

**STEAM**

**Scottish Transport Energy and Air  
pollution Model**

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Meeting with Scottish Government  
21 September 2016



# Presentation outline

1. Purpose
2. Modelling approach UKTCM / STEAM
3. Examples of recent work (using UKTCM)
4. STEAM: potential applications
5. Discussion

# STEAM | UKTCM: purpose

A modelling framework and tool  
to explore transport futures to  
meet carbon mitigation, air  
quality and low energy goals

# STEAM | UKTCM: in a nutshell

- Strategic transport-energy-environment simulation model
- Passenger and freight transport, all modes road | rail | shipping | air
- Annual projections up to 2100
- Built around exogenous scenarios
- Technology rich: endogenous modelling of 730+ vehicle techs
- Wide range of policies that can be modelled: e.g. demand, vehicle ownership and use, fiscal, pricing, eco-driving, fuel obligations, speed limits, technology investment/procurement, urban area access restrictions
- Not just carbon: wide range of output indicators including travel demand, vehicle stock, energy demand, lifecycle emissions, environmental impacts, external costs

# STEAM | key system features

behavioural modelling  
of technology choice

energy use and emissions modelling

life cycle inventory model

vehicle manufacture, maintenance & scrappage  
fuel supply incl. electricity generation

Environmental impacts model

flexible, modular design  
within database environment

(direct and indirect)

**environmental impacts and costs**  
(e.g. GWP, acidification potential, external costs)

**view & export results**  
(Access, Excel)

# STEAM overview | limitations

- Not a detailed forecasting model
  - But: long term forecasting may not be appropriate
- Not a cost optimisation model
  - But: cost not the only factor particularly for private vehicle ownership and use
- Neither economy nor energy systems model
  - But: link with transport or energy systems models possible
- Not a transport network model, with limited geographical resolution (urban, rural, motorway, domestic air, international air, etc)
  - But: network capacity constraints for road network modelled endogenously via congestion/speed profiles, otherwise exogenously

# graphical user interface the 'home screen'

STEAM - revision STEAM transport scenarios - project folder: C:\STEAM\REF\

## Scottish Transport Energy Air pollution Model

main menu

Model Version:  Version information and modifications  
Of Date:  Quit STEAM

STEAM - revision STEAM transport scenarios - project folder: C:\STEAM\REF\

### demand and supply

- TDVS admin
- TDVS policy modelling
- Run the TDVS model
- TDVS modelling results

### direct energy and emissions

- DEEM admin
- DEEM data imports
- DEEM policies and runs
- DEEM data export

### lifecycle emissions and impacts

- LCEIM admin
- LCEIM policy modelling
- LCEIM runs and results
- LCEIM data export

Action

Help

# UKTCM / STEAM: dissemination

**UKERC**

Wed 16 June 2010 10:00 BST

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## Model available on request

(suitable for analysts and technical users)

### UKERC UK Energy Research Centre

#### UK Transport Carbon Model: Reference Guide

4000+ downloads  
in 5 years



This document has been prepared to enable results of on-going work to be made available rapidly. It has not been subject to review and approval, and does not have the authority of a full Research Report.

### Energy Research Centre

Energy Research Centre is the focal point for an independent, whole-systems approach, drawing on environmental and social sciences.

#### News



The world's leading intellects in energy research will arrive in Warwick this month for the annual UK Energy Research Centre (UKERC) Summer School, held at the University of Warwick.

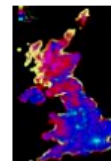
25 June 2010. [More](#)

The European Energy Research Alliance (EERA) - of which UKERC is the UK representative - has launched a series of new Joint Research Centres. You will see major European research institutions working together for the first time. [Download full release](#)



proposed Renewable Heat Incentive financial support scheme

April 2010: Download UKERC's response to DECC's consultation on the



#### UK Transport Carbon Model

A newly developed transport, energy, emissions and environmental impacts model

### UKERC UK Energy Research Centre

#### UK Transport Carbon Model: User Guide

2500+ downloads  
in 5 years



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# UKTCM: recent/on-going work

- UKERC Energy 2050 'lifestyle' scenarios
- Speed limits and CO<sub>2</sub>
- Car purchasing incentives, behavioural model
- Incorporate consumer segmentation for LDVs
- Beyond 'Dieselgate', AQ and CO<sub>2</sub> trade-offs and co-benefits of various of policy and industry
- adVANce: carbon emissions reductions for vans
- Other work: MOT project, DEMAND centre

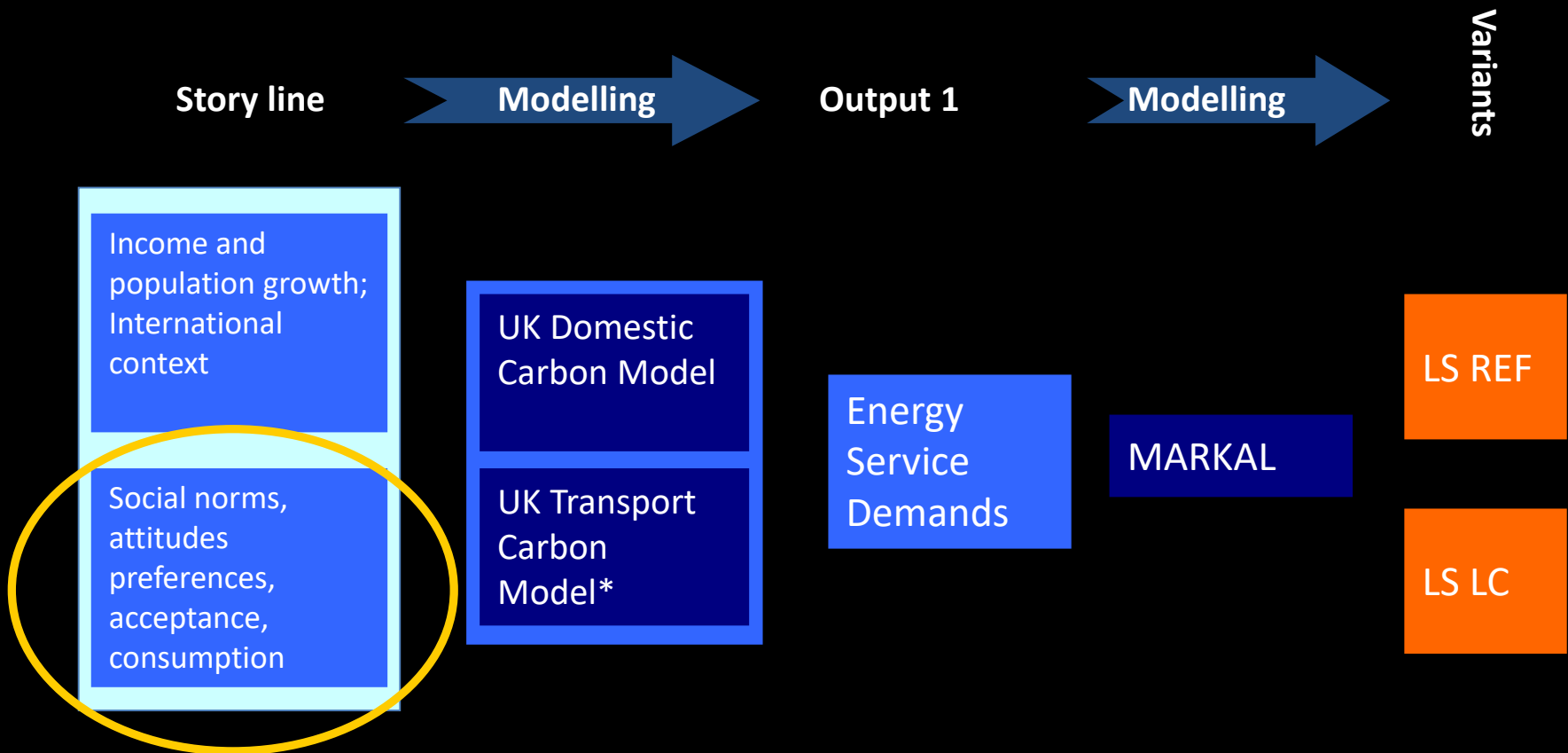
# Example 1:

## UKERC ENERGY 2050

- Assessment of how the UK can move to a resilient and low carbon energy system over the period to 2050
- Suit of sectoral + ‘whole system’ models of the UK *energy system*
- How will the energy system evolve?
- Systematic comparison of scenarios:
  - Carbon constraints & cost optimisation
  - Technology acceleration
  - **LIFESTYLE change**



# Lifestyle scenario - methodology



\* UKTCM = UK Transport and Carbon Model (Brand 2010; Brand et al 2012)

# Lifestyle scenario – storyline

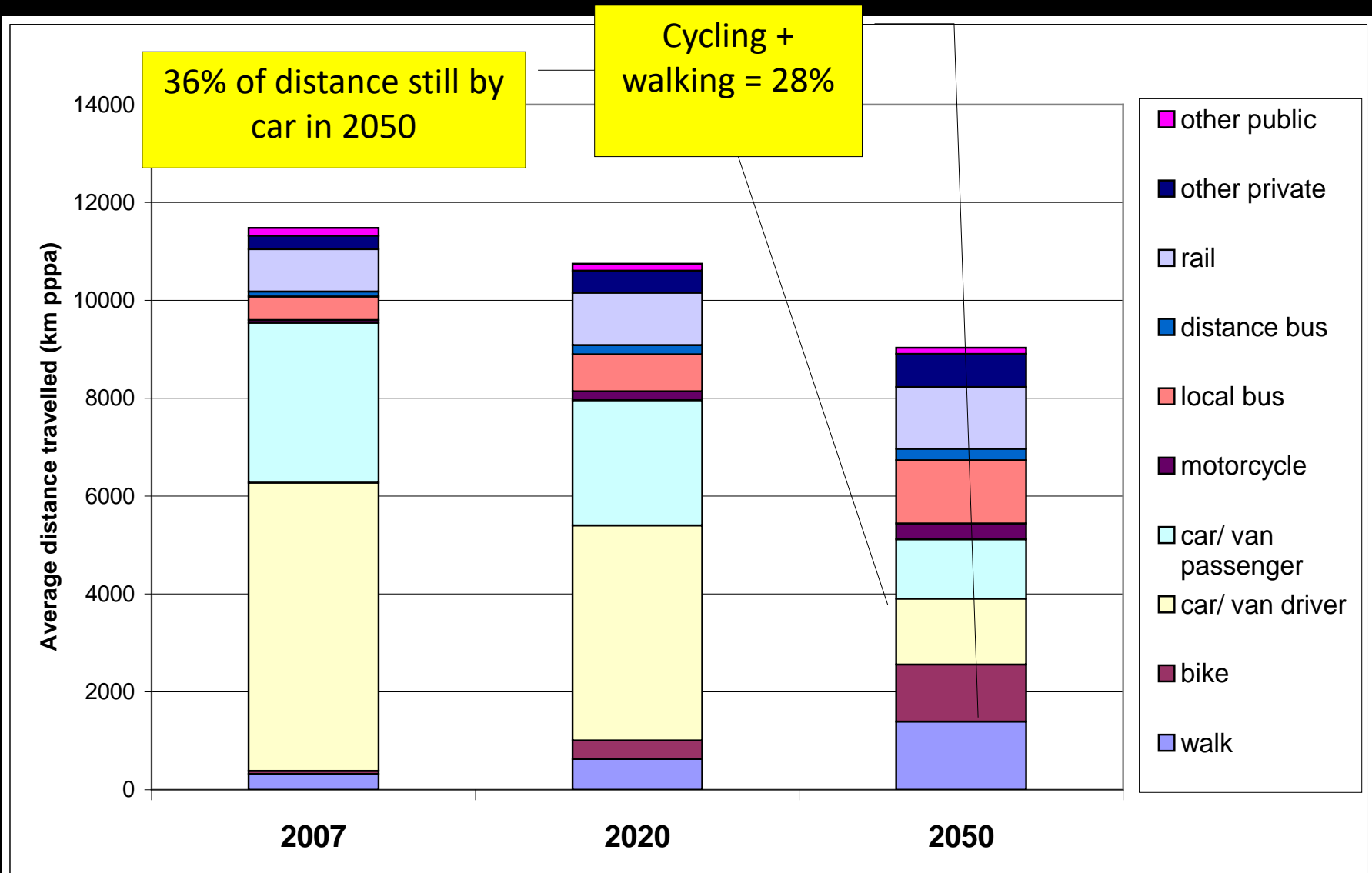
- Social norms elevate active modes and low carbon vehicles in status and demote large cars, single occupancy car travel, speeding and air travel.
- **Move towards localism**
- Information and Communication Technologies
- **New models of car ownership: e.g. small car + car club**
- Phasing out of large vehicles in town/city centres, increased parking charges and strict speed enforcement.
- **Policy environment is one of ‘push and pull’ as fiscal and regulatory sticks are combined with the carrot of infrastructure investment (e.g. in car clubs, public transport, cycle infrastructure, railway capacity).**

# Transport sector – lifestyle and mobility changes in 2050

- Accessibility
- Localism
- Slower speeds
- Compact cities
- Car-free zones
- Car clubs
- ICT
- Teleworking
- Tele-shopping
- Less air travel
- Policy acceptance

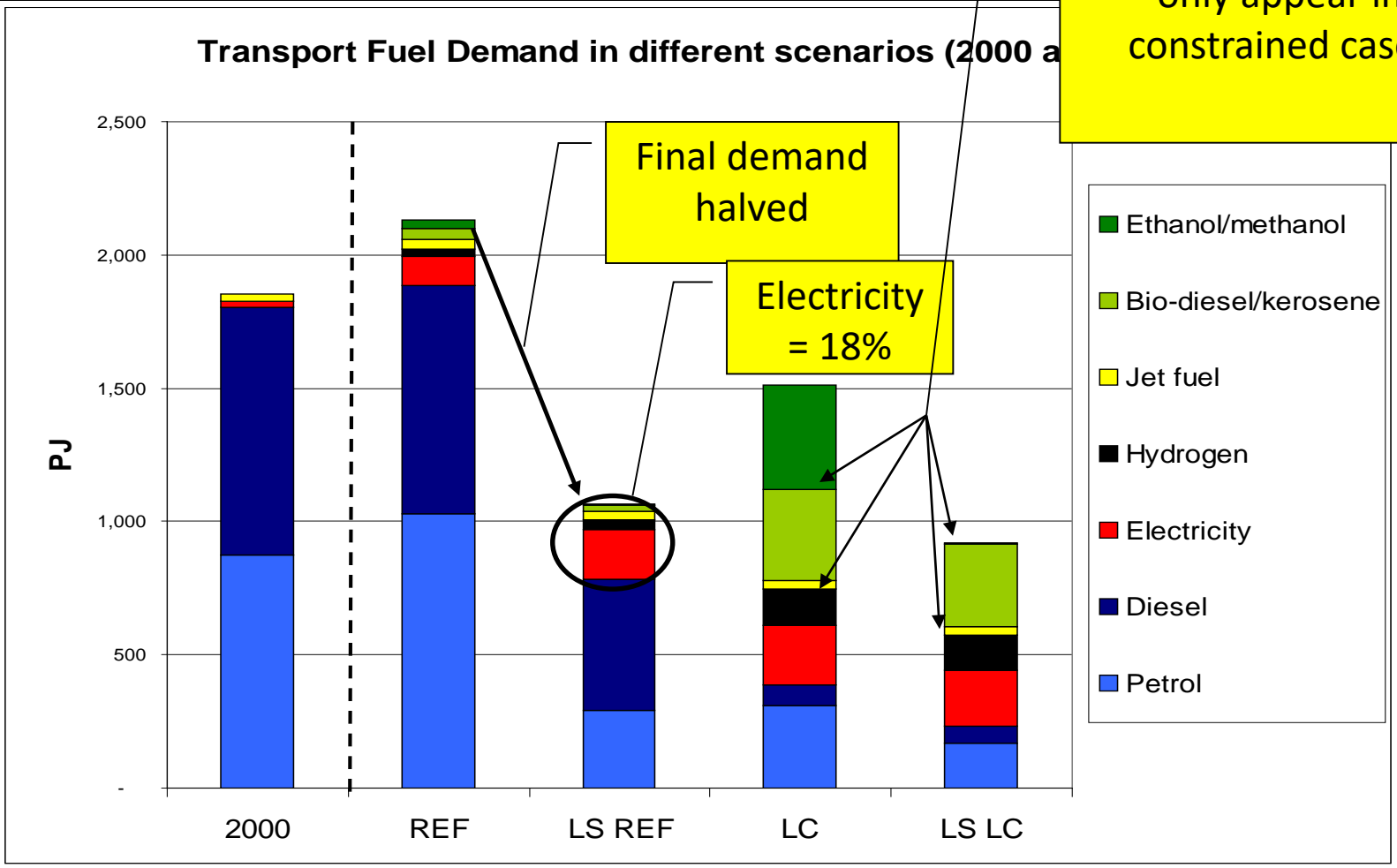
Total distance	Down 21%
Mode choice	<u>Car</u> from 81% - 38% distance <u>Cycling</u> from 1% -13% distance
Vehicle choice	HEV + BEV + PHEV = 77% share of total VKMs in 2050
Driving Style	'Eco-driving' = 5% reduction in FC and CO <sub>2</sub> per km by 2025
Load factors	Car occupancy up 23% by 2050

# Mode split in 2007, 2020 and 2050

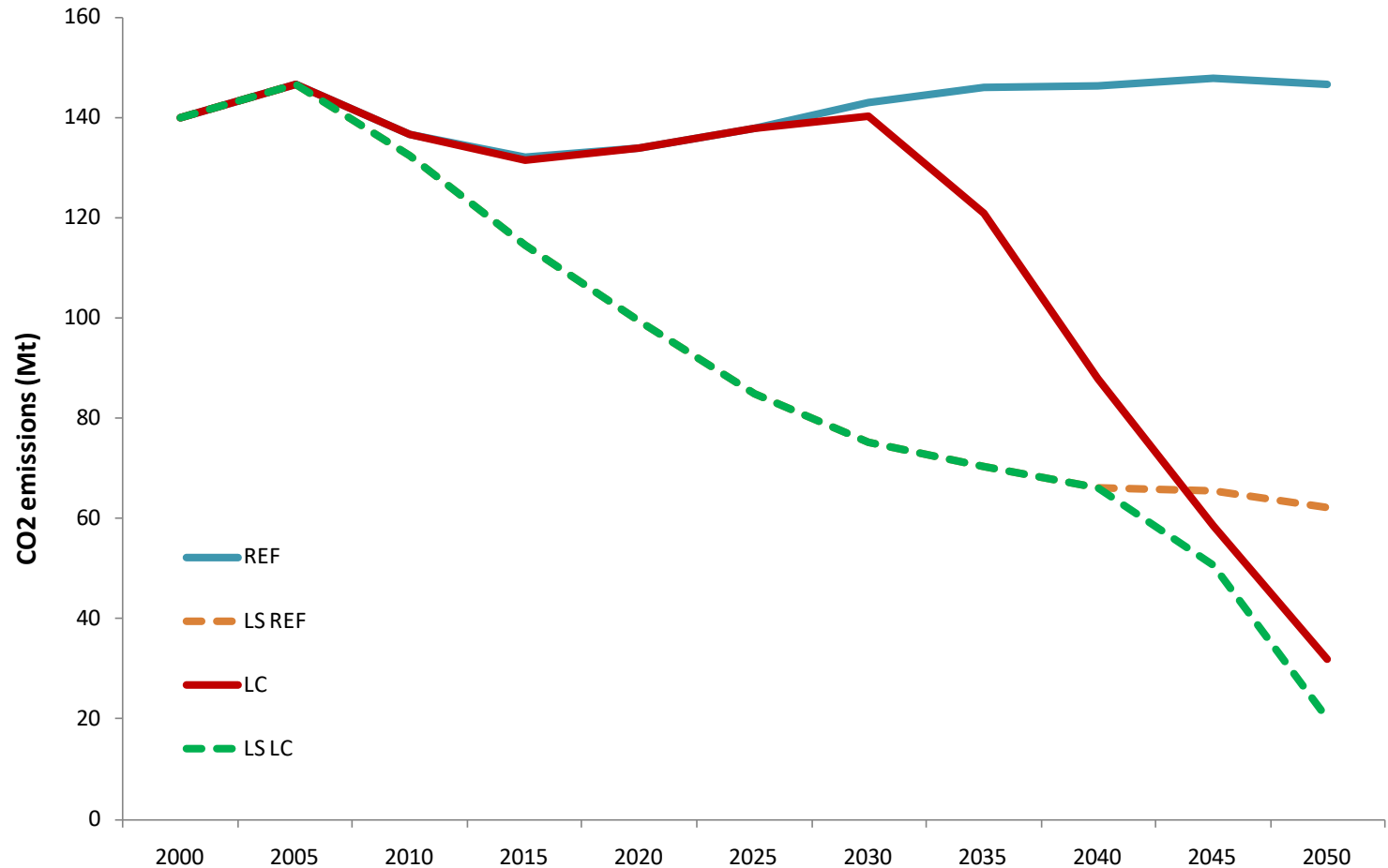


# Transport sector – impact on fuel demand

Biofuels and hydrogen only appear in constrained cases



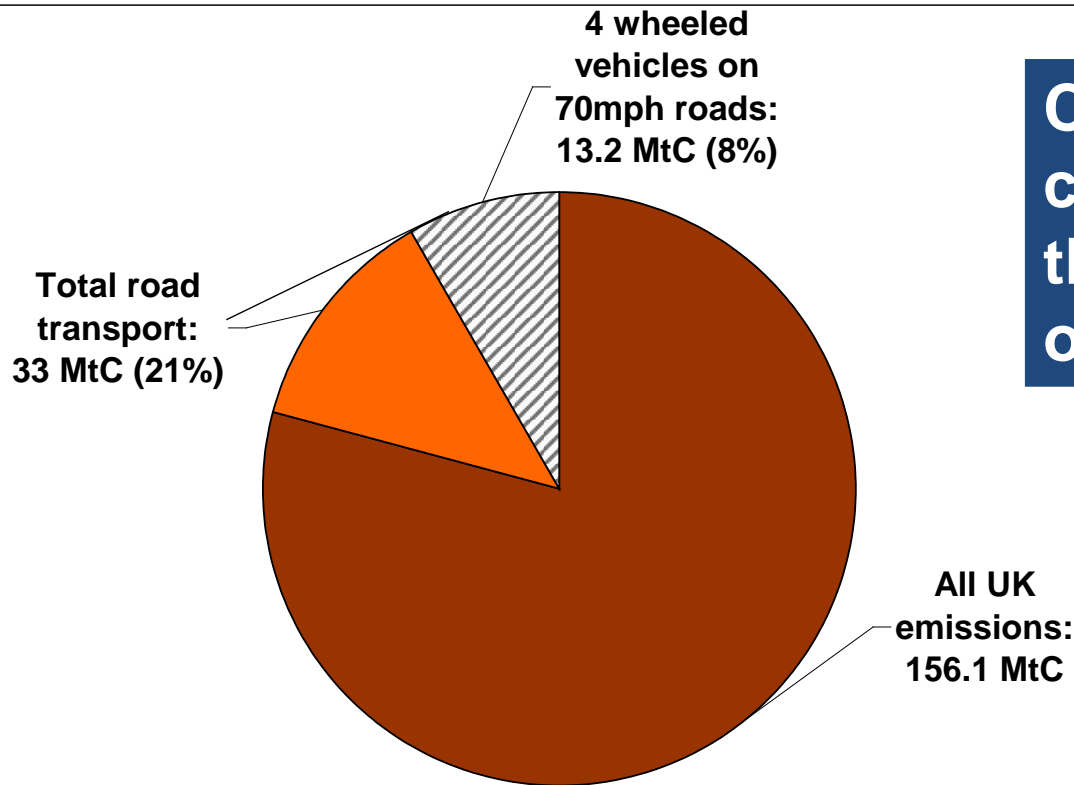
# Projections of CO2 emissions (in MtC at source from domestic transport in each scenario, MED results)





# Example 2: Motorway speed limits (and enforcement)

4-wheeled vehicles on 70 mph roads = 41% road transport CO<sub>2</sub> & 8% of all CO<sub>2</sub>

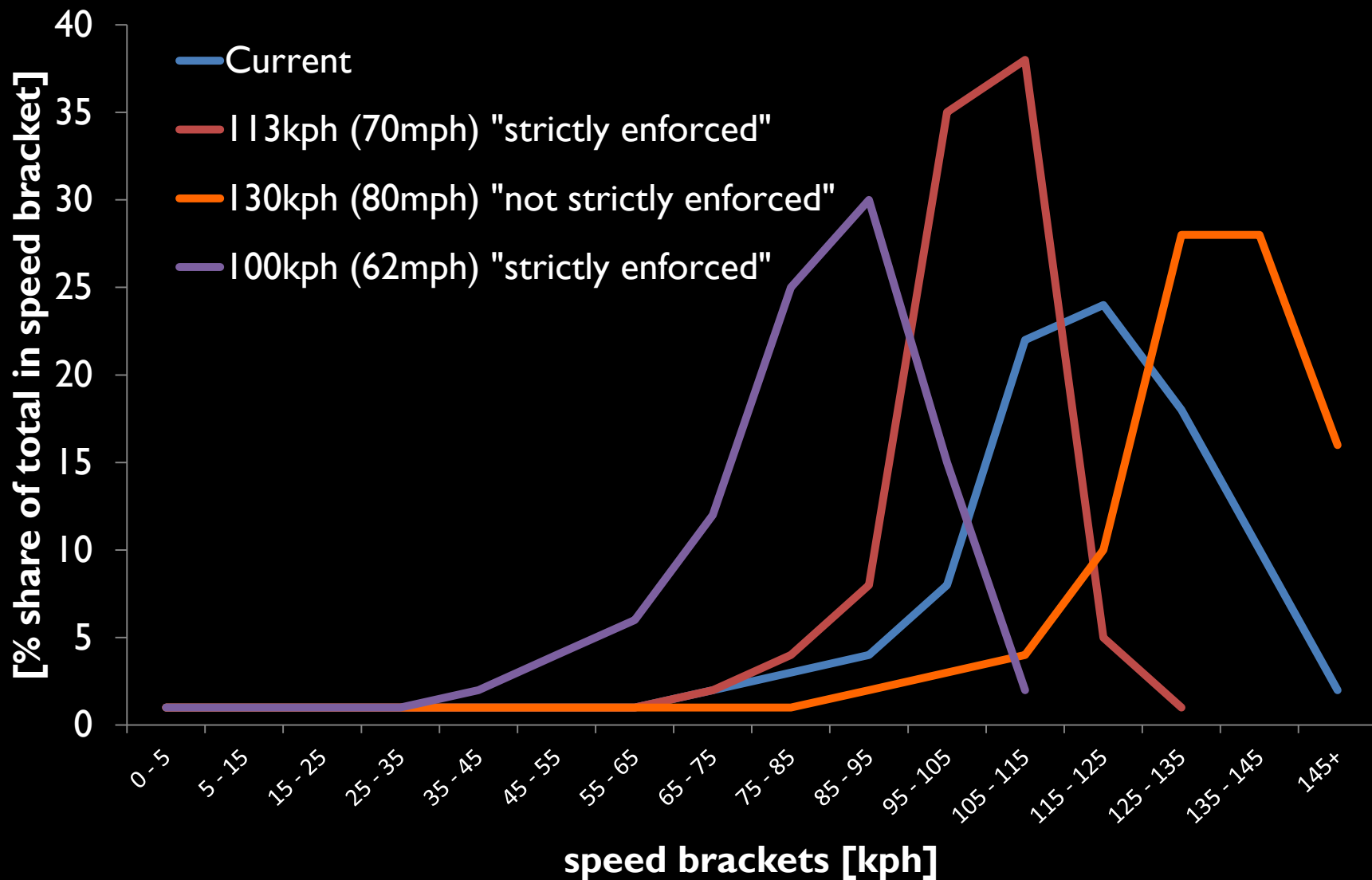


Ca. 50% of cars exceed the speed limit on motorways

**Back in 2011...**



# Motorway speed limits - model setup

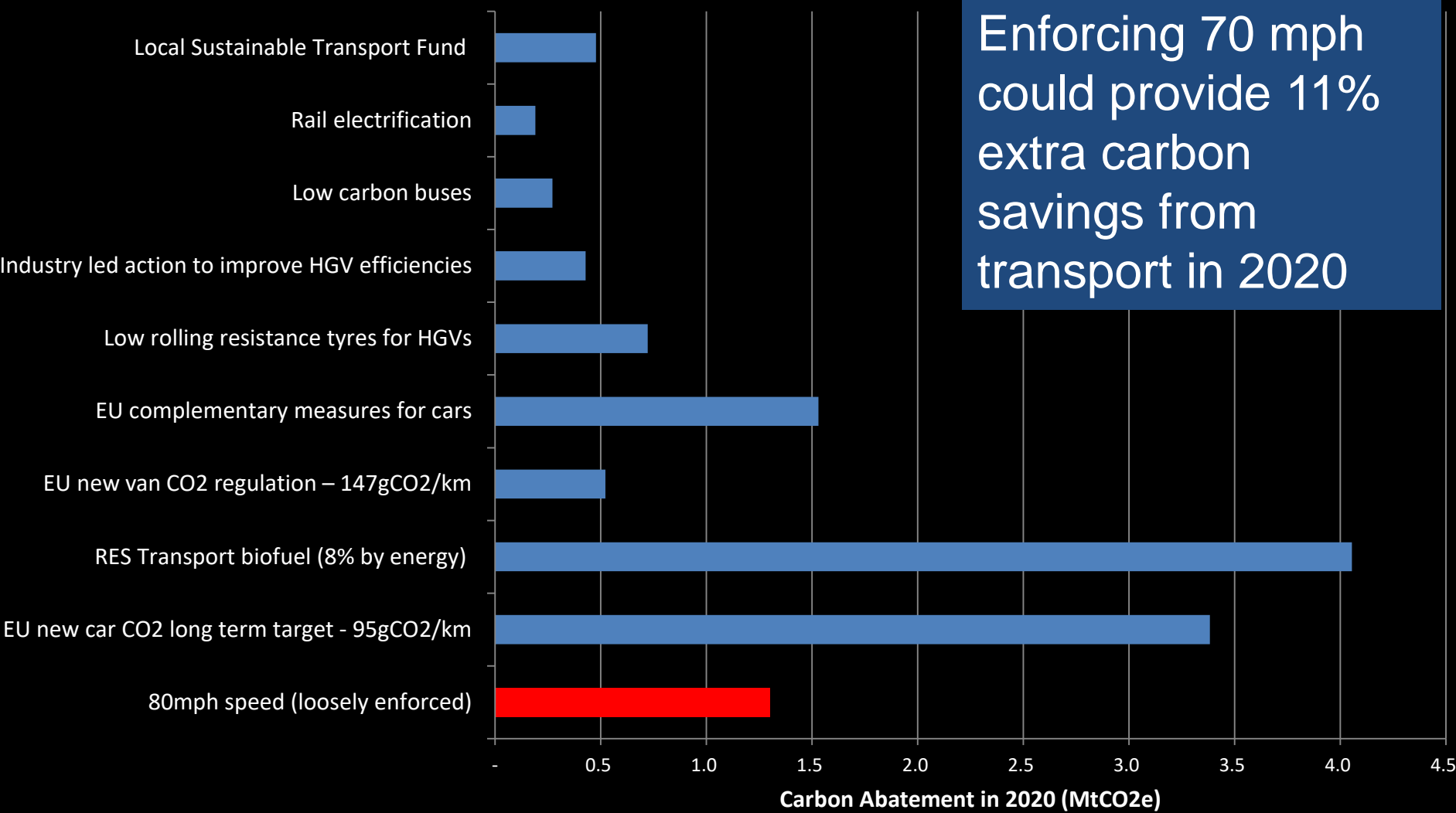


# Motorway speed limits - key results

Life-cycle carbon in 2020	113kph (70mph) 'enforced'	130kph (80mph) 'not enf.'	100kph (62mph) 'enforced'
change vs REF (MtCO <sub>2</sub> e pa)	-1.3	+1.3	-2.7
change vs REF* (% over total)	-0.9%	+0.7%	-2.1%

# Projected CO2 savings from transport policies in 2020 (comparison of DECC 2011 and UKERC Speed enforcement analysis)

Enforcing 70 mph could provide 11% extra carbon savings from transport in 2020



# Speed enforcement is good because

- Relatively **large carbon saving**
- Potentially **cost-effective**
- **Quick hit**
- Evidence from controlled motorway trials shows **potentially good public acceptability**
- **Ancillary benefits** – safety, air quality, network optimisation
- Knock-on **effect on car market?**

**Example 3** - scenario analysis exploring  
UK Committee on Climate Change EV  
pathway for 4<sup>th</sup> and 5<sup>th</sup> carbon budget

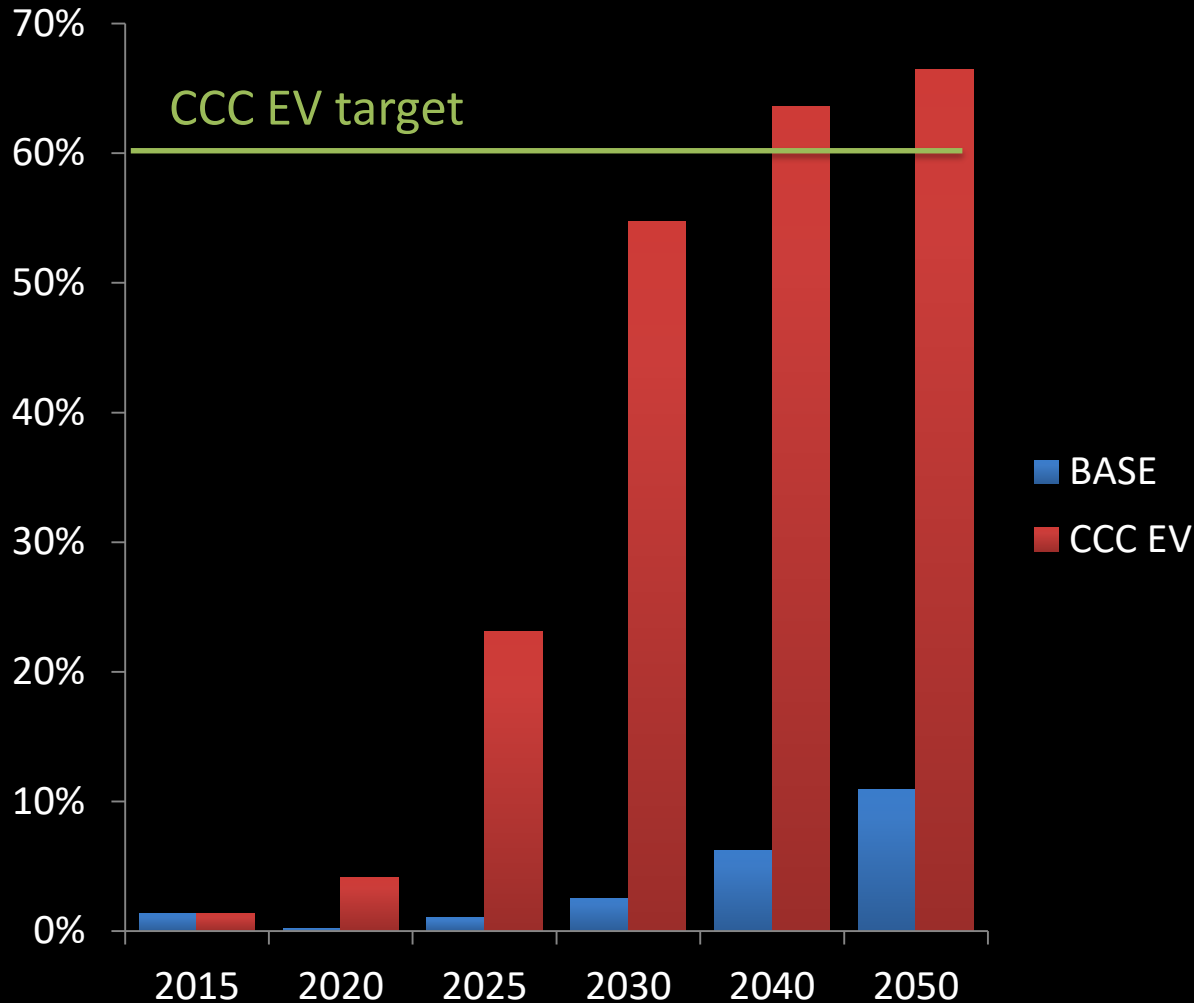
*consumer segmentation in a  
heterogeneous car market*

## UK CCC's *high EV uptake pathway*:

- 9% market share for EVs by 2020
- 60% market share for EVs by 2030
- Indicative 100% market share for EVs by 2040, so that, taking the stock turnover into account, the vehicle stock is 'virtually decarbonised' by 2050
- NB: in 2013 only 0.1% of new car sales were EV; in 2015 they were higher at 1.4%



# Results: electric vehicle sales (share of total)



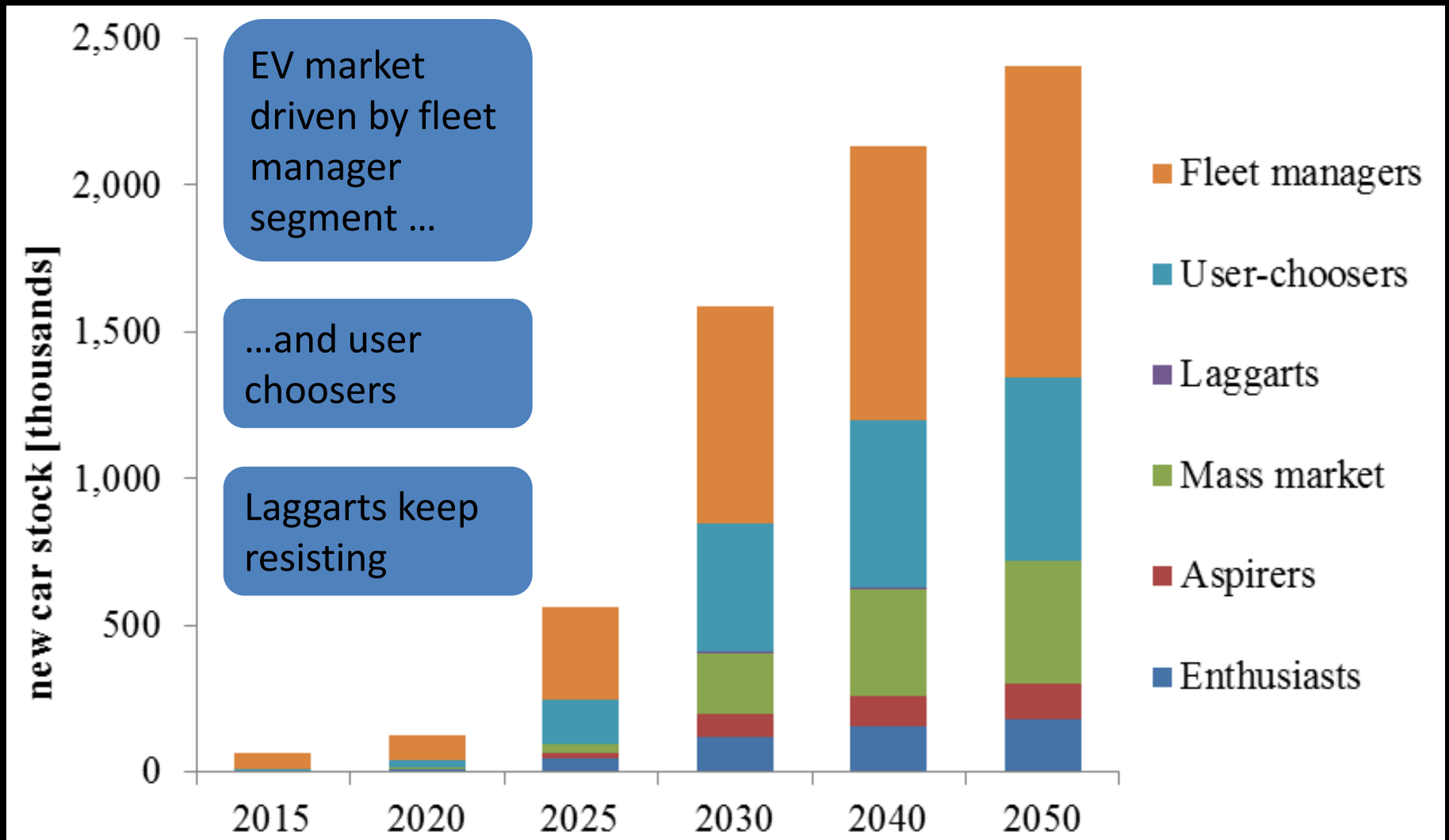
In baseline scenario market collapses then picks up again

In CCC EV much higher uptake and pace in 2020s – plateau from 2030s?

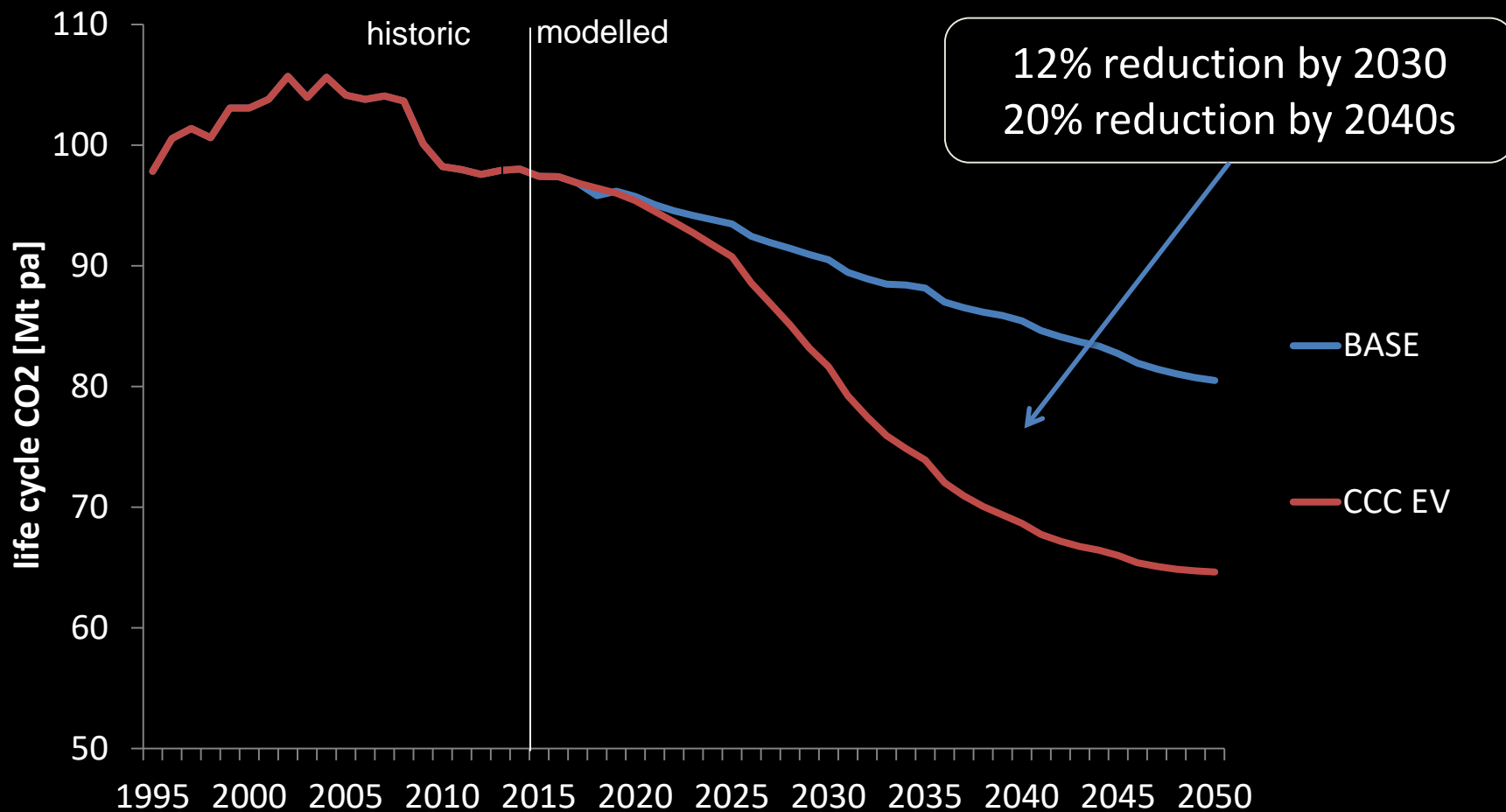
100% will be difficult to achieve even in long term

Continued value support (EV grant, ECA) needed

# Who buys electric vehicles? (CCC high EV scenario)



# Direct CO<sub>2</sub> emissions decrease for cars but offset by indirect emissions from electricity generation and car manufacturing and disposal



## Example 4: Upfront cost incentives are crucial – e.g. car purchasing ‘feebates’

Car purchasing **feebates** can be effective in accelerating low carbon technology uptake and reducing life cycle GHG emissions whilst **ensuring revenue neutrality – adaptive CO<sub>2</sub> grading and flexible and dynamic policy design** crucial in achieving transition

Brand, C., Anable, J., Tran, M. (2013) Accelerating the transformation to a low carbon passenger transport system: The role of car purchase taxes, feebates, road taxes and scrappage incentives in the UK. *Transp. Res.: Part A: Pol. Practice* 49, 132-148.

# STEAM | UKTCM: current work

- **LA STEAM**: a spatially more explicit version for Scotland (LAs) – data issues, usefulness for local policy making
- **LA UKTCM**: ditto for the UK (regions, LAs) – UKERC
- **Improved demand model** framed around decision making and ‘transport user groups’ rather than demand sectors/modes of transport – individuals, fleet managers, organisations

**SOME STEAMY OUTPUTS?**

# STEAM: opportunities

- Scotland Energy 2060 – an exercise similar to E2050 but focussing on Scotland
- Specific policy areas:
  - speed limits
  - active travel
  - travel behaviour change including destination shifting
  - zoning (links to AQ policy)
  - shared mobility using low carbon modes
- Very much open for ideas – we like to make this useful

## Thank you!

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**SPARE SLIDES**

# EV uptake REF vs CCC target for 2030

3.2m new cars predicted in 2030 (UK tcm)

So EV target is 60% of this = 1.92m

- **Baseline / REF scenario**

- CC tax regime unchanged beyond 2020
- no plug-in vehicle grant (£5k) beyond 2017
- no infrastructure intervention
- UKERC/CCC assumptions on vehicle costs, efficiency improvements, etc.

- **CCC target scenario**

- All aware by 2026
- preferences 'equalise' once 25% of new market share (except Resistors)
- Increase in overnight access and rapid network
- certainty of access to charging for fleet=40%, reduced charging times,

# STEAM | summary conclusions

- **Tool for policy analysis** within scenario framework
- Wide range of quantifiable variables for **scenario analysis**
- **Evolving stock model**, simulating fleet renewal, vehicle ownership, vehicle technology choice, vehicle use
- **Detailed energy and emissions model**, simulating fuel quality/carbon content, cold starts, congestion, eco-driving, on-road driver behaviour, speed effects, real world emissions
- **Full environmental consequences**: pollutant emissions by source, by end user, domestic and 'international', targets vs. cumulative, etc.
- **Flexible database system** with graphical user interface