# Changing energy, changing lifestyles – social simulation of transitions in mobility with an ABM

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EU FP7 PATHWAYS Project



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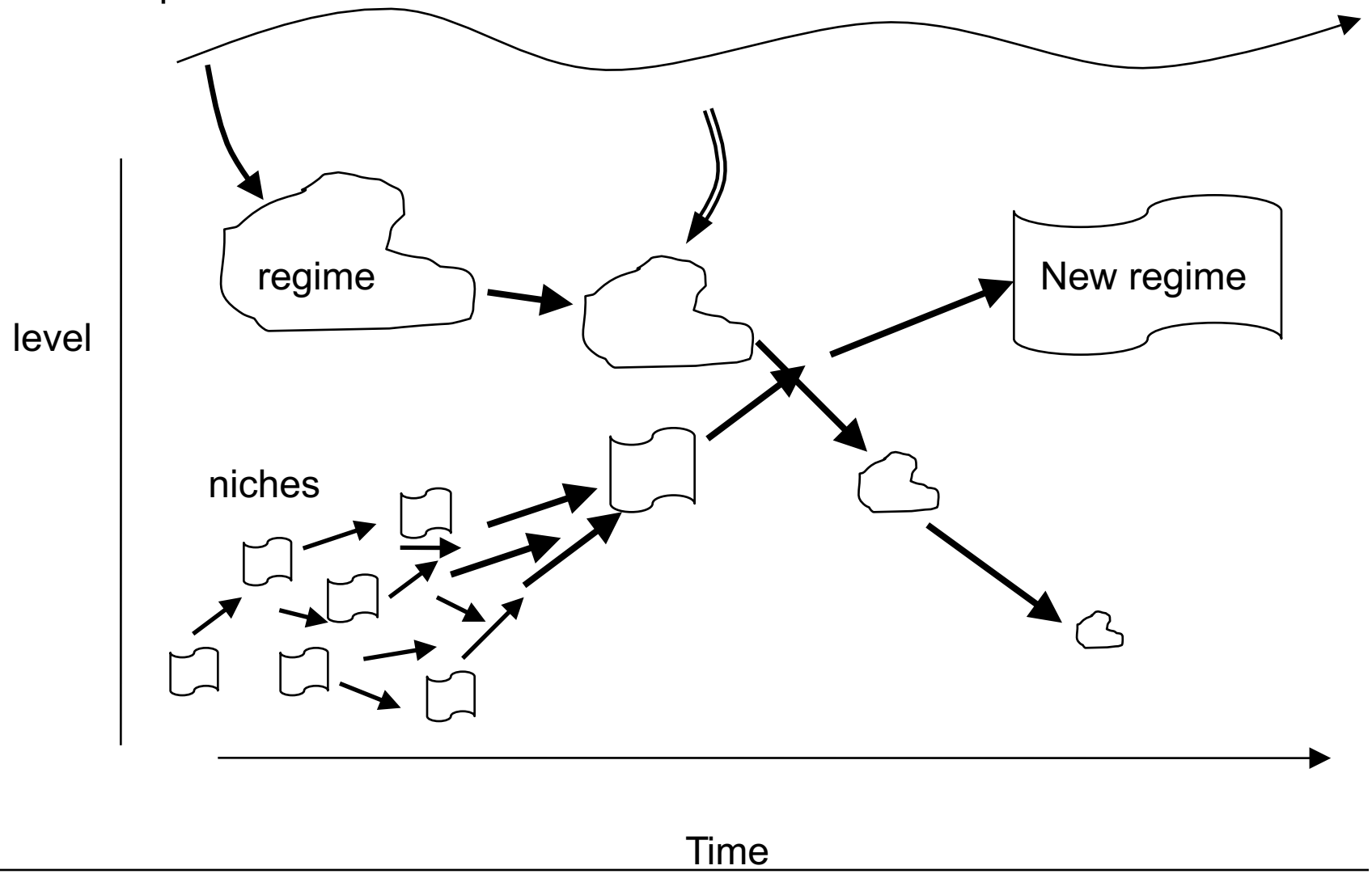
# A Transition: technological substitution pathway







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# Regime and Niches

Car technology agents

• regime of internal combustion engine (ICE) motor cars,

• 3 Car niches: ICE/electric hybrid cars, biofuel cars and hydrogen cars (FCVs).


Other niches:

• Increased use of public transport

• Product to service shift (from car ownership to car sharing).

• Reduced transport demand can be identified as adoption of slow modes (walking and cycling) and urban ICT.

# Practices

**Quantitative**

- CO2 emissions of vehicles (gCO2/km),
- cost of transport (€/yr),
- Private motorised mobility
- Public mechanised mobility

**Qualitative**

- ICT use,
- structure of the built environment (mixed use of zones affecting mobility decisions)
- Percieved convenience




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# A combined system and Agent Based Model

- small number of **complex** agents, which have an internal structure and are therefore sub-systems within society,
- larger number of **simple** agents
- practices as the metric through which agents position themselves in society and over which behaviour is defined.

represented as values along different axes, constituting a multi-dimensional *practices space*. Agents are differentiated by their positions in the multi-dimensional practices space.

**Individual agents interact with niches and the regime via their decision to support the regime or a niche**




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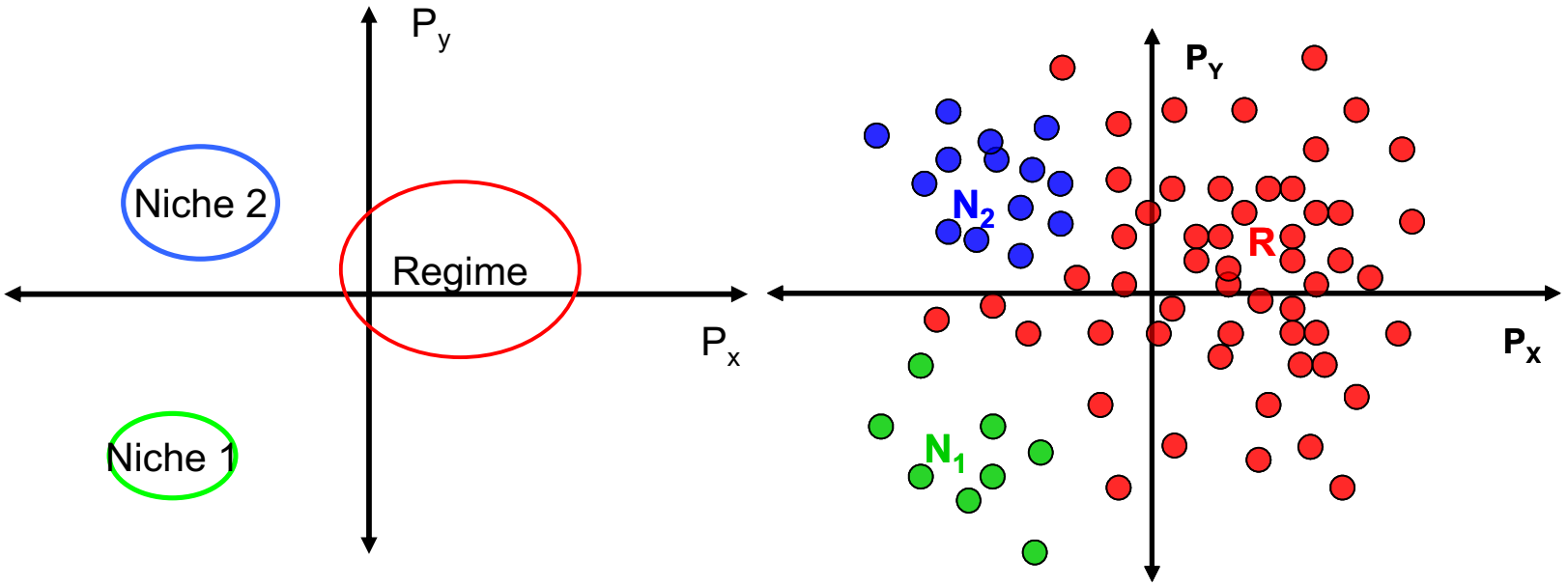
**Two illustrations of a two-dimensional practices space, with practice axes PX and PY.**

**Left: regime and niches, which can move in the space and interact with each other.**

**Right: the consumer agents showing supporters scattered in the practices space, coloured by the agent they support, red = regime (R), green = niche 1 (N1), blue = niche 2 (N2).**



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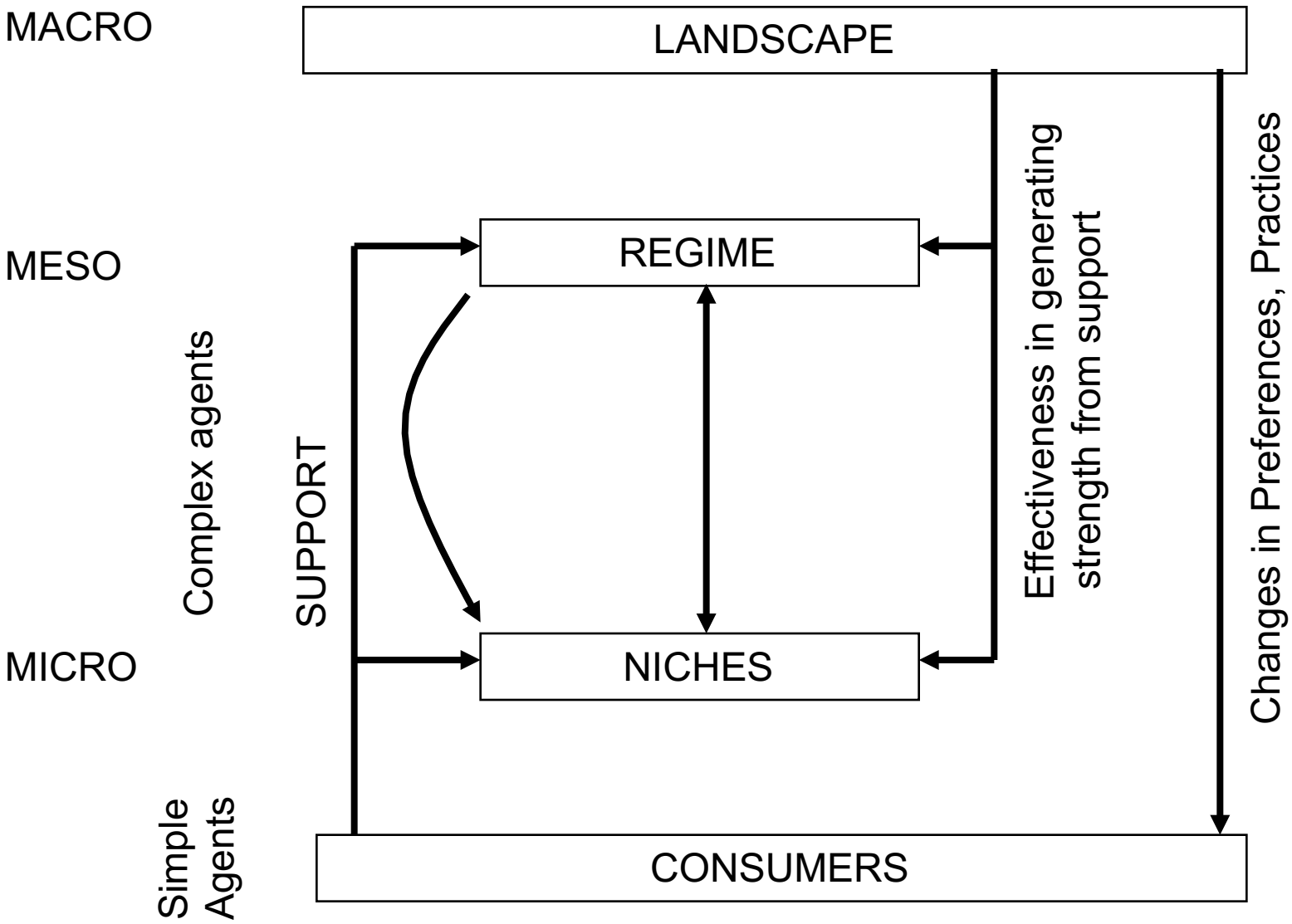





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# Sustainable mobility niches in the NL and the UK

| Niche | Approach |
|---|---|
| 1) Battery electric vehicles | Greening of cars (and/or buses) to improve efficiencies |
| 2) ICE/electric hybrid vehicles | Greening of cars (and/or buses) to improve efficiencies |
| 3) H2 fuel cell vehicles | Greening of cars (and/or buses) to improve efficiencies |
| 4) Biofuels | Greening of cars (and/or buses) to improve efficiencies |
| 5) New forms of car rental/sharing | Reducing or stimulating the need to travel through new social organisation of existing technologies |
| 6) Urban cycling | Encouraging modal shift through new configuration of old technology in new urban cycling system |
| 7) Inter-modal transport: public, car share through internet based information services | Encouraging modal shift through integration – improving linkages between transport modes. Conceptually it is integration that is the signifier of modal shift – and that is populated by a variety of initiatives. |




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# Pathways

| | |
|---|---|
| PHEV: | A |
| BEV: | A |
| Biofuels: | A |
| FCV: | A |
| | |
| Public transport/smart cards: | A/B |
| Car sharing: | B |
| Cycling/cycle sharing: | B |




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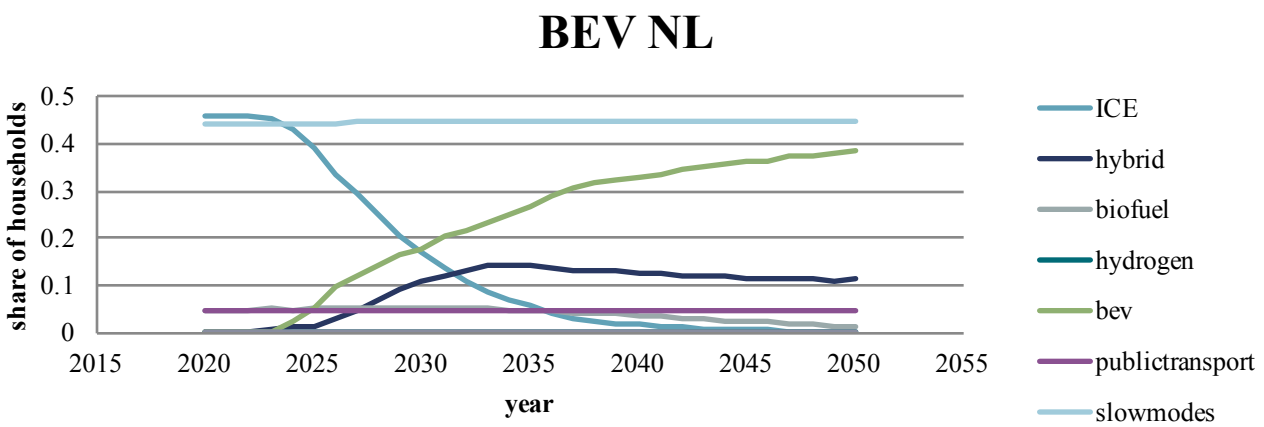
# Pathway A BEVs

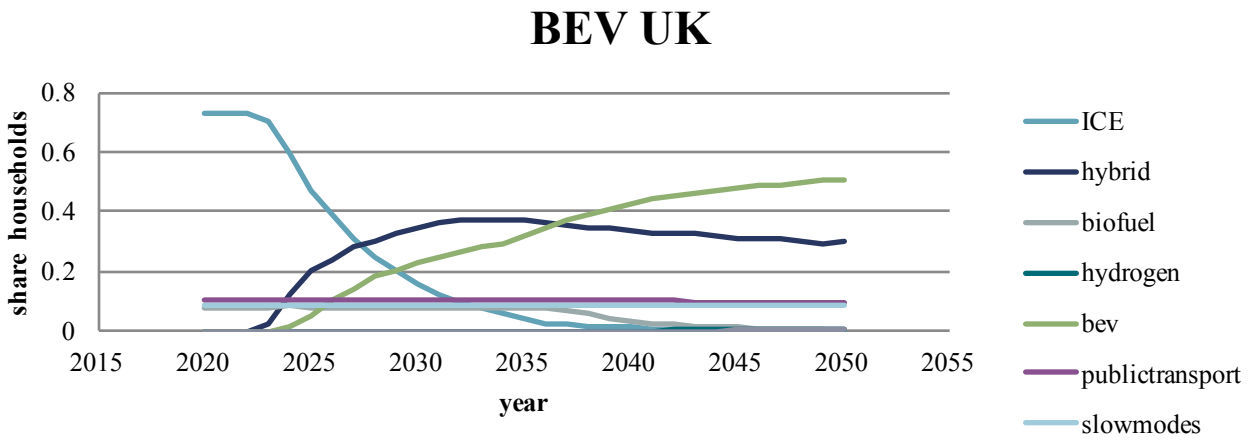
increasing importance of environment

no move away from car-based mobility.

BEVs compete with hybrids and win out in the longer run

BEVs' range problems are solved by more infrastructure and user familiarity leading to higher perceived convenience.







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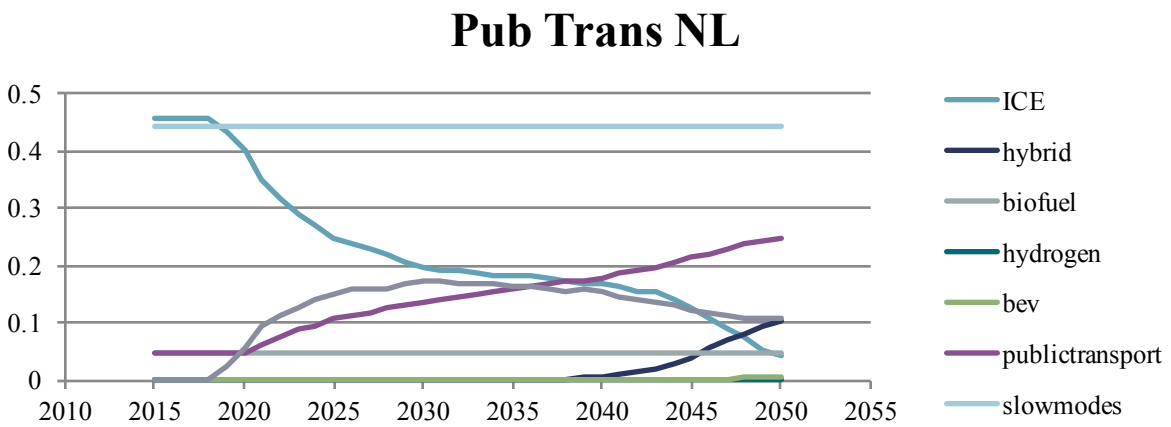
# Pathway B Public Transport

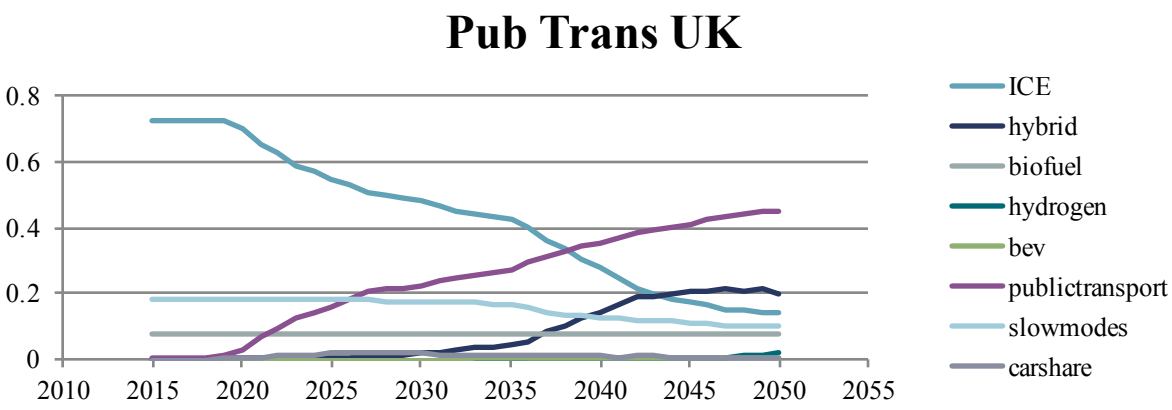
NL and UK:
environment + move away from individualised transport
car share competes with public transport.

NL has so much slow mode that further investment in public transport enables slow modes to combine even better with public transport

UK: public transport improvement, much higher convenience with new mobile/ICT systems.

Combines with power for public transport from renewables and a continuing high level of urbanisation in the UK







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# Pathway B Walking and cycling

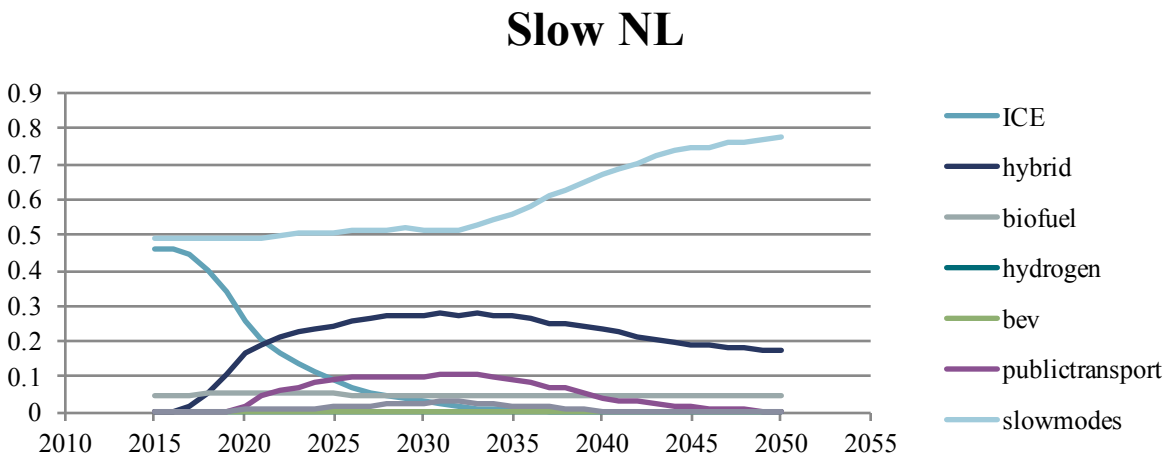
NL initial adoption of electric hybrids, public transport for improved environment

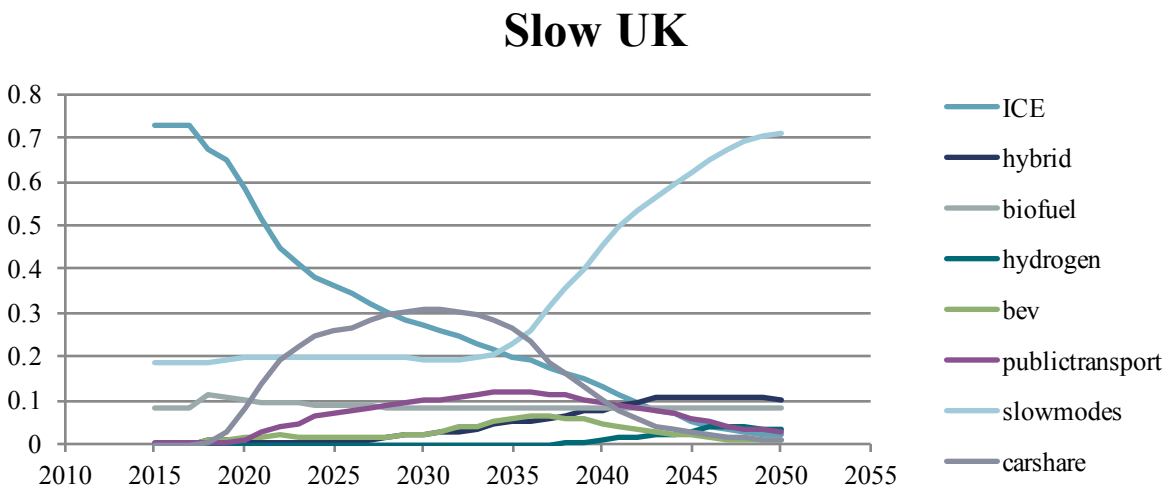
longer run, mobility lifestyles change such that most people walk and cycle hybrid cars for longer distance and using ICT for more remote communication.

UK environment and loss of interest in owning a car.
trong uptake of car sharing,
onger run, slow modes more desirable lifestyle.

NL and UK

slow modes lifestyle does use public transport and car share for longer distances to a limited extent.







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# Conclusions

- Calibrate an ABM simulation of transitions in transport in discussion with qualitative case studies

- Pathway A is achieved through improvements in the technology performance, in terms of emissions and costs and shows in the current simulations the adoption of BEVs

- Pathway B requires households or individual consumers to change their lifestyle away from car ownership to adopting other modes and /or car sharing.

# Initial values of practices und frontiers of transport niches and the regime

- CO2 emissions are actual levels per year
- other practices normalised between 1 and 100, with the initial value shown in the table
- Values in square brackets are the possible range of values consistent with the culture and objectives of the regime or niche
- Values in curved brackets shows the direction of technological change in the niche/regime in the practice dimension for the particular column.

| Name | $CO_2$ Emission $gCO_2/km$ | Cost €/Year | Motorised private mobility pkm/ year | ICT to reduce travel demand (percentages using ICT in this way) | Built Environment | Motorised public mobility pkm/ year | Perceived convenience |
|---|---|---|---|---|---|---|---|
| ***ICE*** | 84.5=169 g [15,85] (-1) | 40 [0,100] (1) | 95=9500 km [50,100] (0.5) | 5 [0,100] (1 ) | 10 [0,50] (0) | 9.5=950 km [0,49] (0) | 80 [60,100] (-0.5) |
| ***Hybrid*** | 78.6=157.2 g [10,79] (-1) | 48 [0,100] (1) | 95=9500 km [50,100] (0.5) | 25 "proximity to ICT wave" (high tech vehicle) [20,100] (1) | 10 [0,50] (0) | 9.5=950 km [0,49] (0) | 80 [60,100] (-0.5) |
| ***Biofuel*** | 43.3=86.73 g [7.4,44] (0) | 44 (=110% of ICE) [0,100] (1) | 95=9500 km [50,100] (0.5) | 15 [10,100] (1) | 10 [0,50] (0) | 9.5=950 km [0,49] (0) | 75 limited refuelling [55,95] (-0.5) |
| ***Hydrogen*** | 8=16 g (10% of ICE, [0,8] (-1) | 100 [0,100] (-2) | 65=6500 km tank constraints) [50,100] (0.5) | 50 "proximity to ICT wave" (high tech vehicle) [25,100] (1) | 10 [0,50] (0) | 24.4=2450 [0,49] (0) | 10 limited refuelling [50,90] (-0.5) |
| ***Bev*** | 30.888=61.776 g [0,31] (-1) | 54 [0,100] (0.5 UK 1.5 NL) | 35 UK 65 NL =6500 km range constraints) [50,100] (0.5) | 50 [40,100] (1) | 10 Mainly single-use zones [0,50] (0) | 24.4=2440 km [0,49] (0) | 40 limited range and refuelling [20,60] (1) |

| Name | $CO_2$ Emission $gCO_2/km$ | Cost €/Year | Motorised private mobility pkm/ year | ICT to reduce travel demand (percentages using ICT in this way) | Built Environment | Motorised public mobility pkm/ year | Perceived convenience |
|---|---|---|---|---|---|---|---|
| ***ICE*** | 84.5=169 g [15,85] (-1) | 40 [0,100] (1) | 95=9500 km (UK) [50,100] (0.5) | 5 [0,100] (1 ) | 10 [0,50] (0) | 9.5=950 km [0,49] (0) | 80 [60,100] (-0.5) |
| ***Public transport*** | 16.9=33.8 g (20%) of ICE [3,17] (-1) | 15 (half local, half long distance) [0,100] (1) | 10=1000 km (low use of borrowed or hired car) [0,49] (-0.5) | 50 [40,100] (1) | 50 [50,100] (0) | 90 UK and NL=5000 [50,100] (0 UK +1 NL +1) | NL 70 UK 40 [40,80] (0.5 NL +1 UK + 0.5) |
| ***Slow modes*** | 0 [0,10] (0) | 1 (cycle cost) [0,100] ( 0) | 10=1000 km (low use of borrowed or hired car) [0,49] (0.5) | 60 [40,100] (1) | 100=full supporter of mixed zones [70,100] (0) | 21.2=2120 km [20,49] (0) | 50 UK 70 NL bad weather [30,70] (0.5) |
| ***Carsharing*** | 70.4=140.8 g (better cars /benefitfrom sharing) [12.4,71] (-1) | 24 [0,100] (1) | 65=6500 50 km [0,70] (0.5) | 60 [40,100] (1) | 50 [30,100] (0) | 32=3200 km [25,90] (0) | 60 UK 80 NL 80 [40,80] (-0.5) |




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