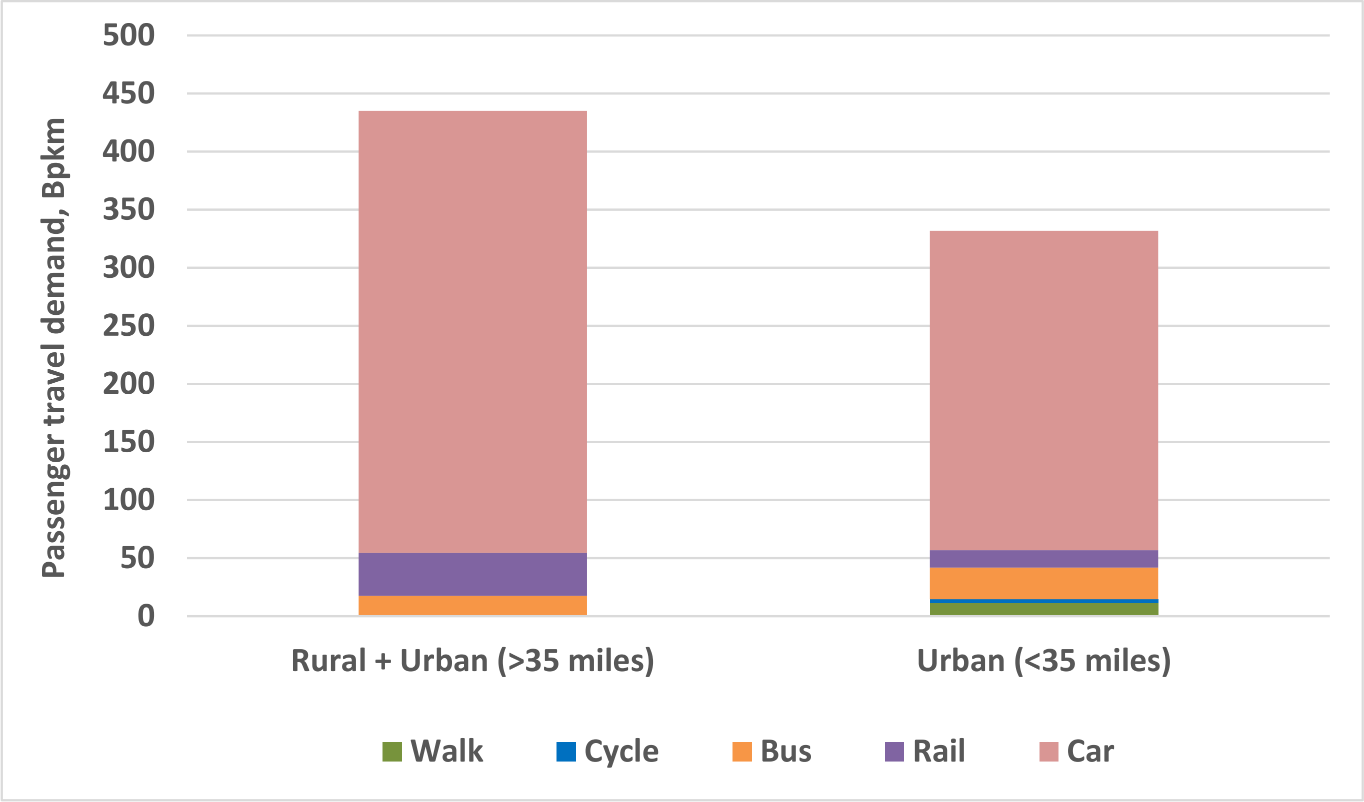
1a. **Demand:** Disaggregating UK surface passenger demand



NTS annual mileage per capita (by area type)

1b. **Demand**: Total urban and rural demand by mode, 2010

- Urban (<35 miles) accounts for 42% of surface transport passenger demand; disaggregated by region.



Total ESME demands disaggregated by area type and mode, 2010

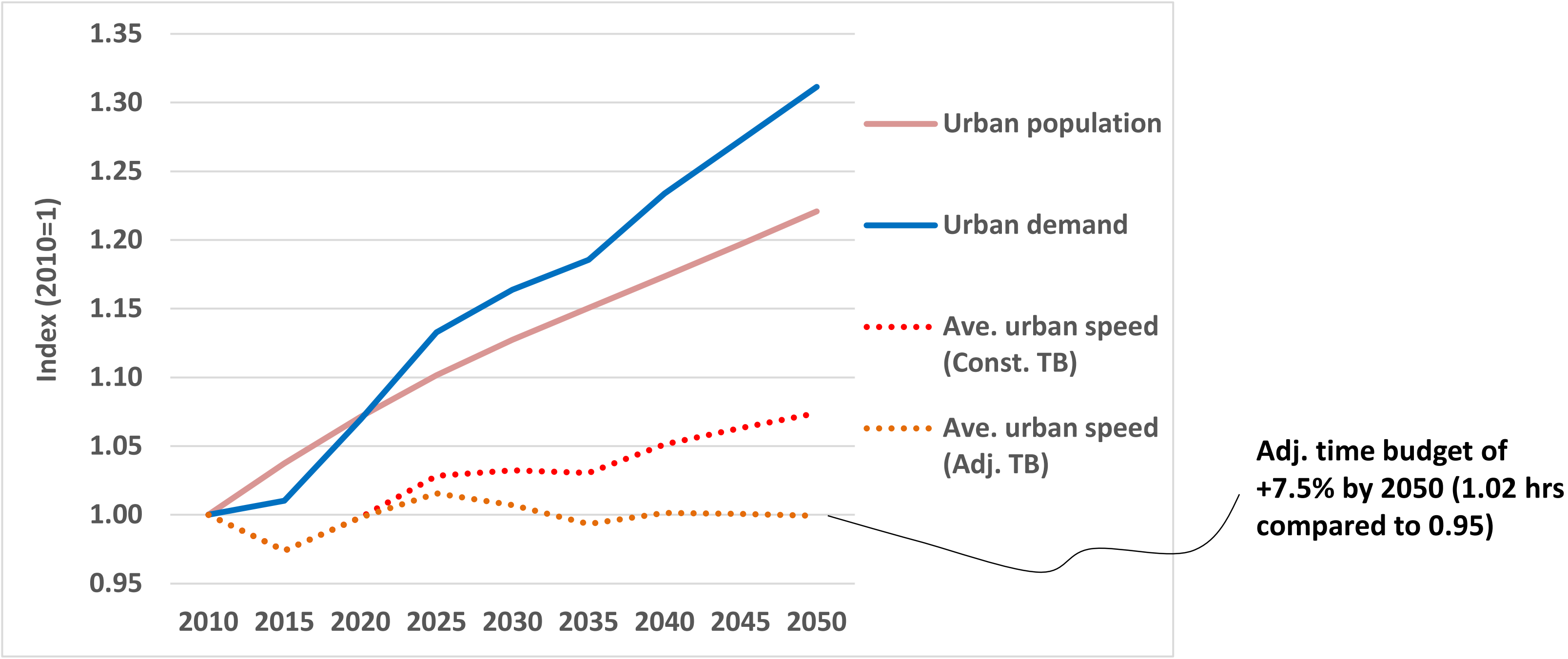
2a. **Mode speed** & the role of time budgets

- Reason for introducing time budget in model is to ensure mix of modes
- The 'need for speed' means we can't all switch to slower non-motorised modes

- Evidence base for time budgets
  - Aggregate constant time budget observed ~1 hr/day/cap; stability of time budgets as a concept (Zahavi and Ryan, 1980)
  - Reasons for this – 'ideal' travel time budget exists? (Mokhtarian and Chen, 2004)
  - Large differences when disaggregated – age, car ownership, gender, income, spatial characteristics (Mokhtarian and Chen, 2004)
  - Different in other countries; rising in Netherlands (van Wee et al. 2006)
  - Sceptical positions; stability of concept is questioned (Goodwin 1981)

2b. **Mode speed** & the role of time budgets

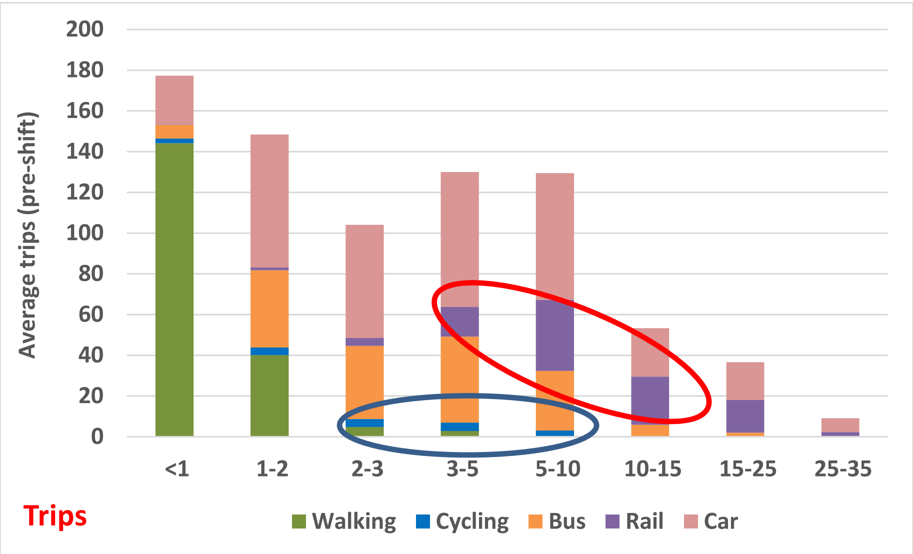
- Problem of assuming constant budget for analysis
- Overall demand increasing at higher rate than population; holding time budget constant requires that average speeds have to increase (red dash line)
- However, mode shift potential may require a higher share of slower modes

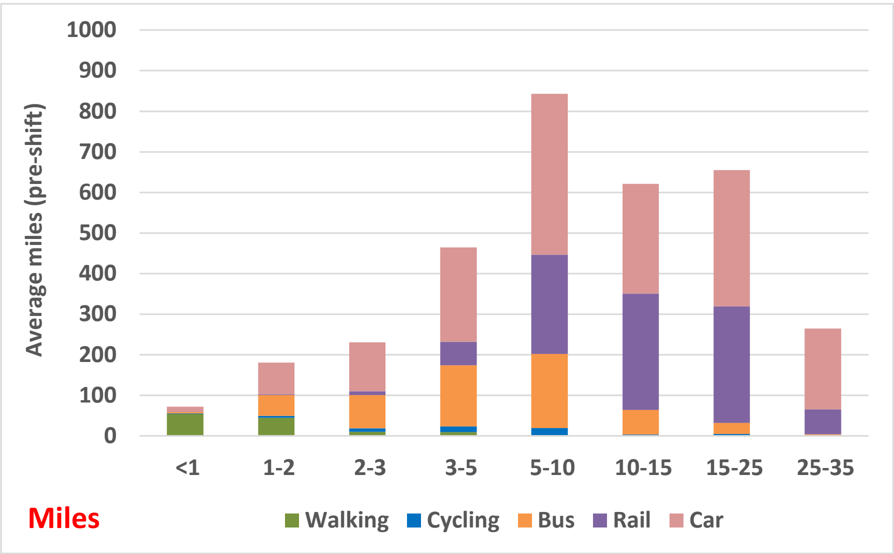


3a. **Rate & level of mode shift** estimates

- Assess urban trip distance profile; replacement of car trips by other modes limited due to distance

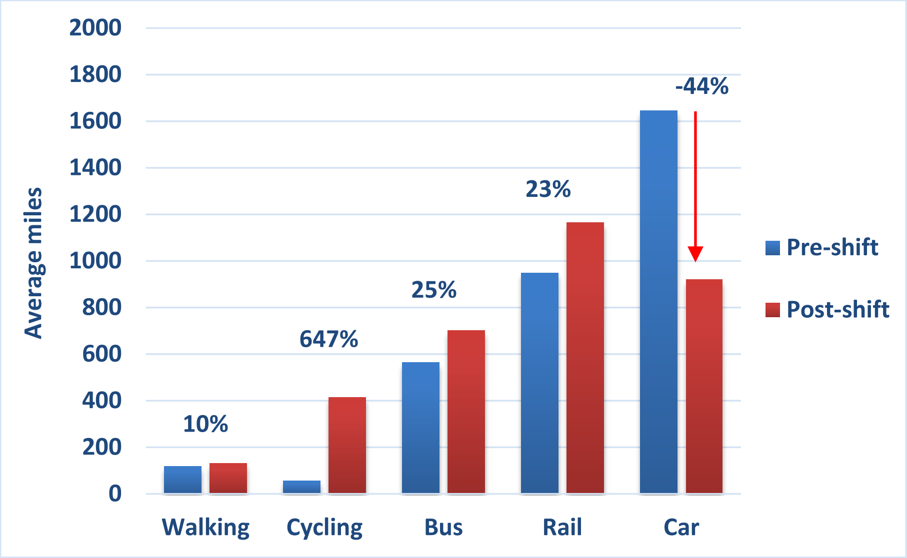
Greater London: Average miles & trips /capita by MODE & TRIP DISTANCE



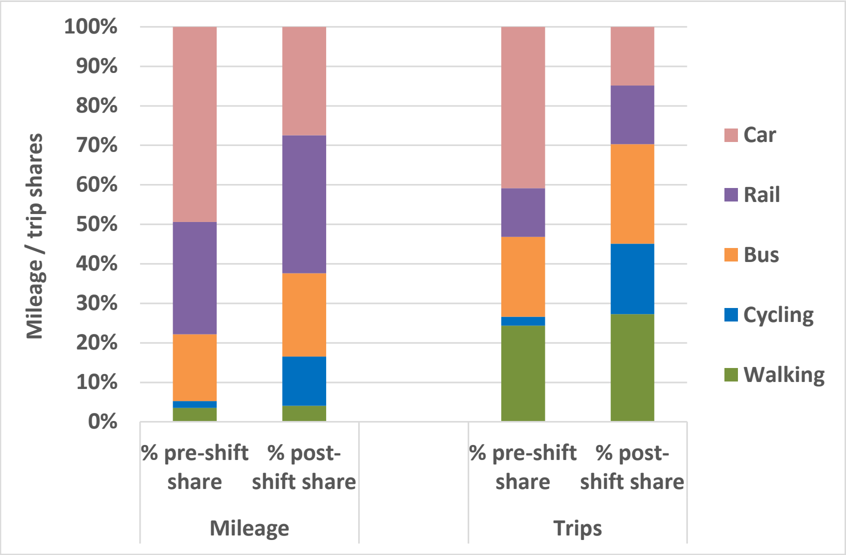


3b. **Rate & level of mode shift** estimates

- Determine maximum mode shift by 2050. Already limited by distance, additional information from other analysis / international experience
- Rates of mode shift over time based on linear interpolation, achieving maximum in 2050



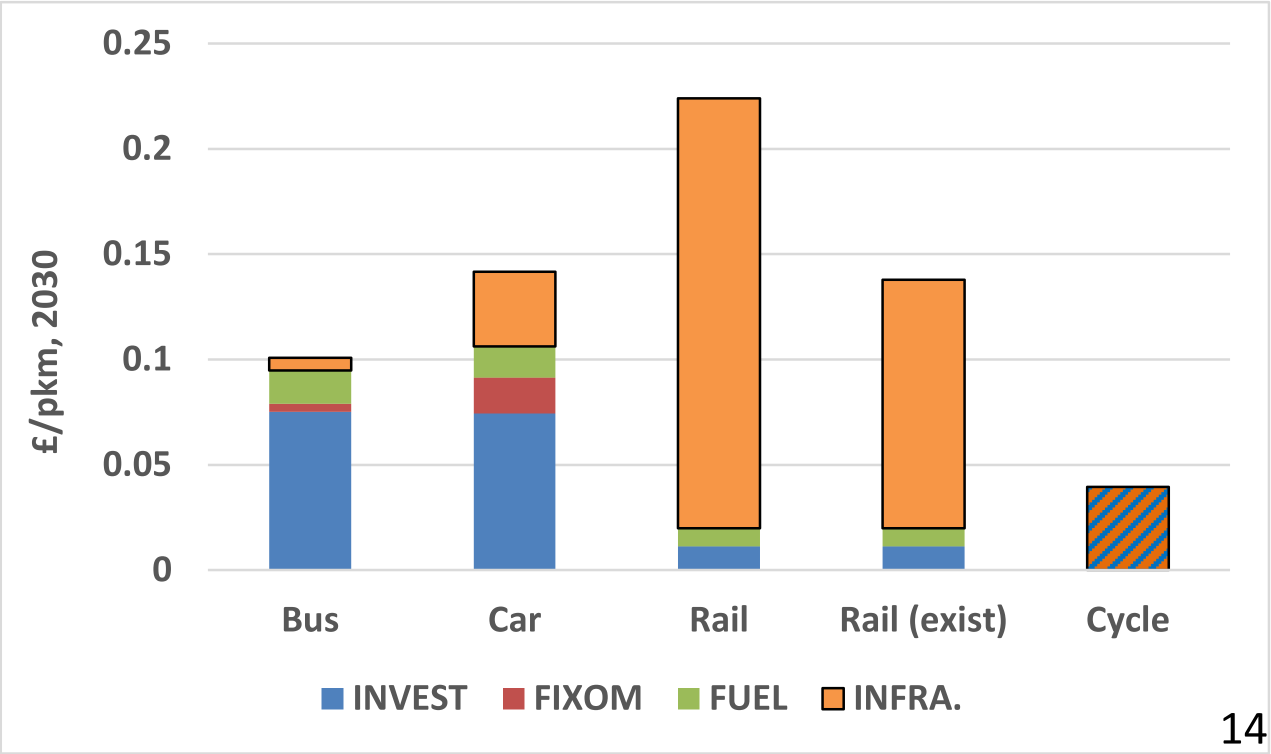
Greater London; max. permitted change in per capita miles by mode



Trip mileage share by mode

4a. **Cost factors** in mode shift

- Within constraint of mode shift potential and rate, optimisation will play role
- Mode costs considered given inter-modal competition, and non-mechanised modes
- Inclusion of infrastructure costs; no repr. of other key factors (value of time, convenience etc.)



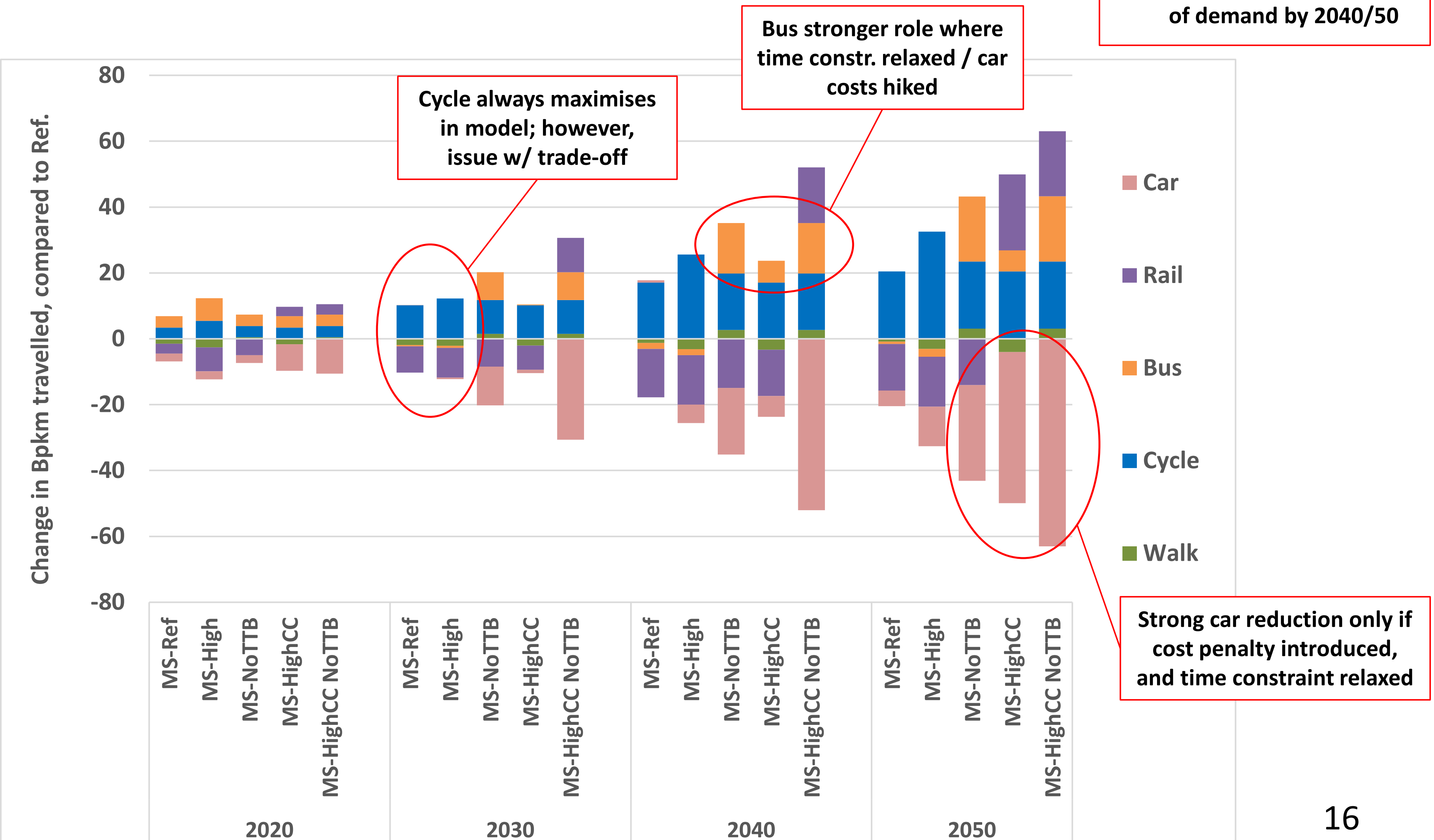
Model analysis

- Runs focus on exploring model behaviour and future application of approach
- All runs under LT climate policy scenario

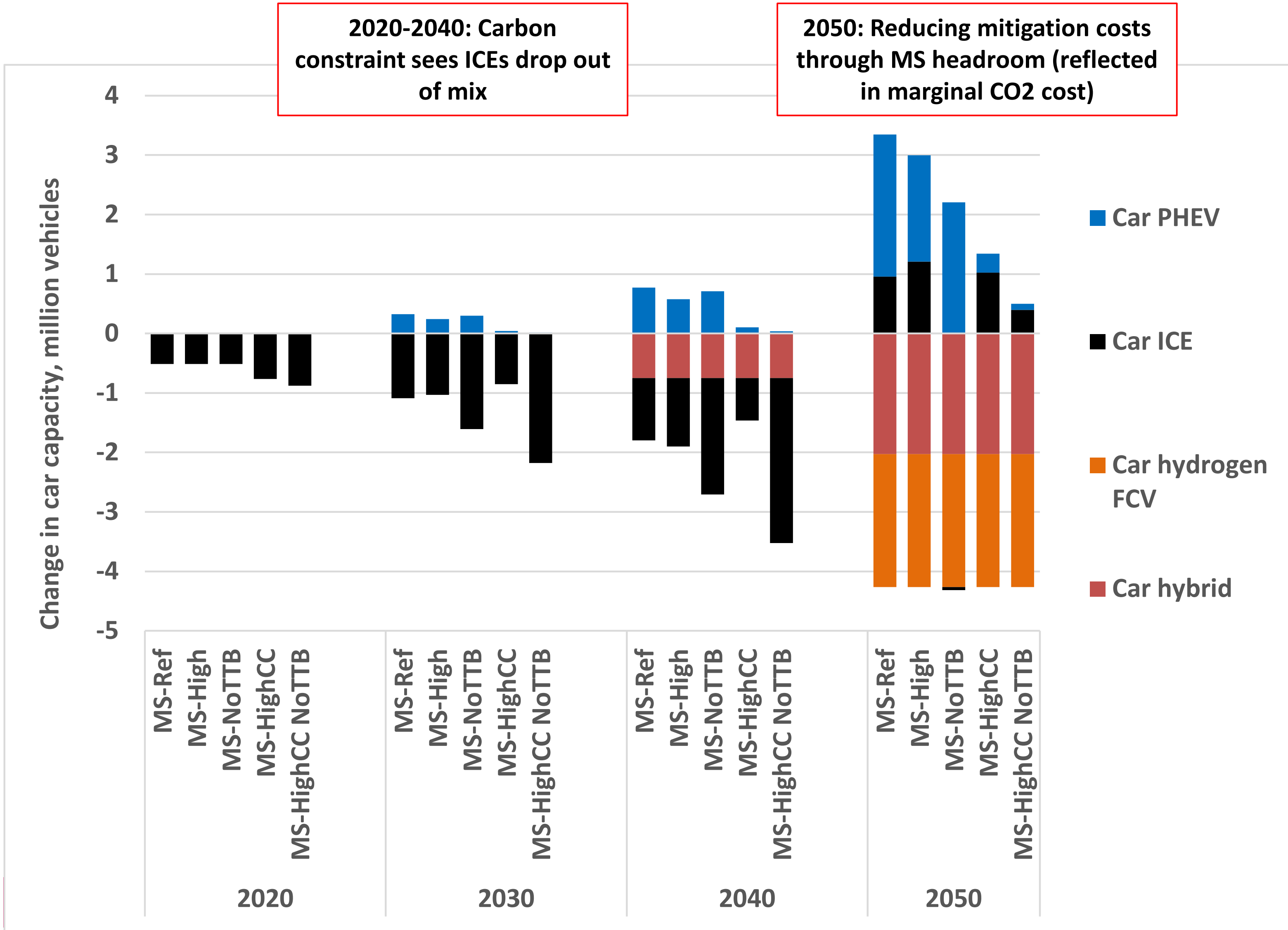
Run	Description
Ref (v3.3)	ESME v3.3 standard run for comparison
MS-Ref	Modal shift ref. case (as presented)
MS-High	Strong push on sustainable transport, increasing MS potential
MS-NoTTB	Innovation erodes assumptions of time budgets
MS-HighCC	External costs penalising car travel
MS-HighCC NoTTB	Combined sensitivity case

Levels of shift: key sensitivities

- Increasing levels of mode shift over time
- Levels of shift – 5-15% of demand by 2040/50

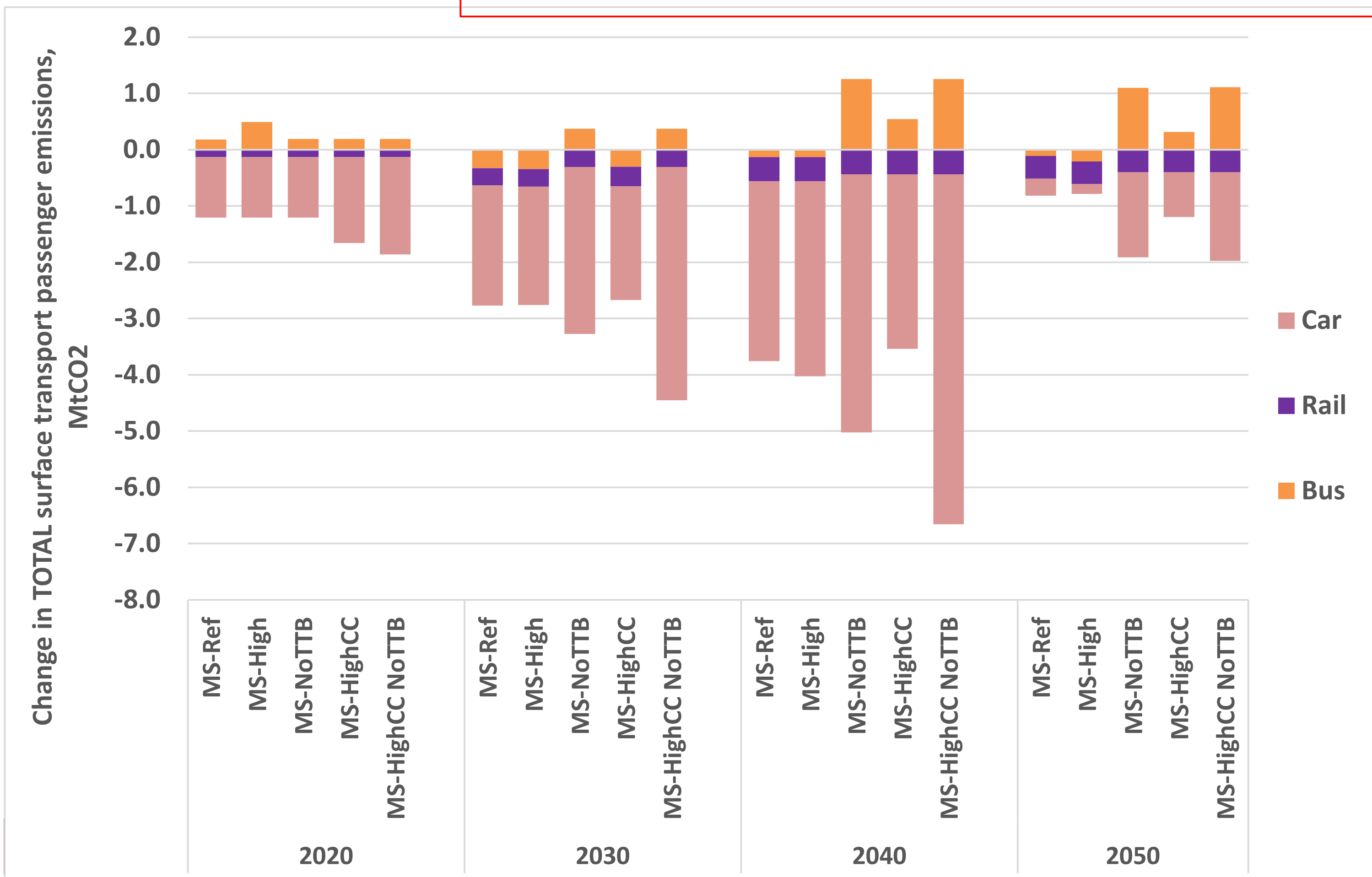


Technology impacts: change in car capacity



Reductions in passenger transport emissions

- Highest % reductions where non-motorised demand increases / motorised decreases
- Percentage reductions small in 2050 due to strongly decarbonised sector & reduction in ULEV vehicles
- Broadly speaking, shifts supply-side options down the technology cost curve



Findings

- Cost optimal solutions favour sustainable transport modes if included. Relative strength is contingent on disincentivising car travel, and affecting travel time considerations

- Demonstrates application of approach to mode shift in energy systems models, and sub-optimality of supply-side focused approaches

- Strengths of approach
  - Demonstrates approach in full systems model, and considers non-motorised modes
  - Begins to capture infrastructure requirements explicitly
  - Allows for endogenous shift, capturing technology trade-offs

- Limitations
  - Lack of ‘choice’ considerations (engineering perspective only)
  - Data needs and model re-configuration not insigificant

Further research

- Extend scope of approach to capture longer distance trips; this is where most emissions are derived

- Key questions across constraints
  - Level of time budget?
  - Maximum shift achievable, and rate of change?

- Development of consumer level choice parameters

- Develop infrastructure capacity constraints, impacting on mode speed (depending on investment)

- Consideration of externalities, particularly relevant for urban transport (pollution, noise, congestion etc.)

Thanks for listening. Any questions?

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References

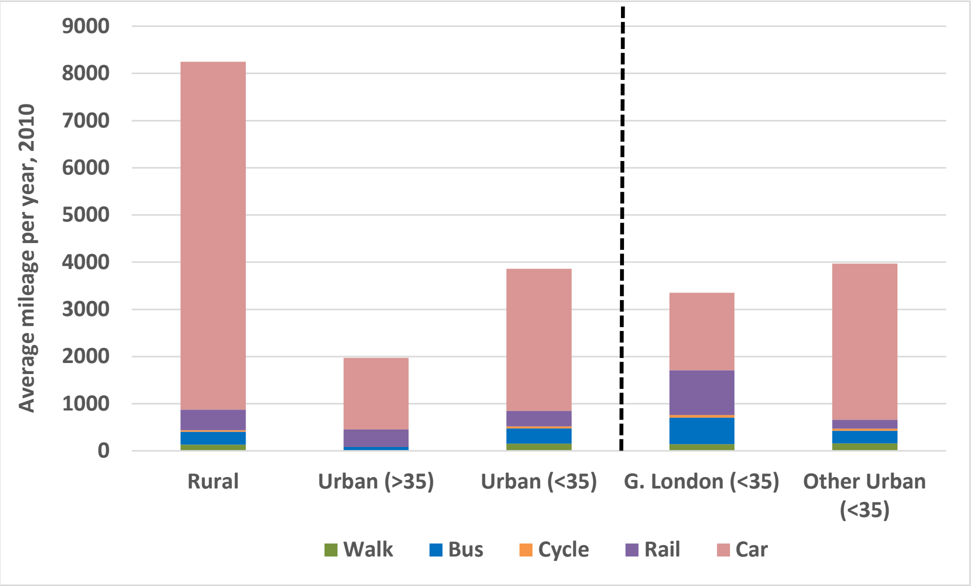
- Banister, D. (2008). The sustainable mobility paradigm. Transport policy, 15(2), 73-80.
- Daly et. al (2014), Incorporating travel time and behaviour into TIMES energy system models, Applied Energy, In Press.
- DfT (2011). Realising the potential of GB rail: final independent report of the rail value for money study. Department for Transport. May 2011. http://assets.dft.gov.uk/publications/report-of-the-rail-vfm-study/realising-the-potential-of-gb-rail-summary.pdf
- EC (2011). Flash Eurobarometer "*Future of transport*" (No 312). European Commission, Brussels. March 2011. http://ec.europa.eu/public_opinion/flash/fl_312_en.pdf
- GLA (2013). The Mayor's vision for cycling in London. Greater London Authority. March 2013. http://www.london.gov.uk/sites/default/files/Cycling%20Vision%20GLA%20template%20FINAL.pdf
- Goodwin, P. (2013). Get Britain Cycling - Report from the Inquiry. All Party Parliamentary Cycling Group (APPCG). April 2013. http://allpartycycling.files.wordpress.com/2013/04/get-britain-cycling_goodwin-report.pdf
- Goodwin, P. (2007). Carbon abatement in transport – Review of demand responses. A review on behalf of the Committee on Climate Change. December 2007. http://archive.theccc.org.uk/aws3/CCC%20transport%20demand%20review%20Goodwin.pdf
- Goodwin, P.B., 1981. The usefulness of travel budgets. Transportation Research 15A, 97–106.
- Kenyon, S., & Lyons, G. (2003). The value of integrated multimodal traveller information and its potential contribution to modal change. *Transportation Research Part F: Traffic Psychology and Behaviour*, *6*(1), 1-21.
- Mann, E., & Abraham, C. (2006). The role of affect in UK commuters' travel mode choices: An interpretative phenomenological analysis. British Journal of Psychology, 97(2), 155-176.
- McKinsey (2011). Keeping Britain moving: the United Kingdom's transport infrastructure needs. March 2011. http://www.mckinsey.com/global_locations/europe_and_middleeast/united_kingdom/en/latest_thinking/keeping_britain_moving_full
- Mokhtarian, P. L., & Chen, C. (2004). TTB or not TTB, that is the question: a review and analysis of the empirical literature on travel time (and money) budgets. Transportation Research Part A: Policy and Practice, 38(9), 643-675.
- Schäfer, A (2012). Introducing Behavioral Change in Transportation into Energy/Economy/Environment Models. World Bank Policy Research Working Paper 6234. http://elibrary.worldbank.org/doi/book/10.1596/1813-9450-6234

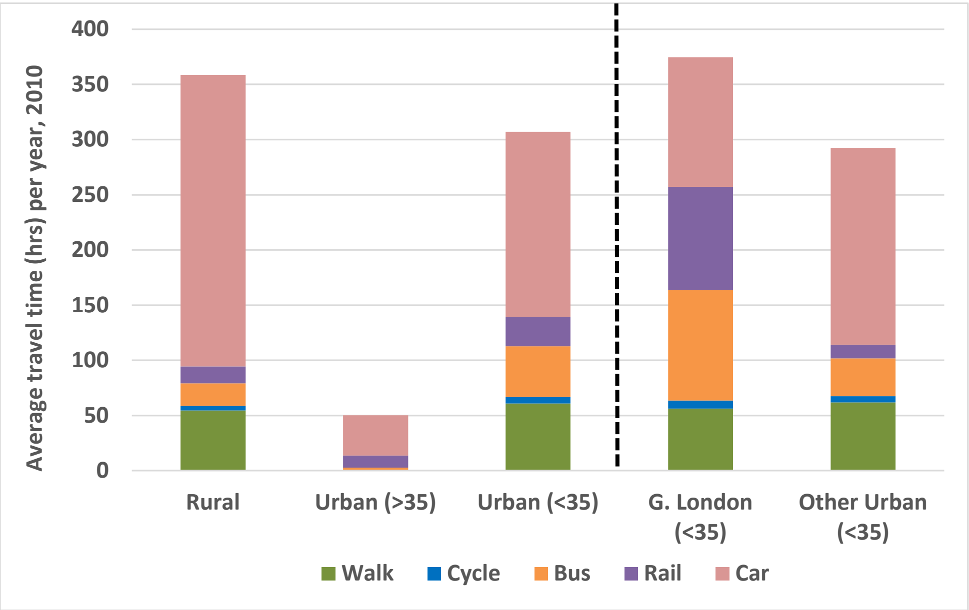
References

- Schwanen, T., Banister, D., & Anable, J. (2012). Rethinking habits and their role in behaviour change: the case of low-carbon mobility. *Journal of Transport Geography*, *24*, 522-532.
- TfL (2010). Analysis of Cycling Potential: Policy Analysis Research Report. Transport for London. December 2010. https://www.tfl.gov.uk/cdn/static/cms/documents/analysis-of-cycling-potential.pdf
- van Wee, B., Rietveld, P., & Meurs, H. (2006). Is average daily travel time expenditure constant? In search of explanations for an increase in average travel time. Journal of transport geography, 14(2), 109-122.
- Zahavi, Y., & Ryan, J. M. (1980). Stability of travel components over time.Transportation research record, (750). Transportation Research Board ISSN: 0361-1981.

Additional slides

Per capita transport demand by area type and mode





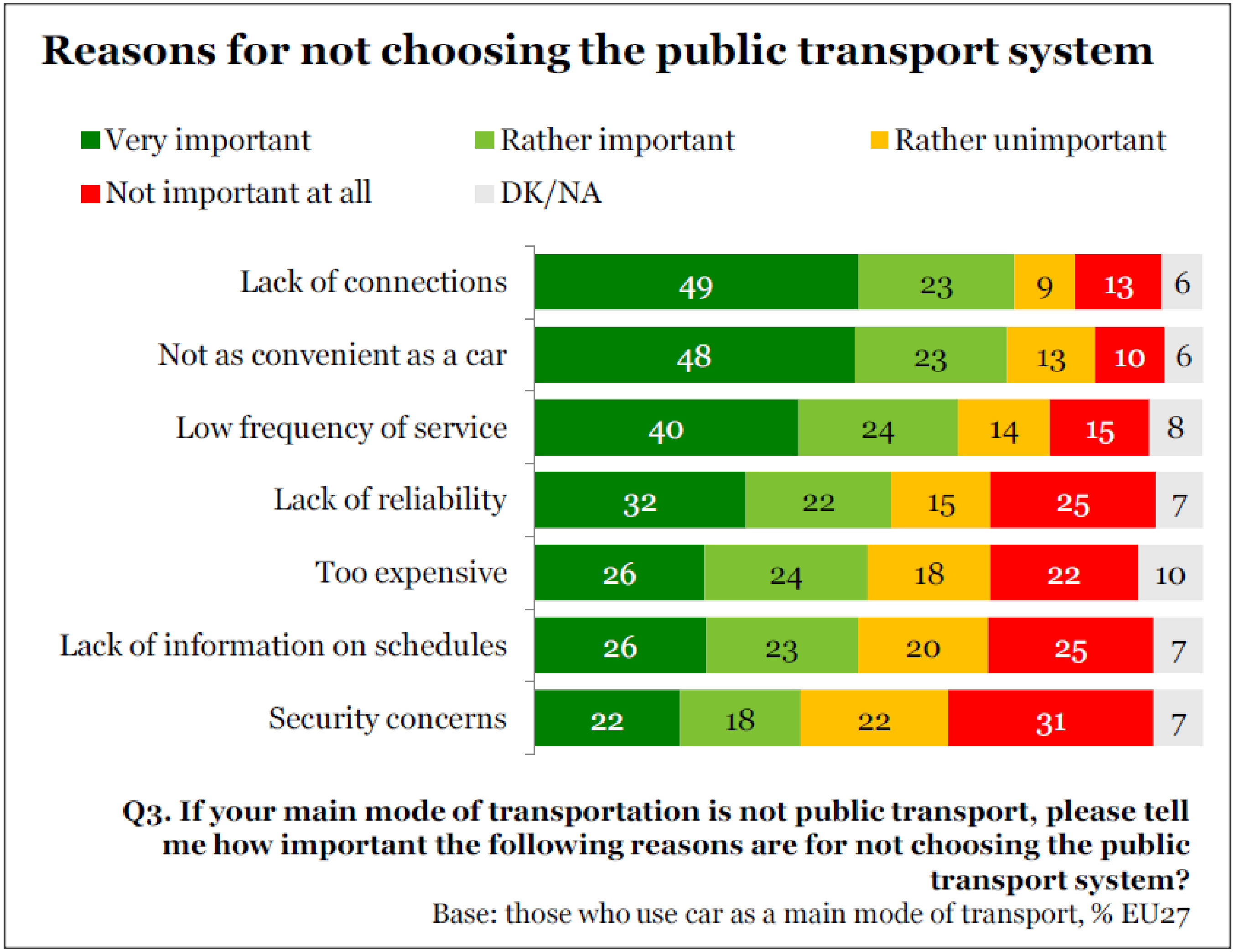
Mileage

- Average mileage dominated by car travel
  - 87% (Rural + Urban, >35)
  - 78% (Urban, <35)
- Greater London profile distinctive; more bus and rail travel, and lower overall demand

Trips

- Urban <35 travel dominates trip profile (97%)
- Distinctive trip profile for Greater London

Mode shift: factors



Source: Flash Eurobarometer "*Future of transport*" (EC 2011)

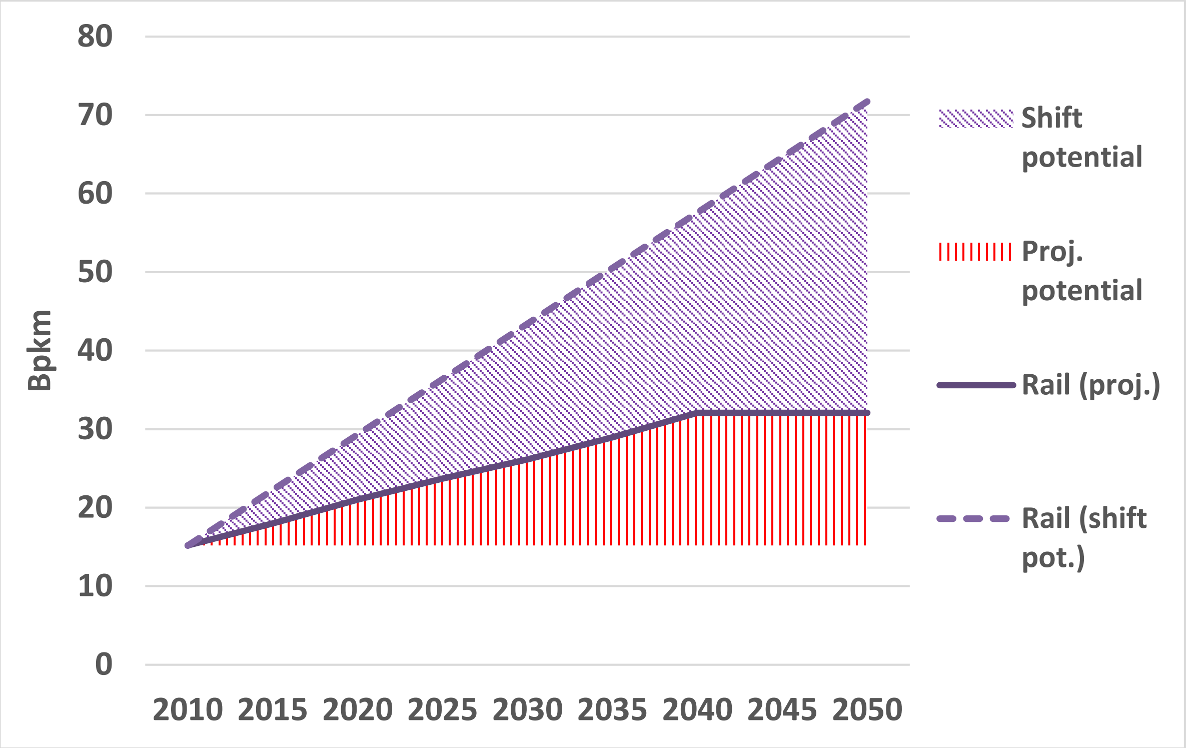
Mode shift factors

Literature suggests many factors at play -

- Lifestyle stability. Change of home, workplace often key factor, known as 'churn' (Goodwin 2007).
    - '9 year period, 50% of commuters changed main mode at least once'
- Lack of information (Kenyon and Lyons 2003).
- Habit of mode choice (Schwanen et al. 2012).
- Public acceptability and demonstration (Bannister 2008).
- Travel as valued activity, not just derived demand e.g. use of ICT on public transport (Bannister 2008).
- The role of affective (emotional) considerations. Car travel provides autonomy, personal space and ownership / identity (Mann and Abraham 2006).
- Land use patterns. Future planning of communities has strong bearing on transport choices (Bannister 2008).

Mode shift rates and potential

- Projected urban passenger demands from ESME projections (blue continuous line)
- Max shift multiplier applied to 2050 demands (excl. cars), and linear extrapolation back to 2010
- Shift above projected demand (purple shaded area)
- Any additional growth (total shaded area) subject to infrastructure costs



Mode shift costs: infrastructure considerations

- Infrastructure costs considered for different modes, to ensure greater cost comparability

Cycling	Under Get Britain Cycling report, consensus around £10-20 / capita year-on-year spend being able to deliver trip mode shares of 20-40% (Goodwin 2013); London Strategy funded at £18 / head to deliver 400% increase by 2026 (GLA 2013). Cost of bikes not included.
Cars	Future investment needs based on McKinsey (2011) *Keeping Britain moving: the United Kingdom's transport infrastructure needs.*
Rail	Costs of infrastructure investment and operation added, based on report *Realising the potential of GB rail: final independent report of the rail value for money study* (DfT 2011). Excluded rolling stock investment (as already in ESME). Future investment needs based on McKinsey (2011) *Keeping Britain moving: the United Kingdom's transport infrastructure needs.*
Bus	As for cars but lower costs in model due to occupancy factor, as McKinsey estimates in vkm.