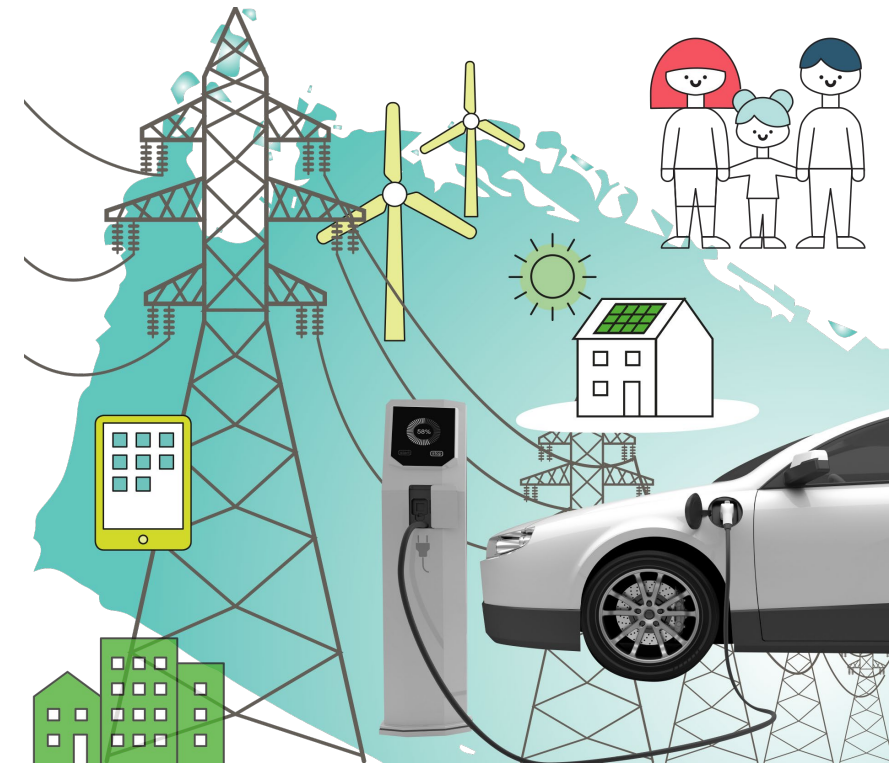


CV EI

Consumers, Vehicles and Energy Integration

Welcome



elementenergy



THE BEHAVIOURAL INSIGHTS TEAM.

Philip New

CEO, Energy Systems Catapult



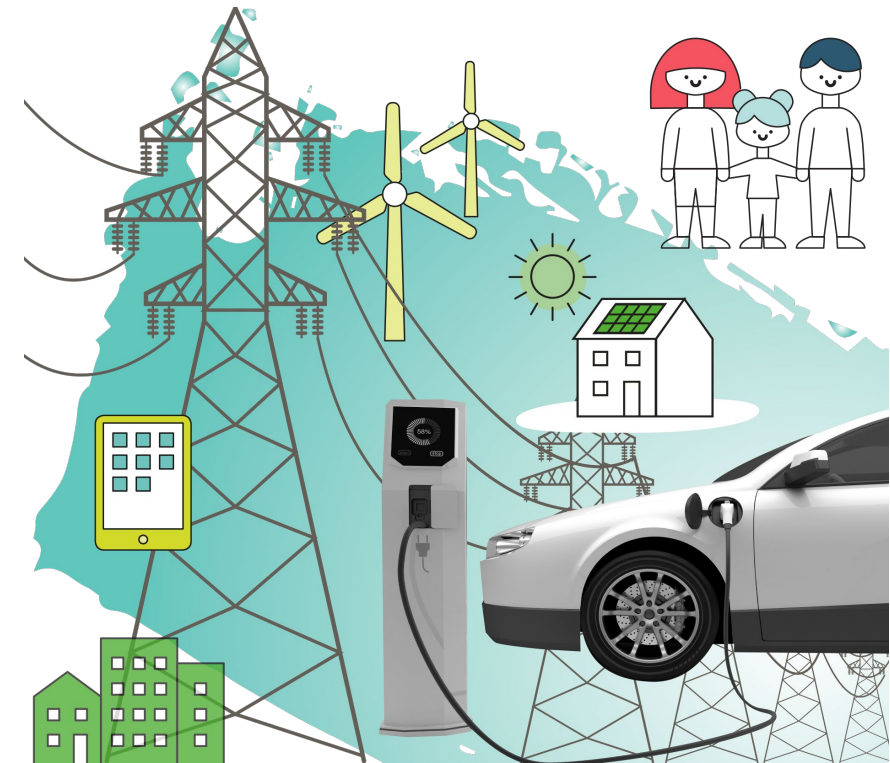
Liam Lidstone

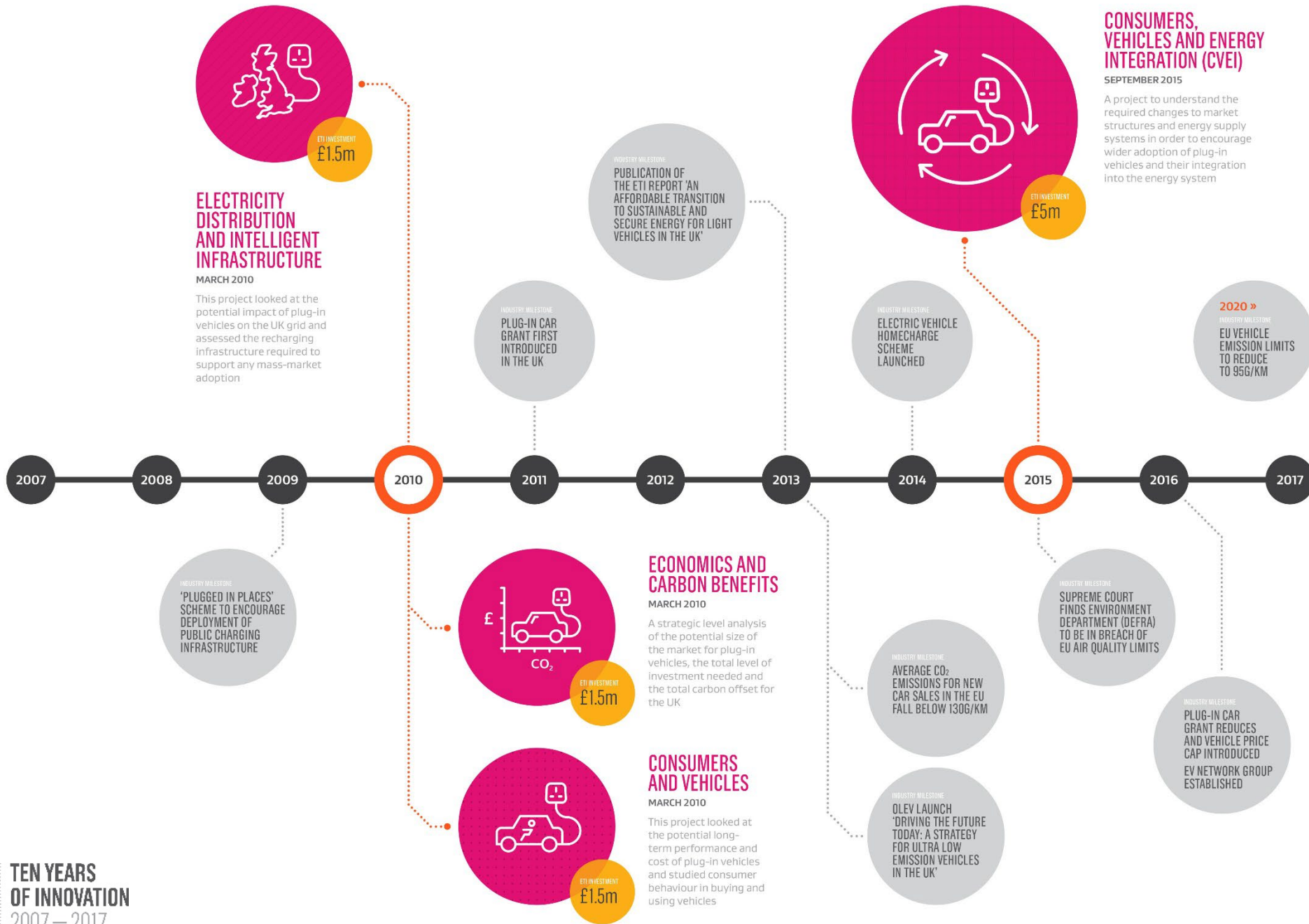
Energy Systems Catapult



Project overview

Liam Lidstone





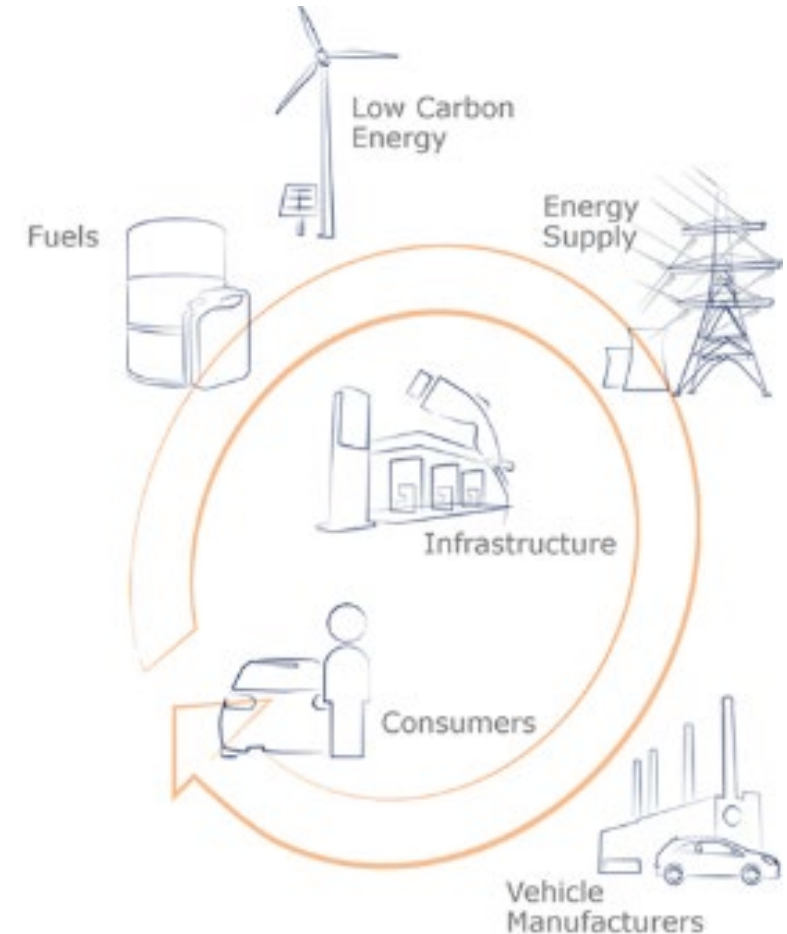
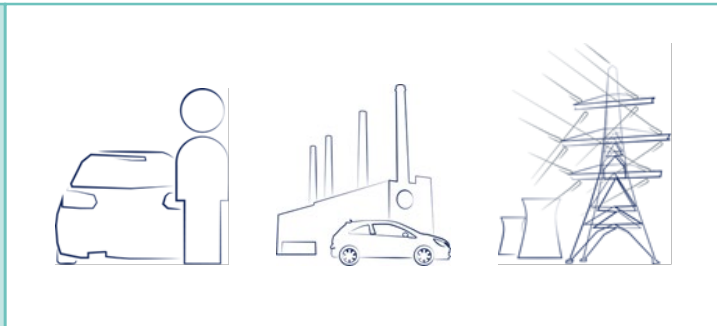
Consumers, Vehicles and Energy Integration project

£5m project to address the challenges involved in transitioning to a **secure and sustainable low carbon vehicle fleet**

*What changes are required to **market structures** and **energy supply systems** to support **high deployment of plug-in vehicles**?*

*What are the **technical implications** of any changes and **how people might respond** to them?*

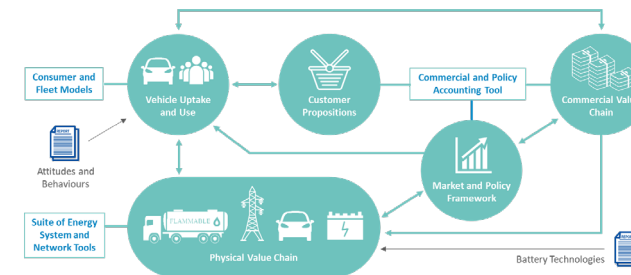
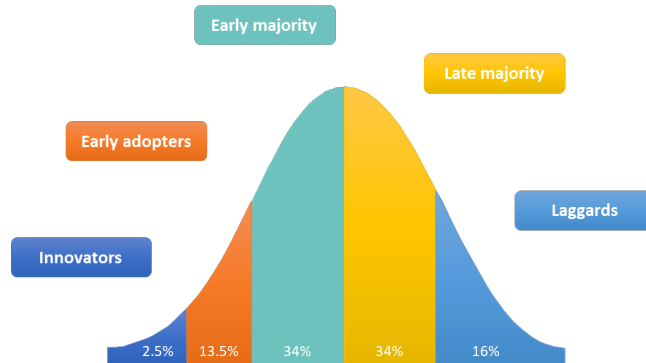
It has examined how tighter integration of vehicles with the energy supply system can benefit:



A first of a kind project

World's first mainstream consumer trials of BEVs and PHEVs

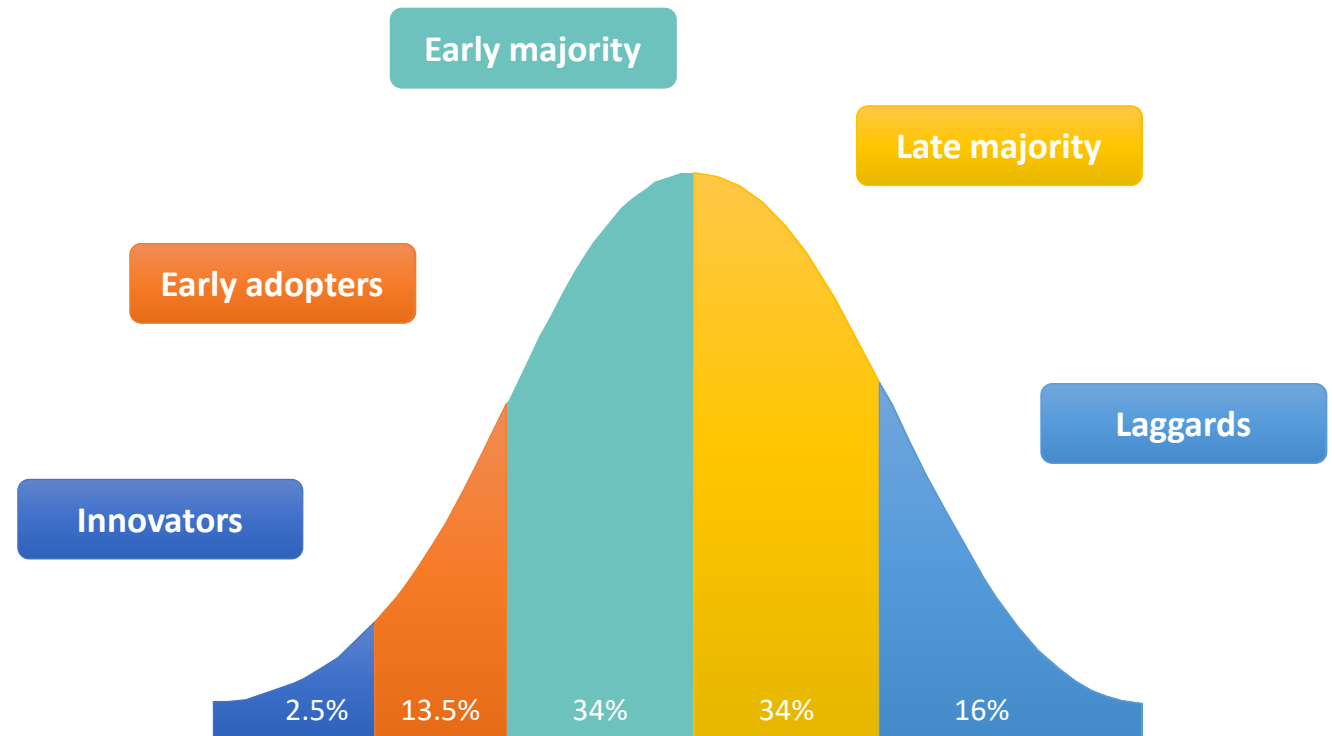
Comprehensive Analytical Framework developed and used to produce data-led Roadmap to 2050



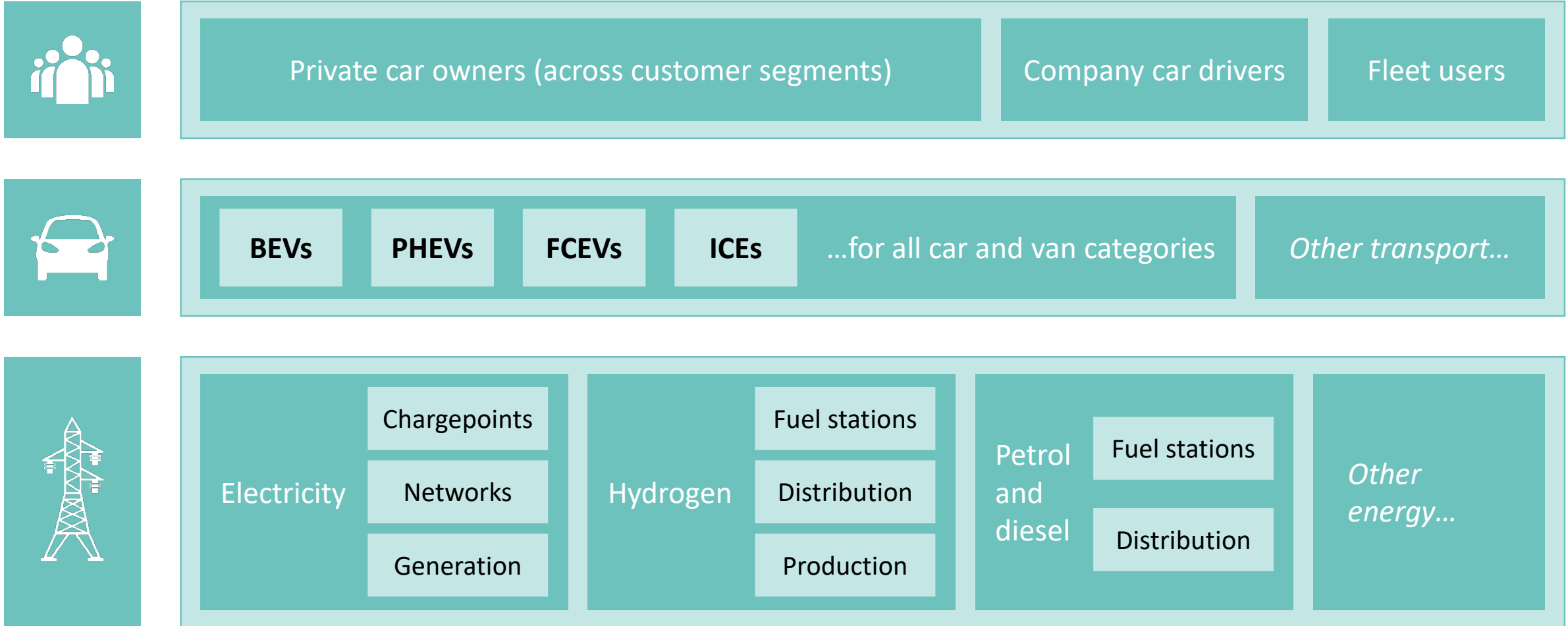
Understanding mainstream consumers

Mainstream consumers

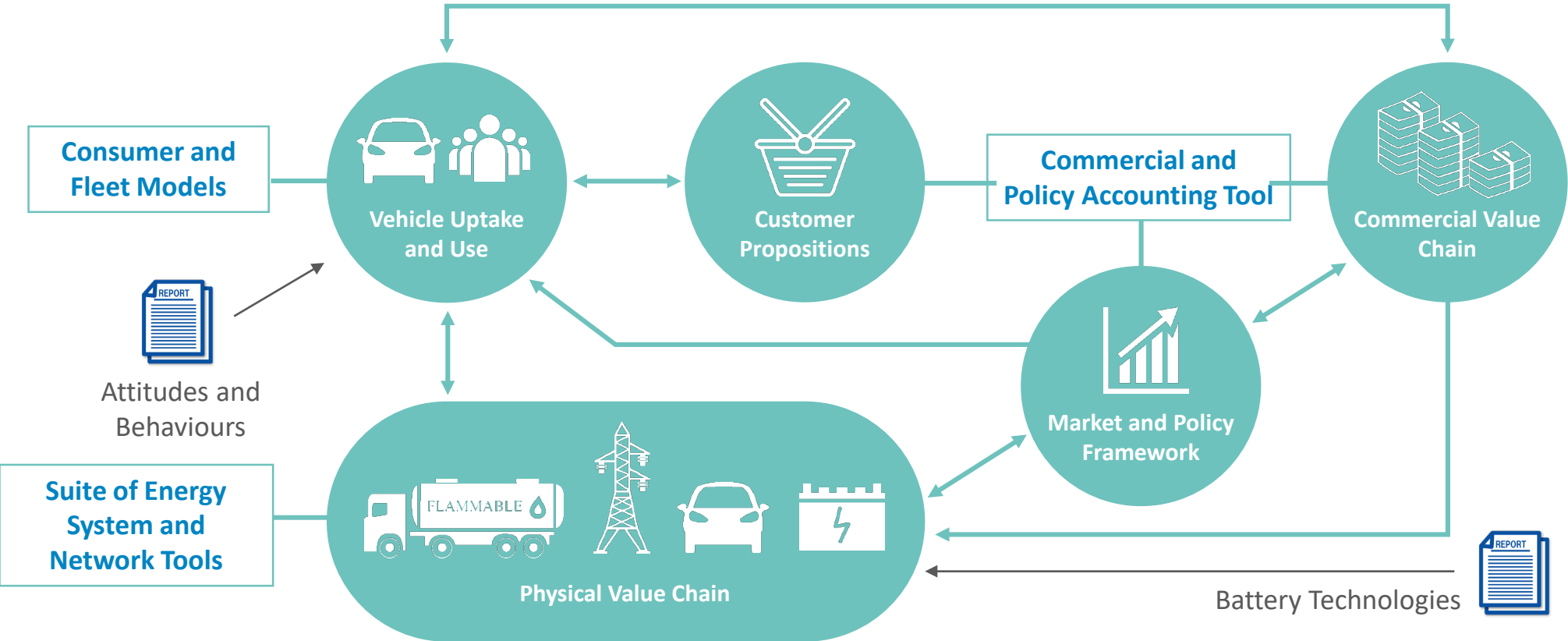
- Unlikely *currently* to use or own a plug-in vehicle
- Much larger numbers of users and so greater impact on the energy system
- Very different motivations, and attitudes to those of Innovators
- Less likely to adapt behaviour to meet needs of the technology
- This project has gathered data with them for both BEVs and PHEVs



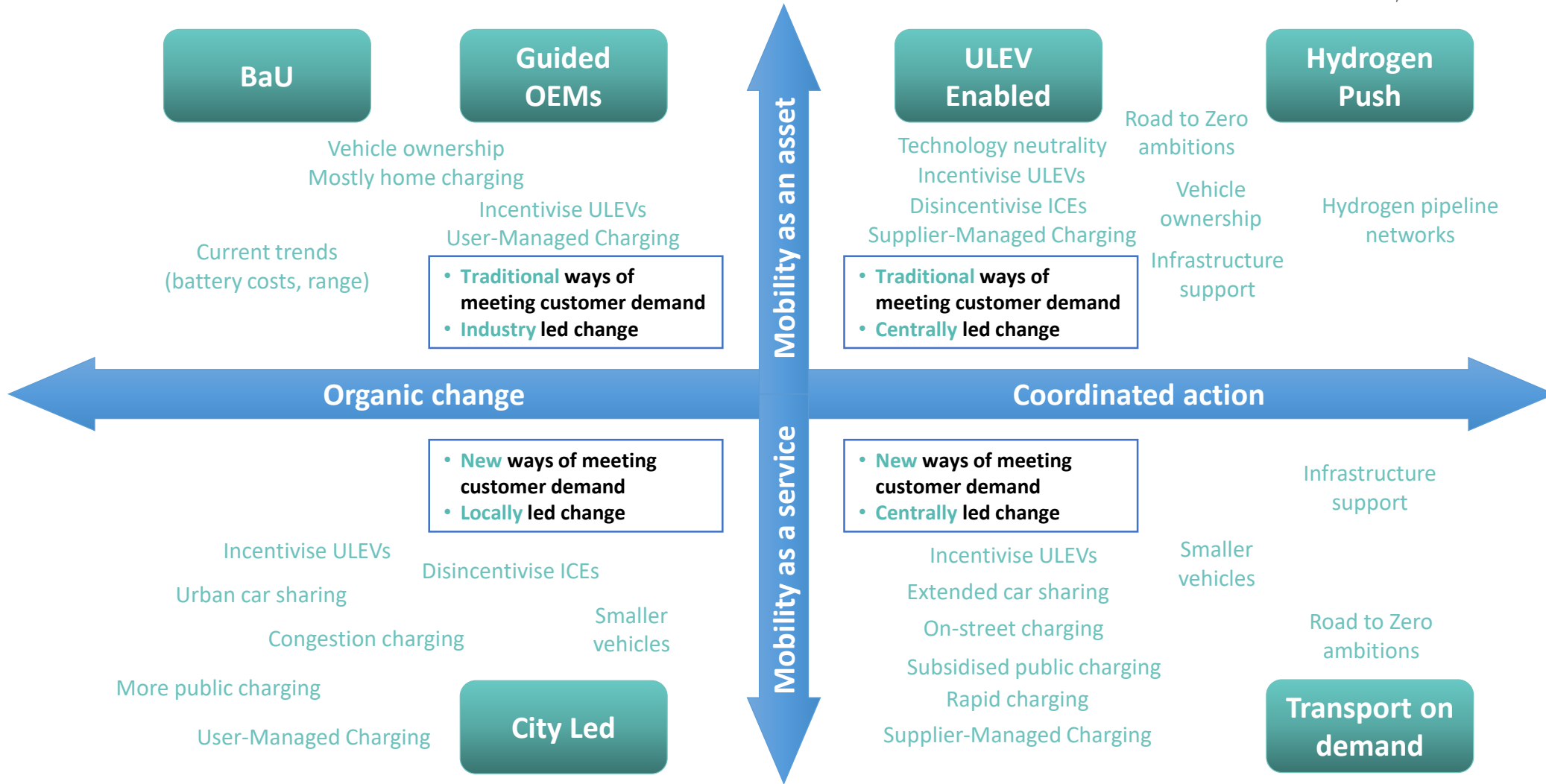
Whole system scope



Whole system assessment



Rich and highly structured plausible future worlds for ULEVs



Published evidence

As well as what we cover today, reports are available covering:

- *Literature review of consumer attitudes and behaviours*
- *Trial designs and methodologies*
- *Case studies for fleets*
- *Battery cost and performance and battery management system capability*
- *Battery state of health modelling*
- *Technology, commercial and market building blocks used in the analysis*



Key messages

The project has revealed:

- What **measures** would **increase uptake of EVs**;
- When **mainstream consumers** would **naturally charge their EVs**;
- How they **respond** to different types of **smart (or managed) charging offerings** and the **appeal** of each;
- The broad **characteristics** of **smart charging offerings** that appeal to consumers;
- The **energy system effects** of these different forms of charging, if used widely
- The **charging infrastructure** required to support the Road to Zero ambitions
- A roadmap of recommended **policy and market interventions** and **actions by commercial entities** to deliver mass-market ULEV uptake and use

Neale Kinnear

TRL



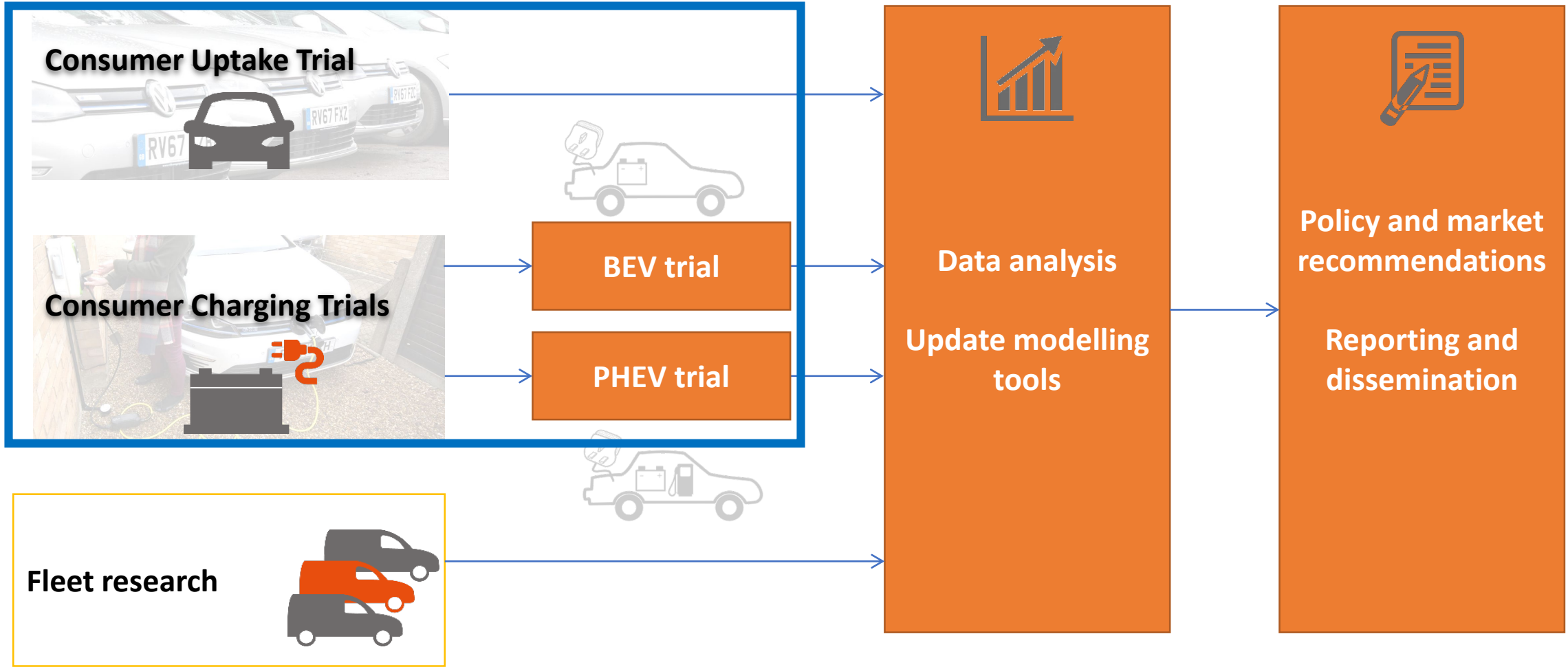
Key findings from the consumer trials

Dr Neale Kinnear

TRL



Recap: What did we do?

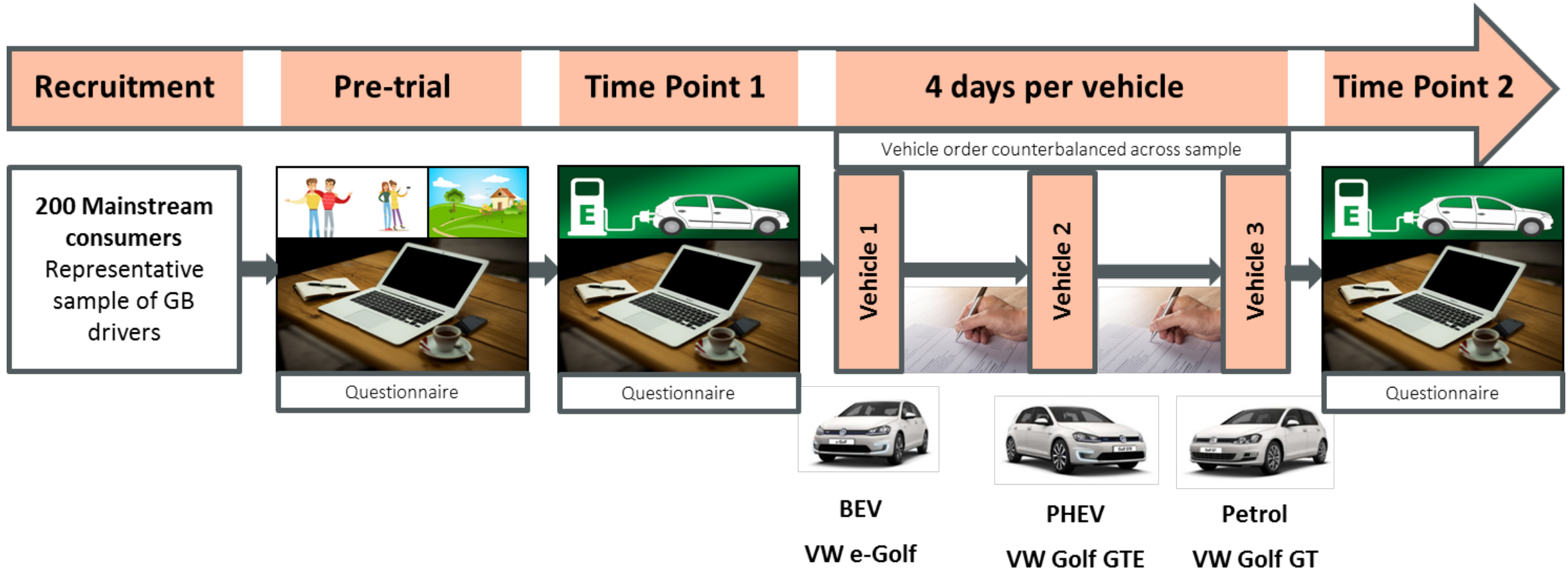


Consumer Uptake Trial

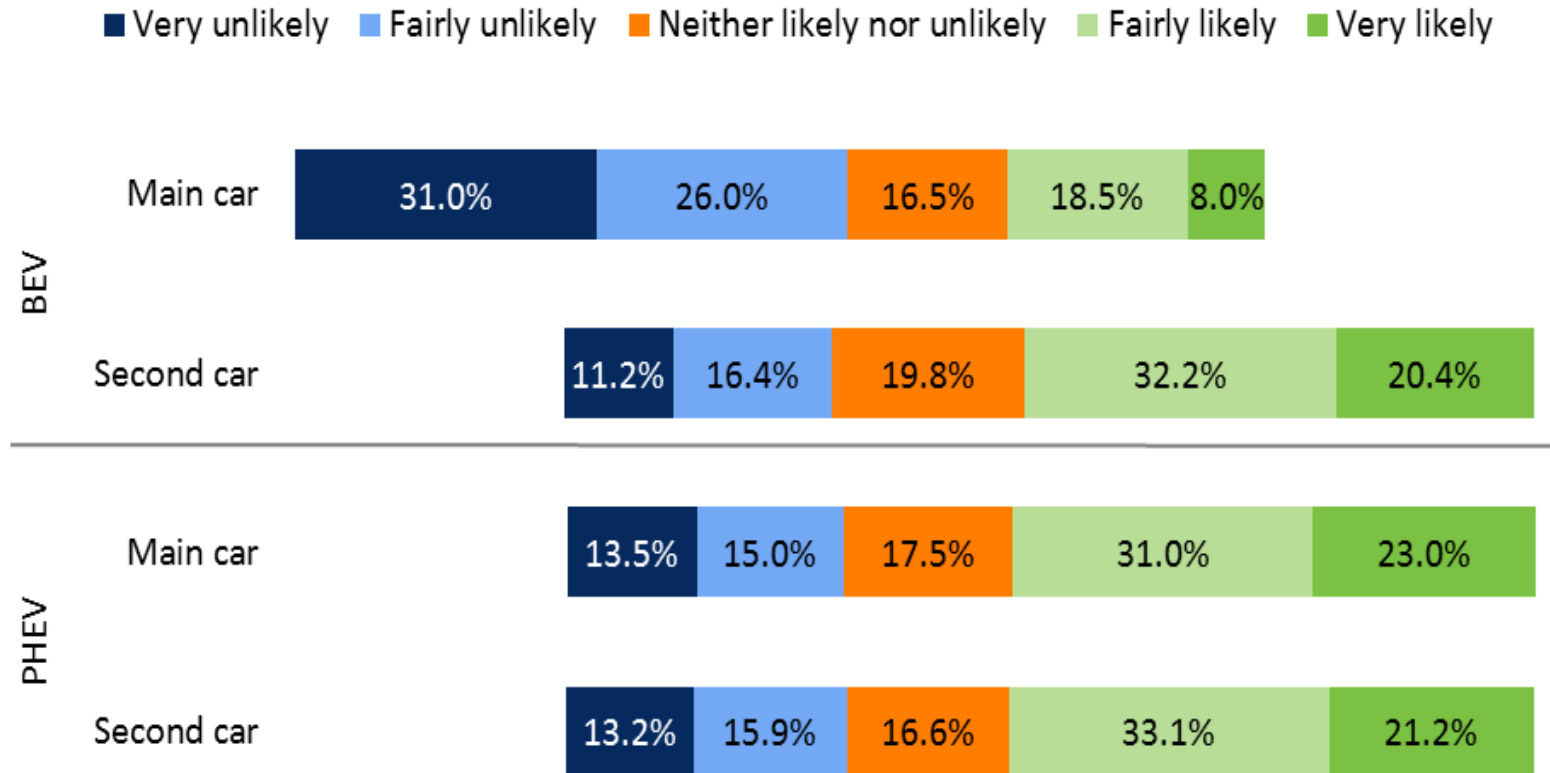
World's first trials of BEVs and PHEVs exploring mainstream consumer adoption



Uptake trial - Overview



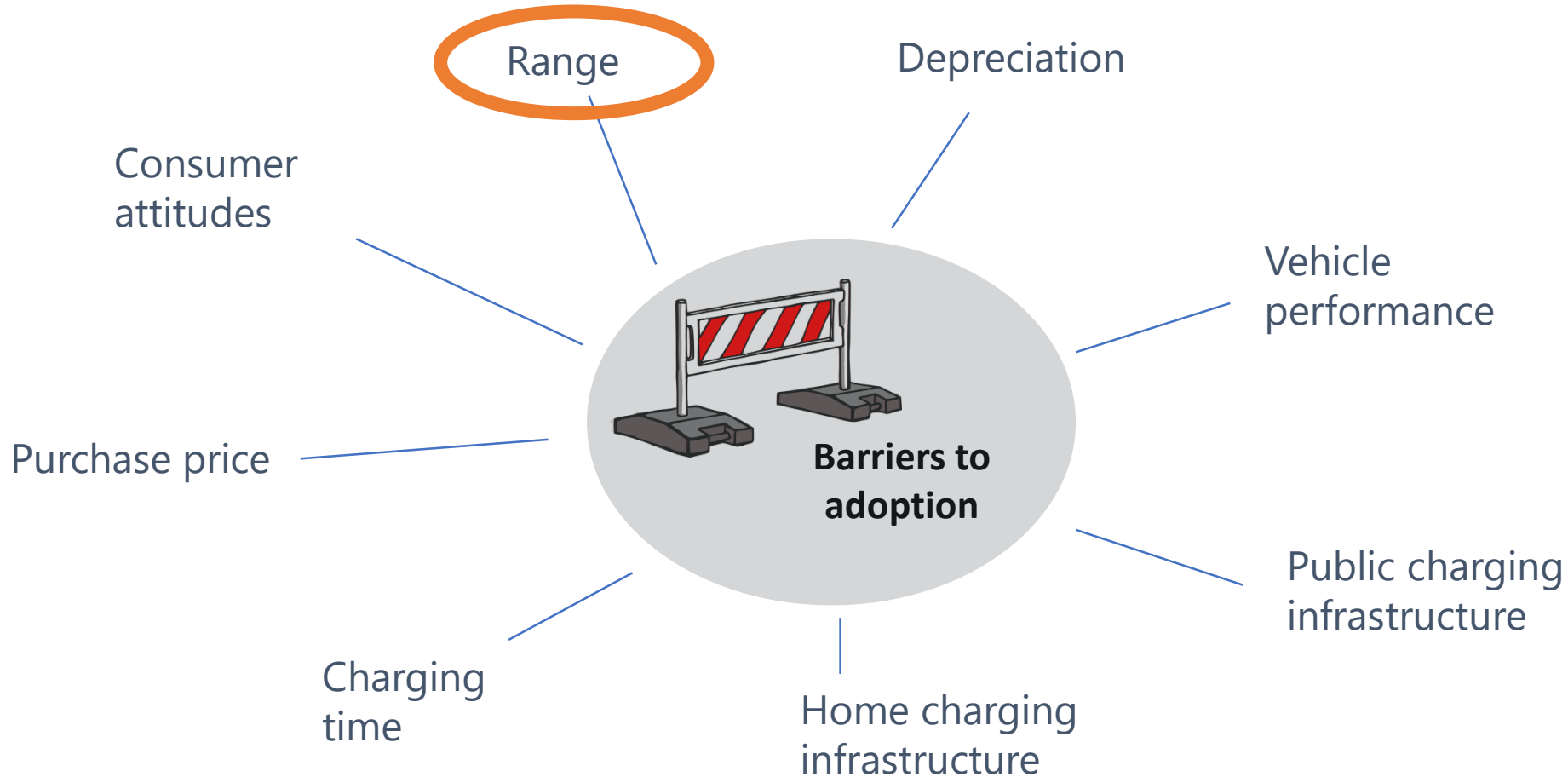
Likelihood to choose a BEV or PHEV in the next 5 years



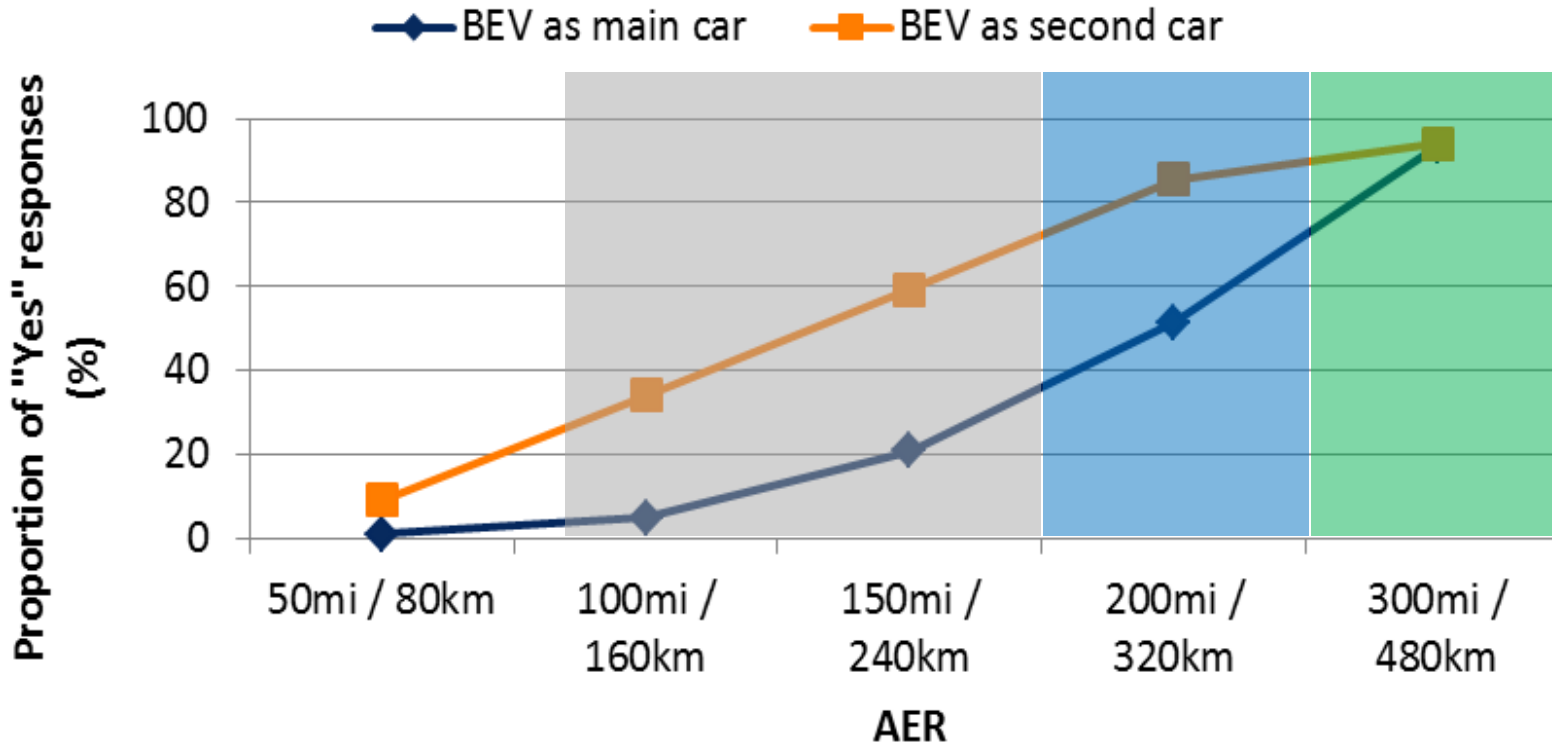
- ~25% likely to choose a BEV as a main car
- ~50% likely to choose BEV as second car
- ~50% likely to choose PHEV, as either main or second car
- Positive outlook for the market in the near term

Reported likelihood to choose a BEV or PHEV

What can we do to encourage the market?



200mi BEVs appeal to 50% consumers; 300mi BEVs appeal to 90%. Lower ranges appeal as second cars

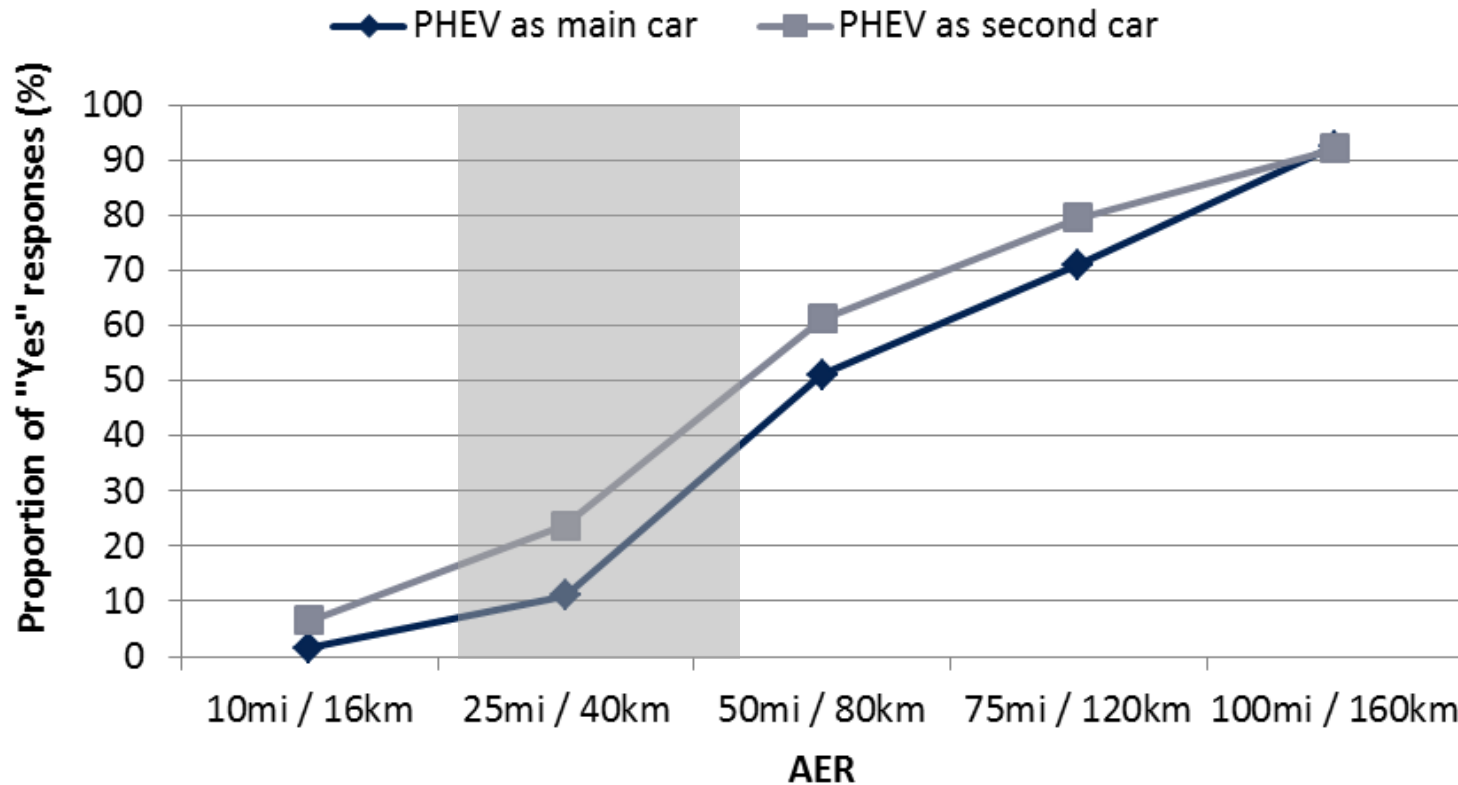


- Tesla Model S Long Range: 375 miles
- Tesla Model 3 Long Range: 384 miles
- Tesla Model X Long Range: 315 miles
- Jaguar I-PACE: 292 miles
- Kie E-Niro: 282 miles
- Hyundai Kona 64kWh: 279 miles
- Audi e-tron: 241 miles
- Nissan Leaf 62kWh: 239 miles
- BMW i3: 193 miles
- VW e-golf: 186 miles
- Renault Zoe: 186 miles

➤ Vehicle models improving, but more choice needed to appeal to majority

Source: WLTP - <https://www.carmagazine.co.uk/electric/longest-range-electric-cars-ev/>

PHEV range is also important: 50mi PHEVs appeal to 50% of consumers; 100mi PHEVs appeal to 90%.

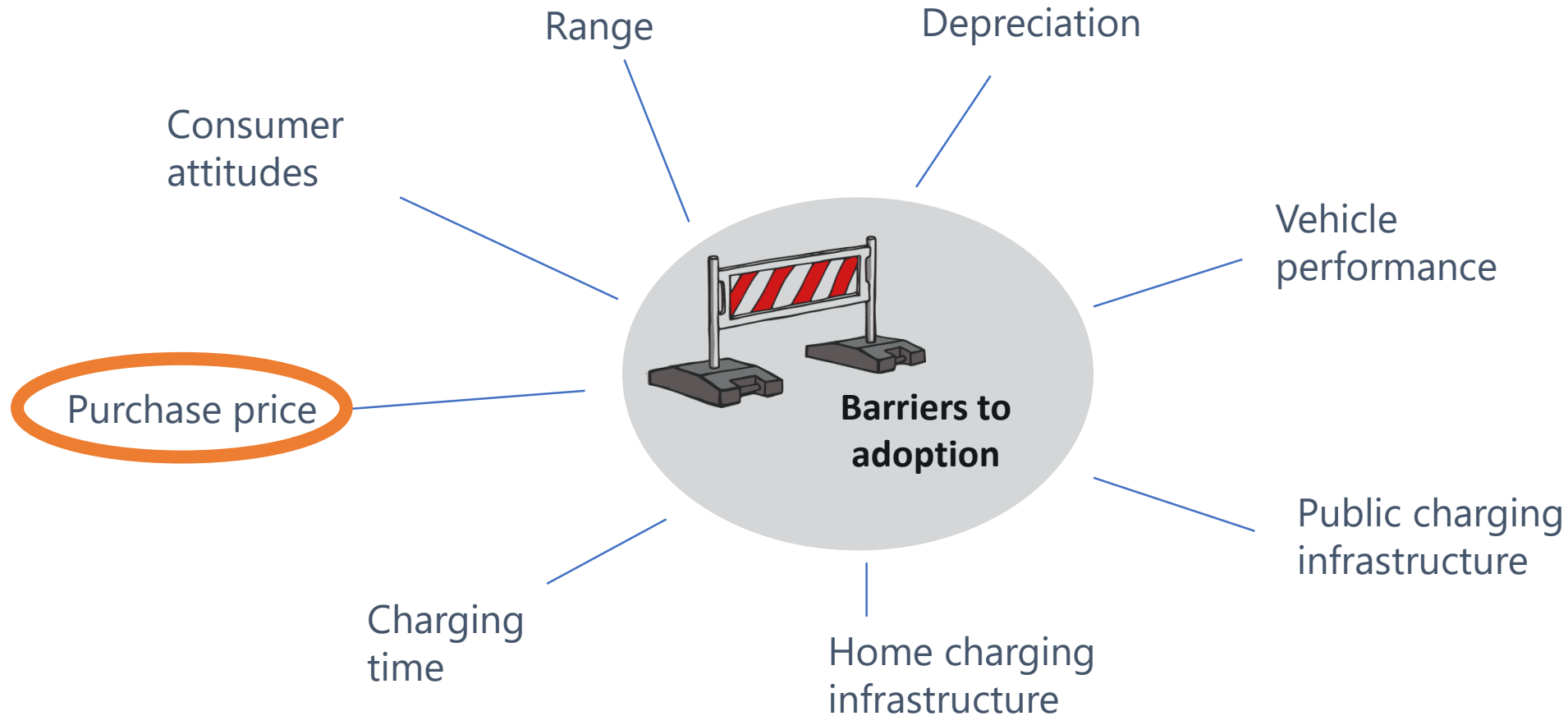


- Hyundai Ioniq PHEV: 39 miles
- Toyota Prius Plug-in: 39 miles
- Kia Niro PHEV: 36 miles
- Mercedes-Benz E300e: 31 miles
- VW Golf GTE: 31 miles
- VW Passat GTE: 31 miles
- Mitsubishi Outlander: 28 miles
- Volvo XC60 PHEV: 29 miles
- Volvo V90 PHEV: 29 miles
- BMW 330e: 25 miles

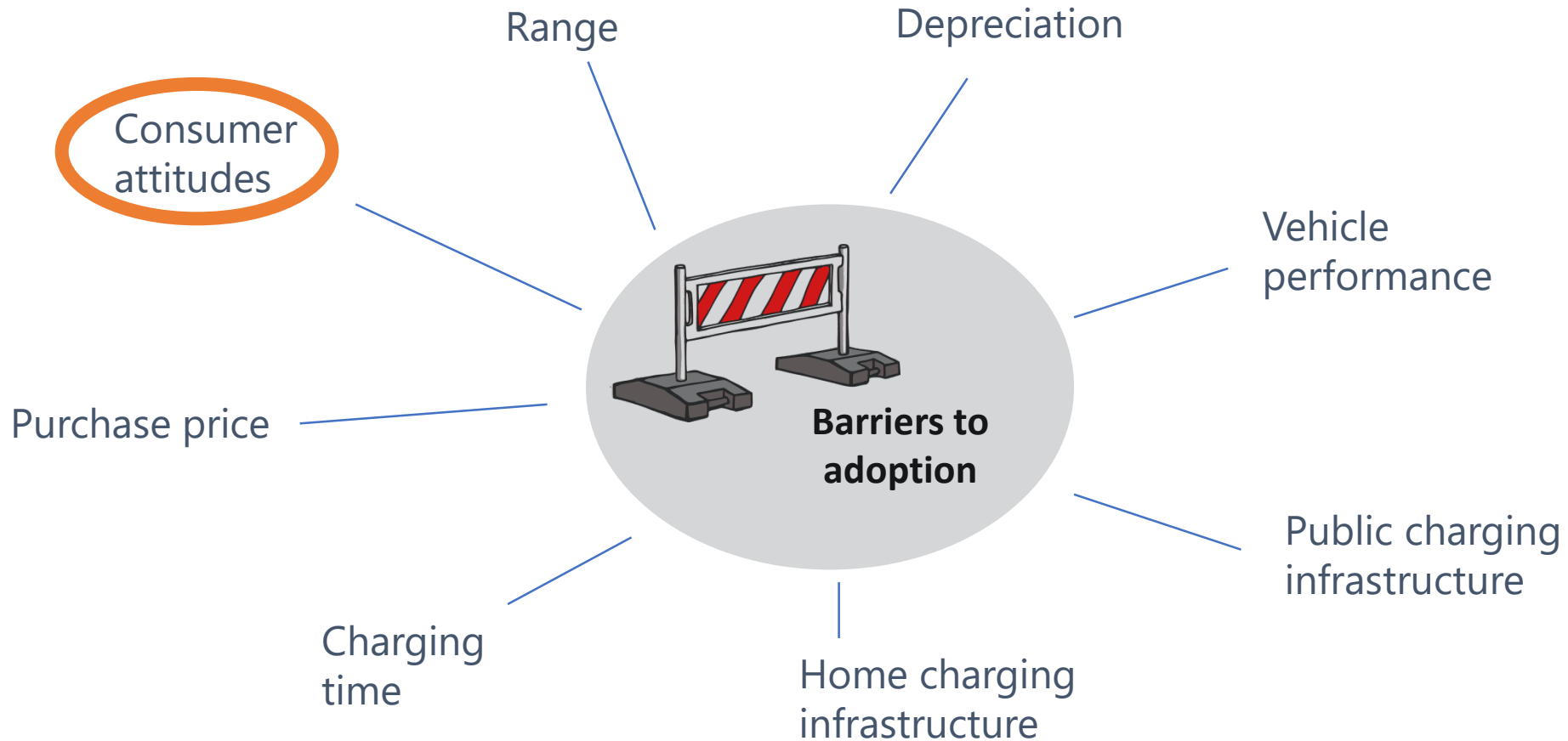
➤ Majority PHEV models around 30mi AER – improvements will increase appeal

Source: nextgreencar.com

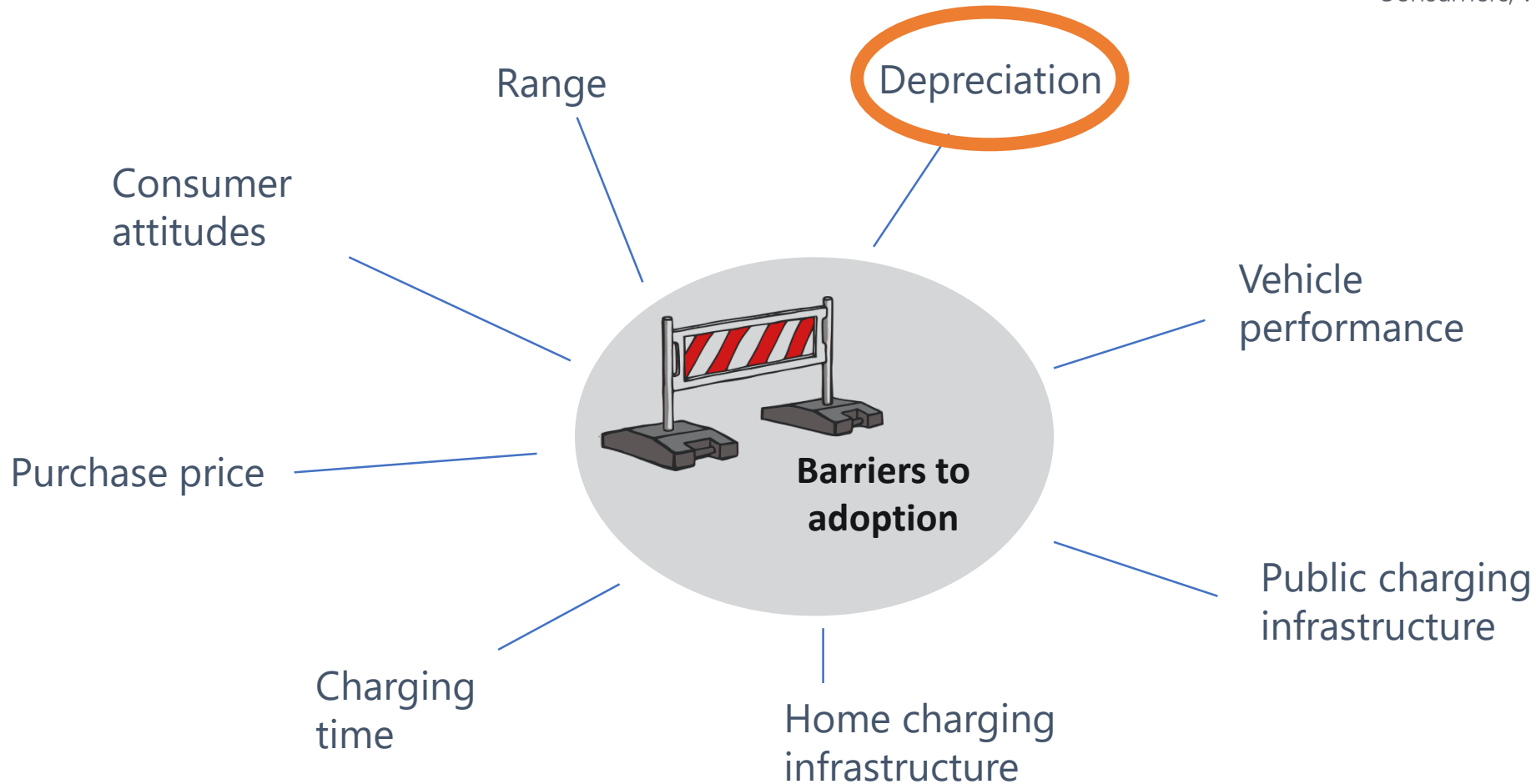
What can we do to encourage the market?



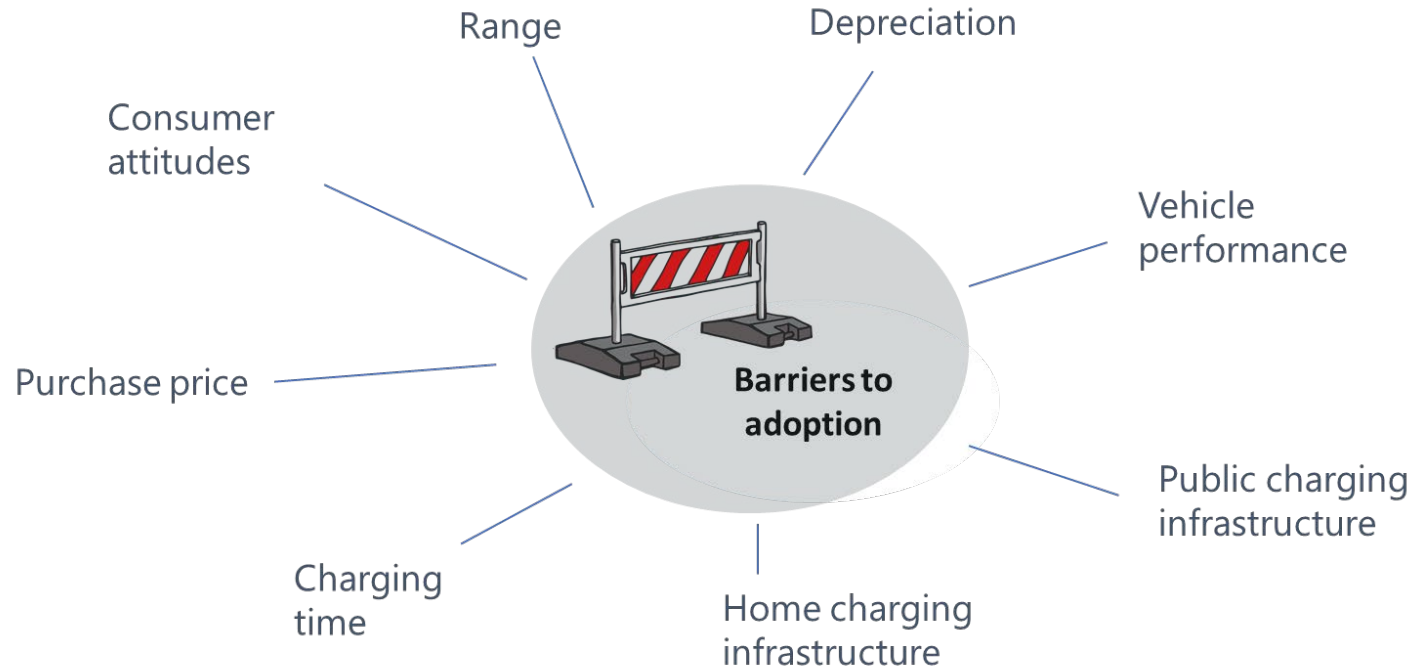
What can we do to encourage the market?



What can we do to encourage the market?



What can we do to encourage the market?



- Full details in the published Uptake Trial report
 - "Deliverable D5.2"

<https://trl.co.uk/consumers-vehicles-and-energy-integration-project-cvei>

or

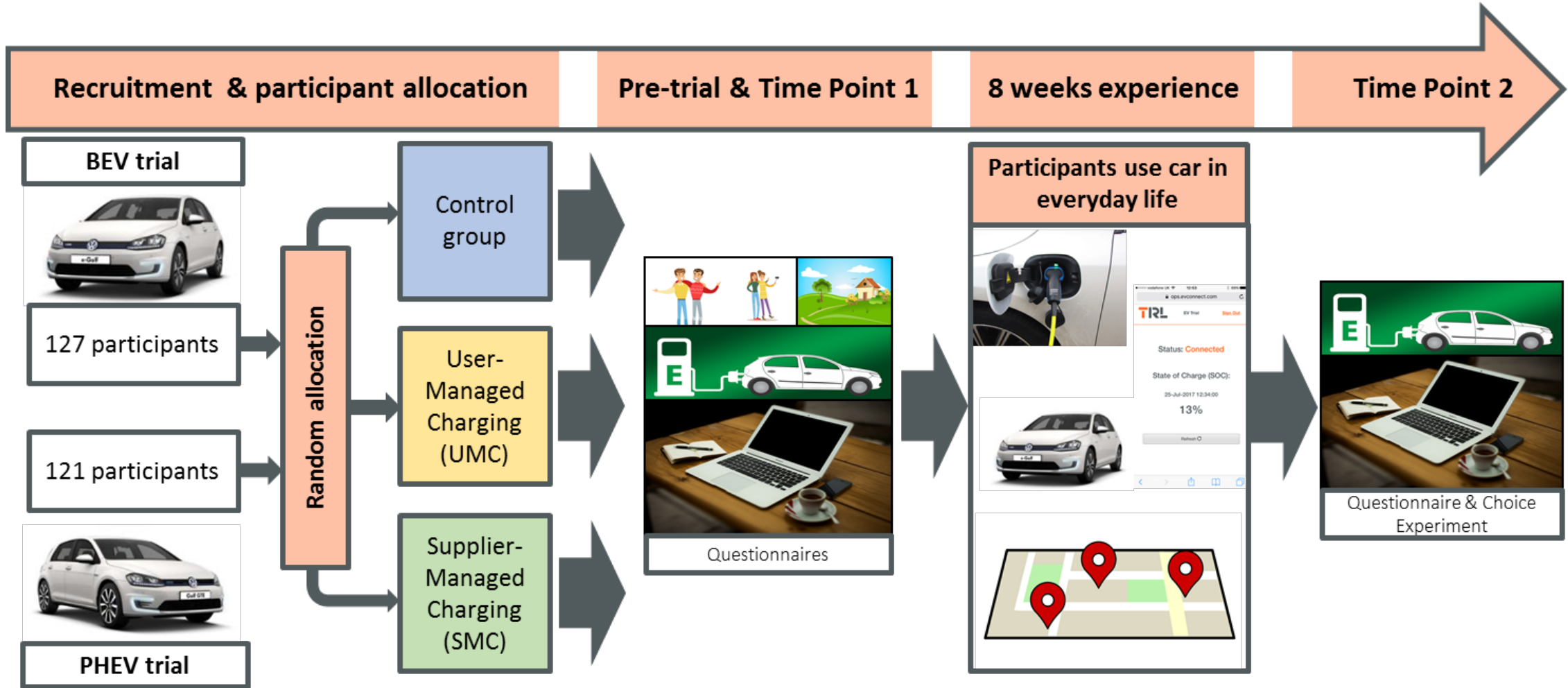
<https://www.eti.co.uk/programmes/transport-ldv/consumers-vehicles-and-energy-integration-cvei>

Consumer Charging Trials

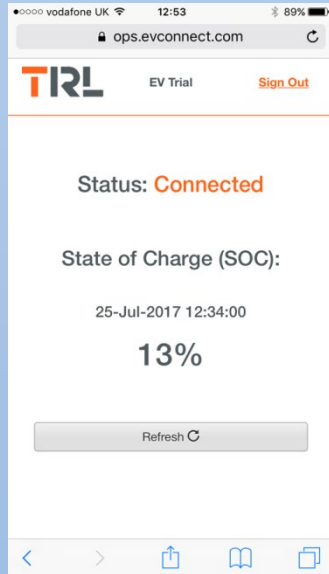
World's first mainstream consumer trials of BEVs and PHEVs exploring how these vehicles will be used and charged



Charging trials - Overview

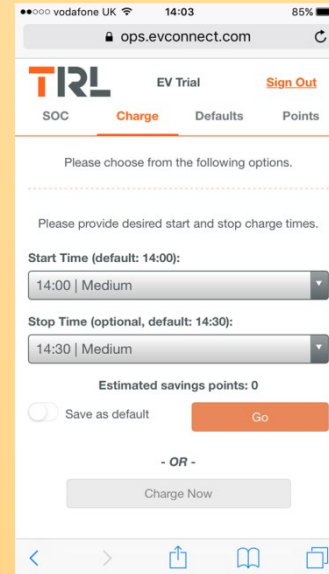


Three charging groups



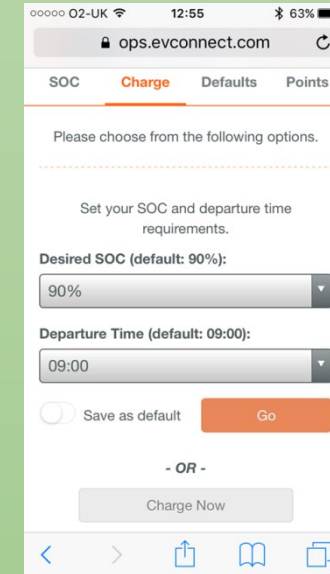
Control group

Free to charge as they wish



User-Managed Charging

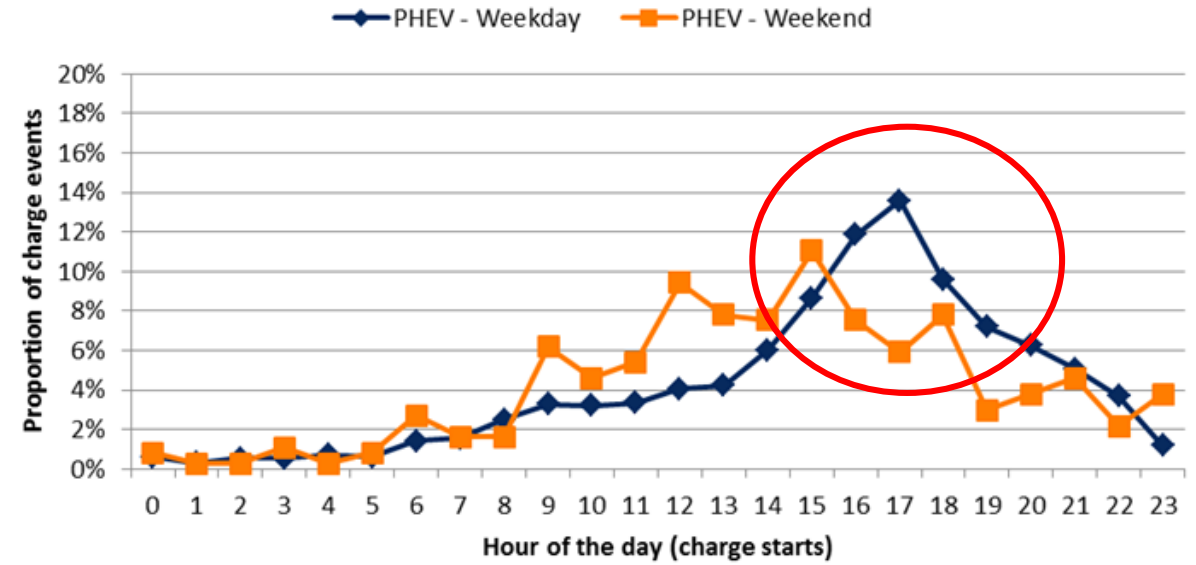
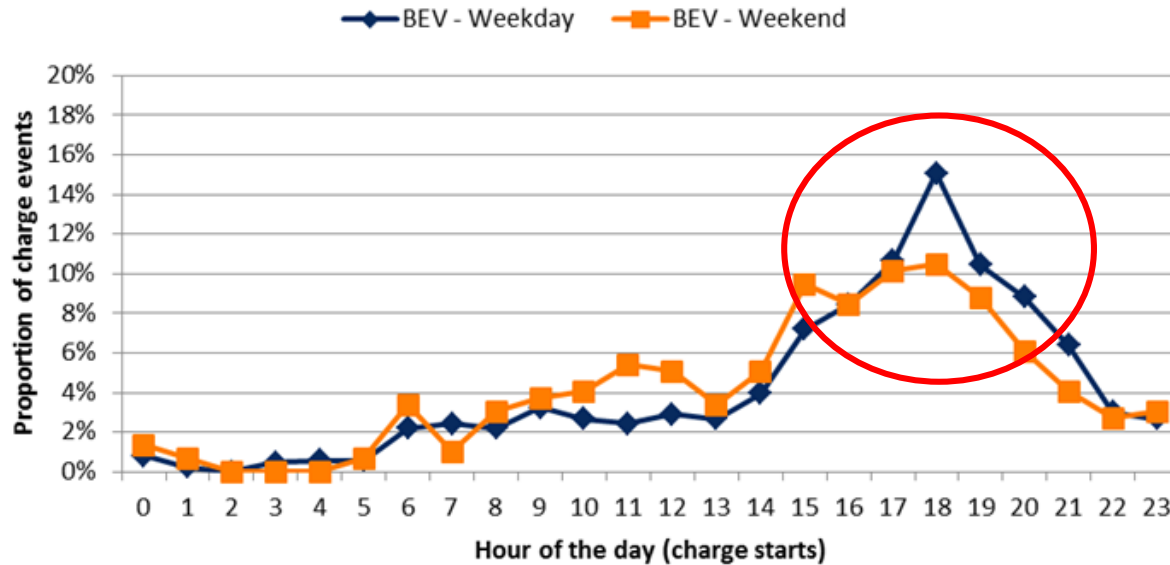
Incentivised to charge at off-peak times
e.g. Static Time of Use tariff



Supplier-Managed Charging

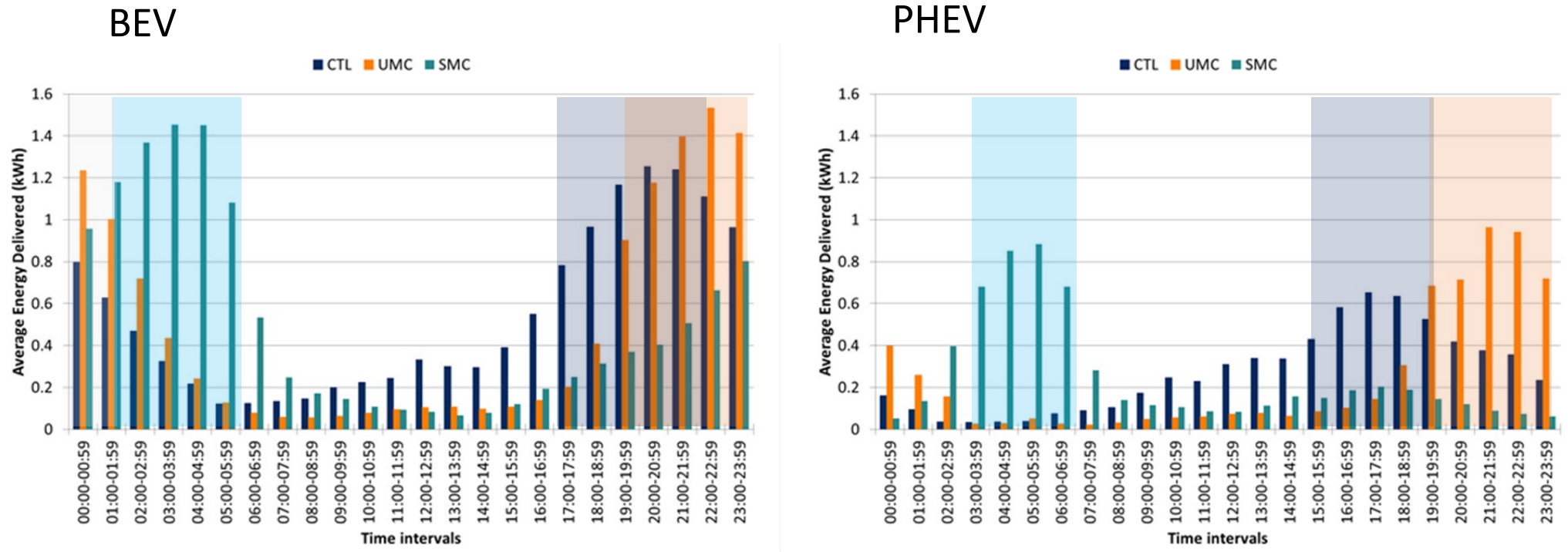
Incentivised to give control to
(simulated) energy supplier;
> plug-in for as long as possible and
define charging needs

With unmanaged charging, consumers charge at existing peak times (16:00-19:00)



- Without intervention, plug-in vehicles likely to accentuate existing peaks in electricity demand
- Could lead to issues in supply-demand balancing or local network capacity

Managed charging is effective at shifting demand away from peak times

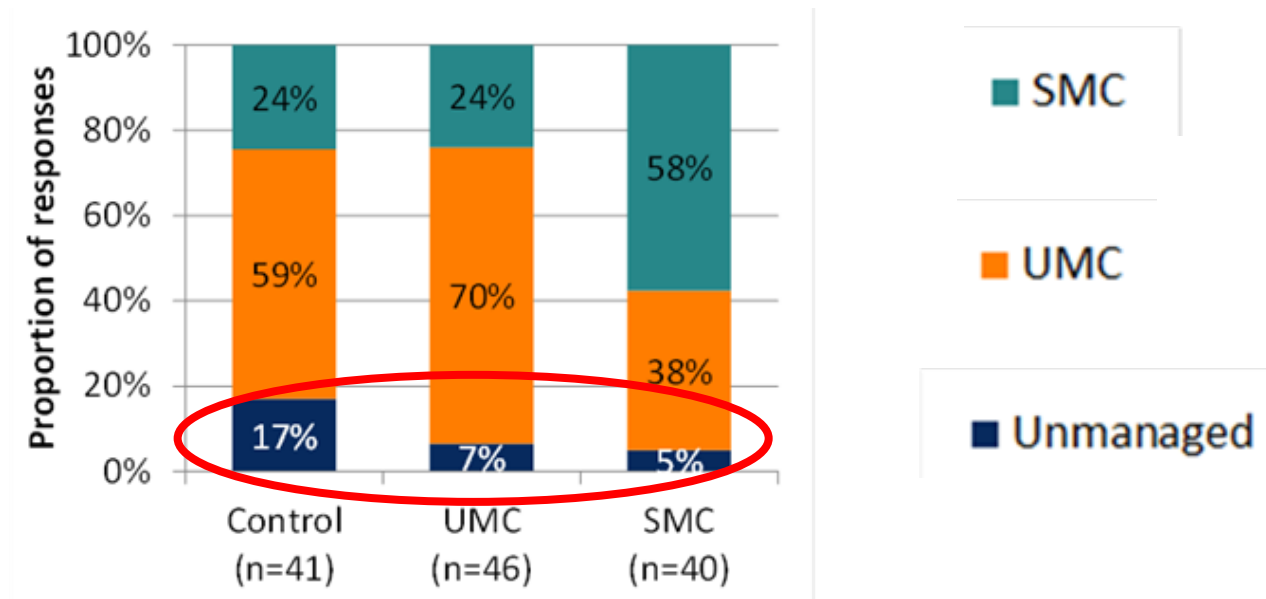


Average energy delivered, per participant, per hour of the day

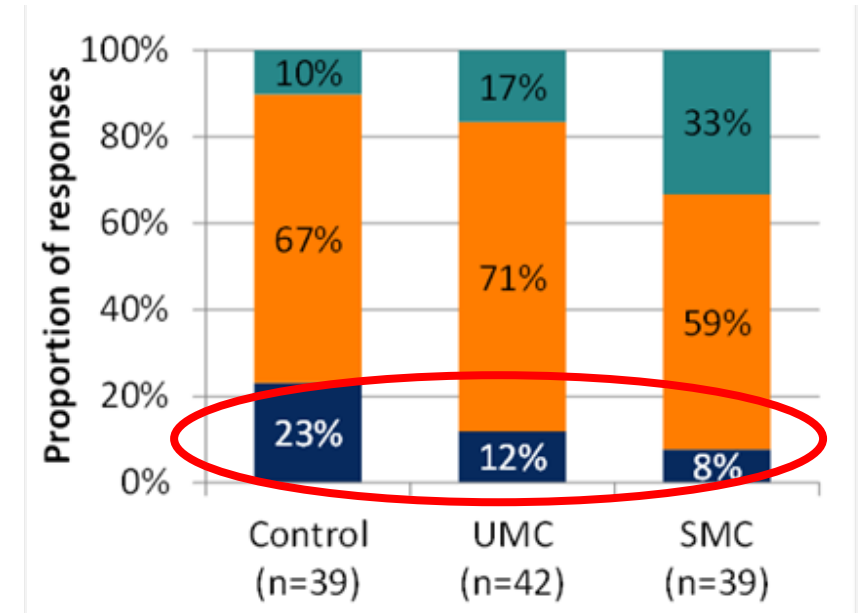
- UMC shifted charging to later in the evening; SMC shifted charging into the overnight period
- UMC and SMC-type systems can be effective solutions for managing demand

Mainstream consumers prefer managed charging over unmanaged charging

Preferred scheme if BEV trial participants owned a BEV...



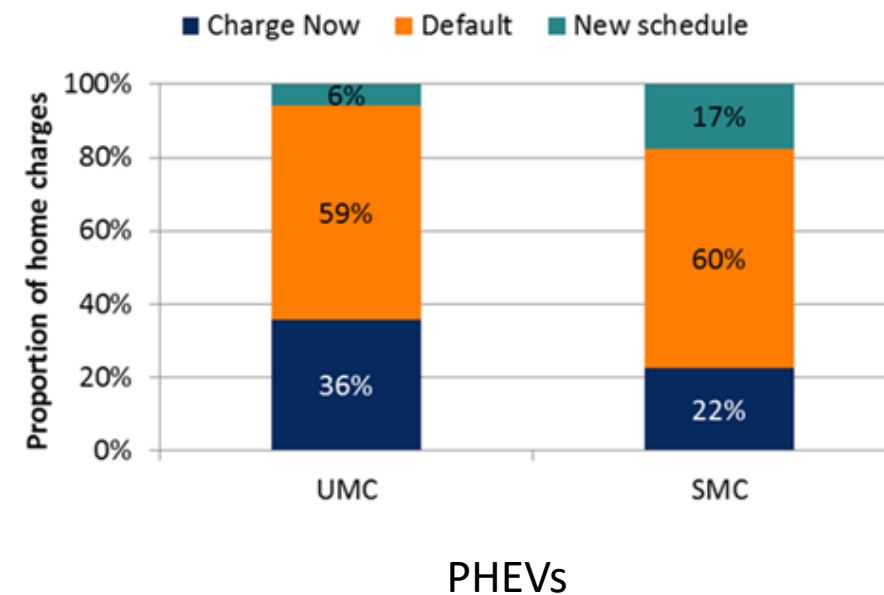
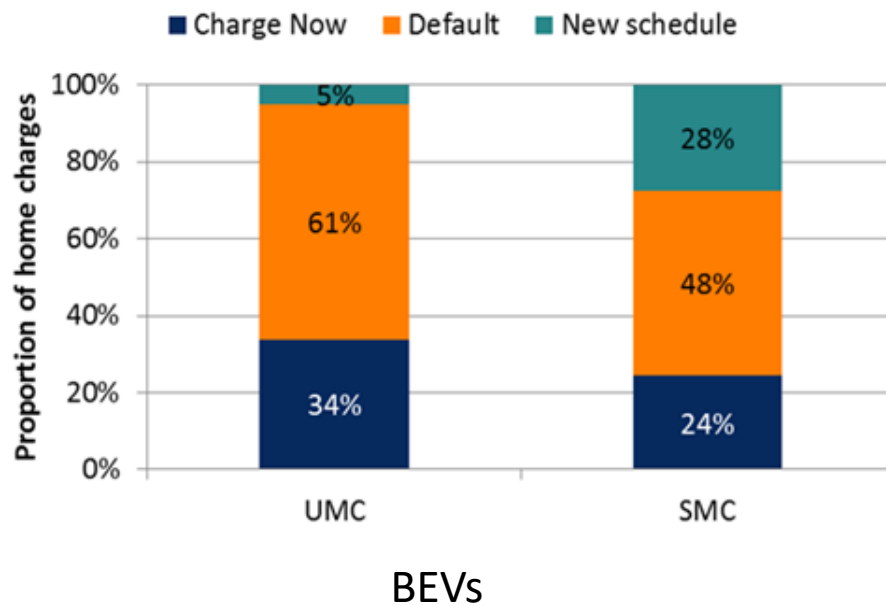
Preferred scheme if PHEV trial participants owned a PHEV...



- Underlying preference for managed charging; shows mainstream consumers' willingness to be flexible with EV charging

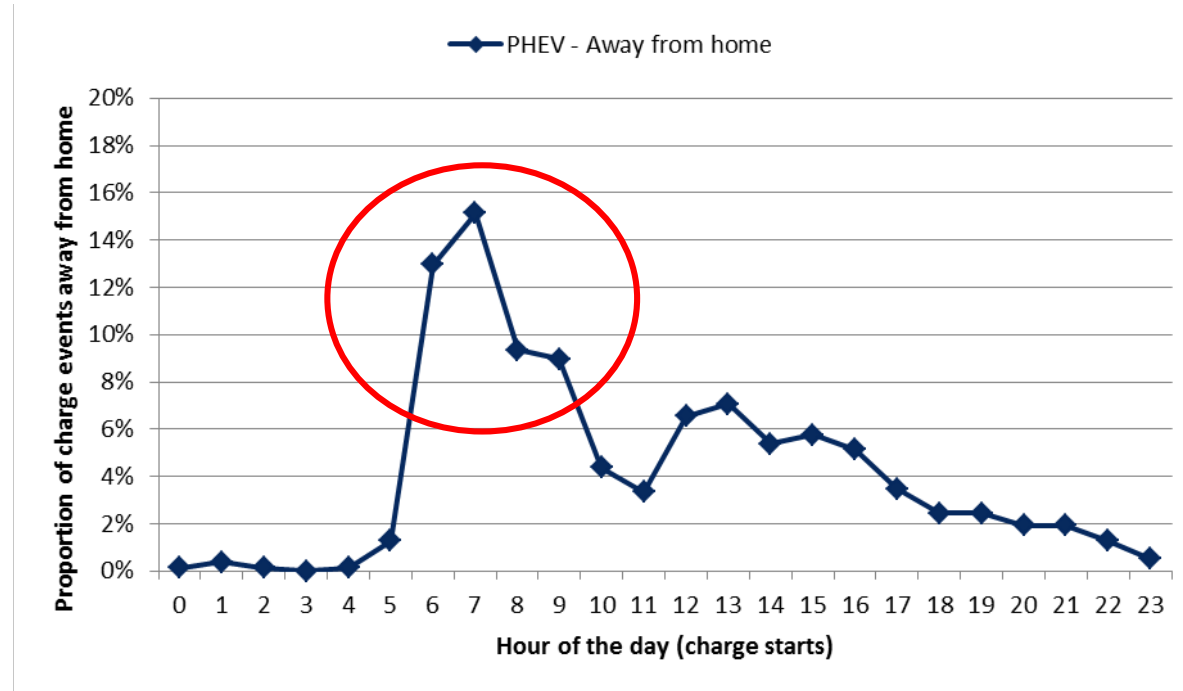
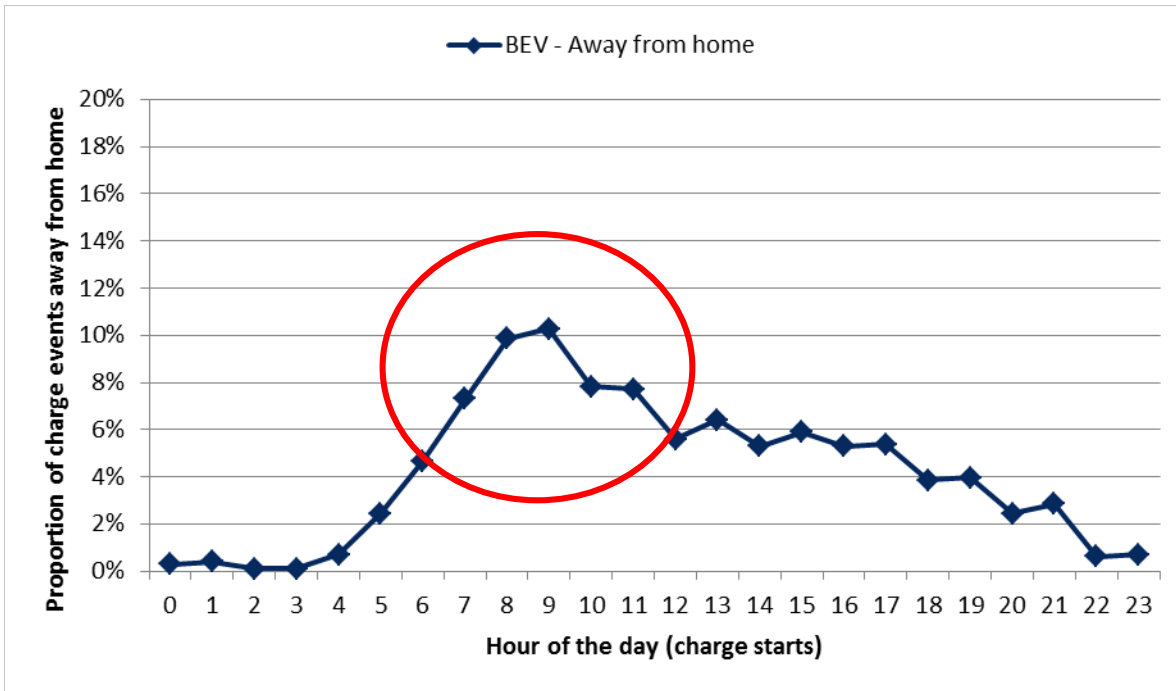
Engagement with managed charging should be as easy as possible

Majority of charge events used consumers' default app settings



- Future managed charging schemes should provide defaults for consumers; to make engagement as easy as possible
- Other aspects required for MC schemes to be attractive for consumers discussed later...

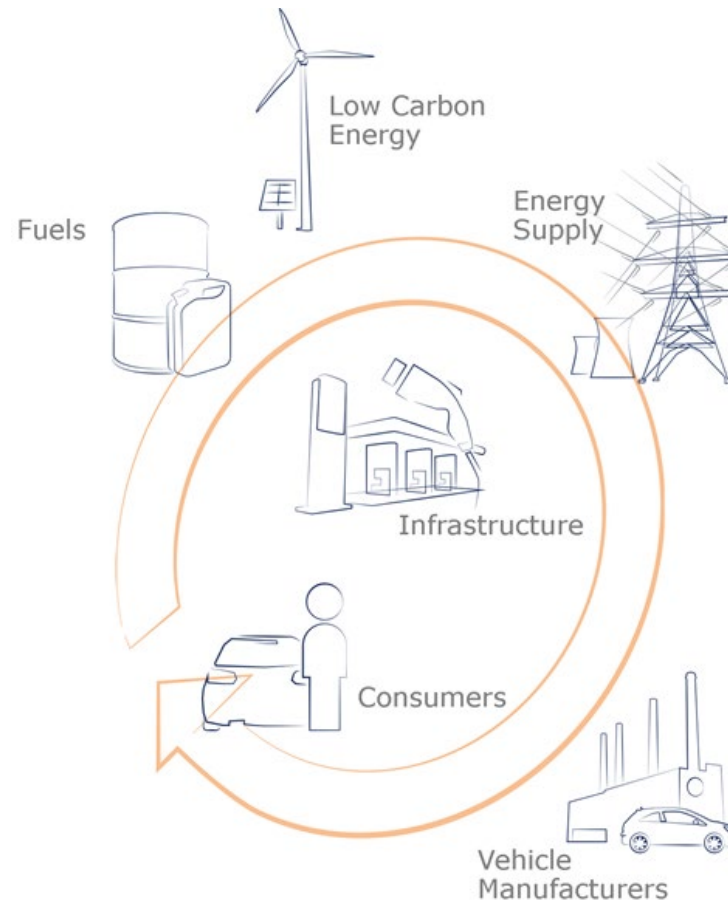
Charges away from home peaked in the morning (06:00-09:00)



- Generally low incidence of charging away from home; but evidence of patterns of charging at work in the morning
- As uptake increases, could be a need for managed charging at locations away from home

Summary

- Electrification of vehicle parc requires understanding mass market motivations
- Positive outlook in the next five years, but...
- Range 'wants' versus 'needs' must be addressed
- Barriers to adoption need to be brought down (e.g. upfront cost, anxieties and concerns)
- Providing positive experiences likely to be beneficial



- Mainstream consumers charge at peak times
- Managed charging solutions are effective at influencing charging behaviour
- Mainstream consumers are positive about the concept of managed charging solutions
- Engagement promoted by ease of use (apps and default settings)
- Charging at work could cause morning peak; may require management in future



Thank you for listening

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Tristan Dodson

Element Energy



Automotive and Fleet Findings

Tristan Dodson
Element Energy



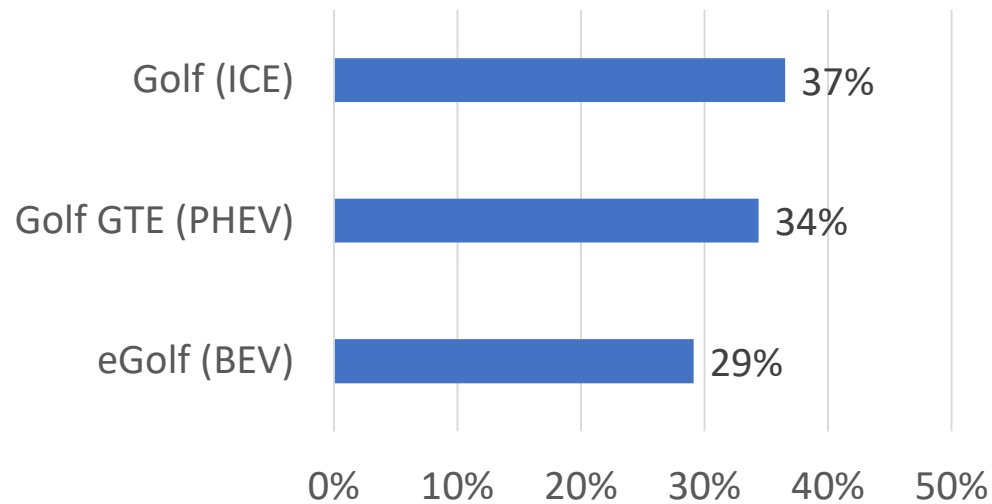
Influence of vehicle attributes on uptake

Upfront purchase price has a significant influence on consumer choice

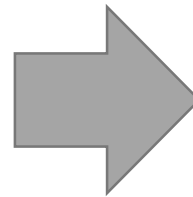
Prices of Golf variants used in trial:

- Golf (ICE) = £26,445
- Golf GTE (PHEV) = £30,635
- eGolf (BEV) = £28,690 (inc. grant)

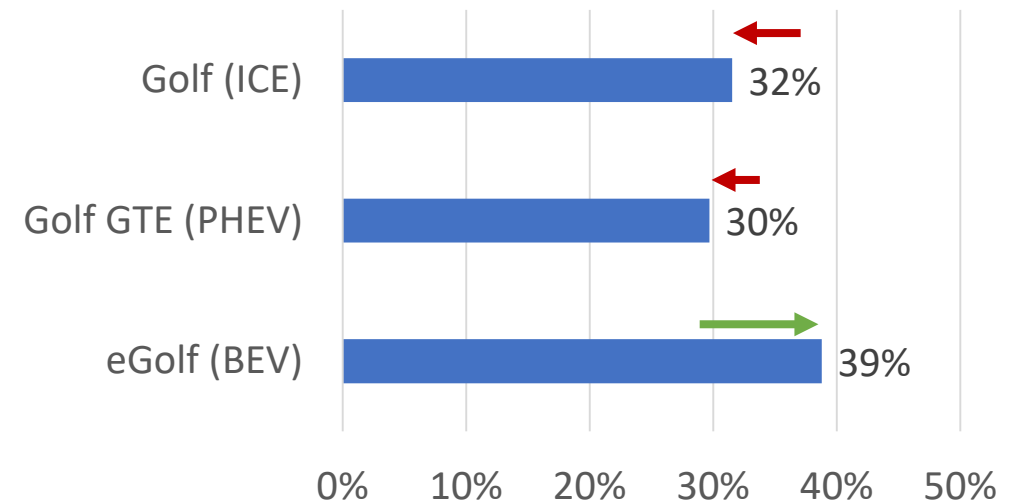
Predicted choice shares with current prices



Reduce BEV price by £2,200

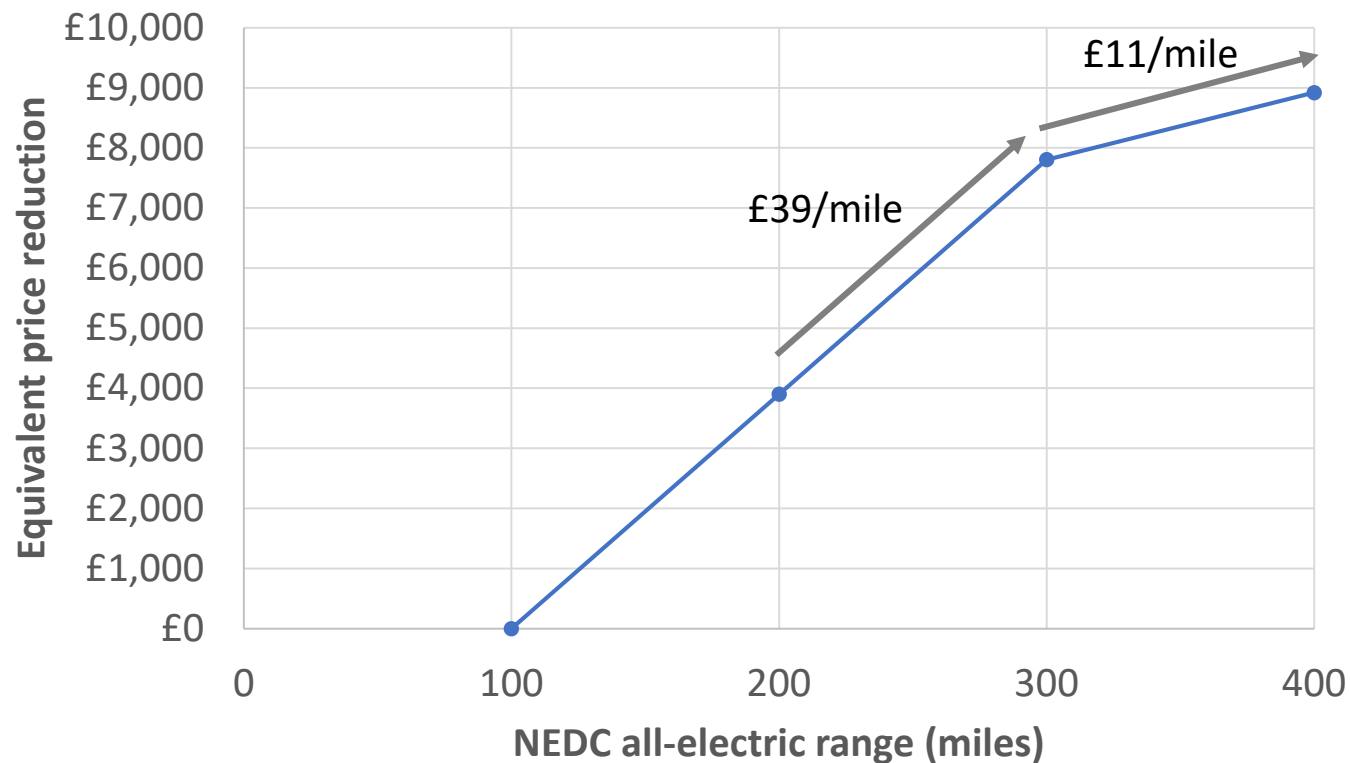


Predicted choice shares with eGolf costing same as Golf ICE



Mainstream consumers place less value in additional BEV range above 300 miles

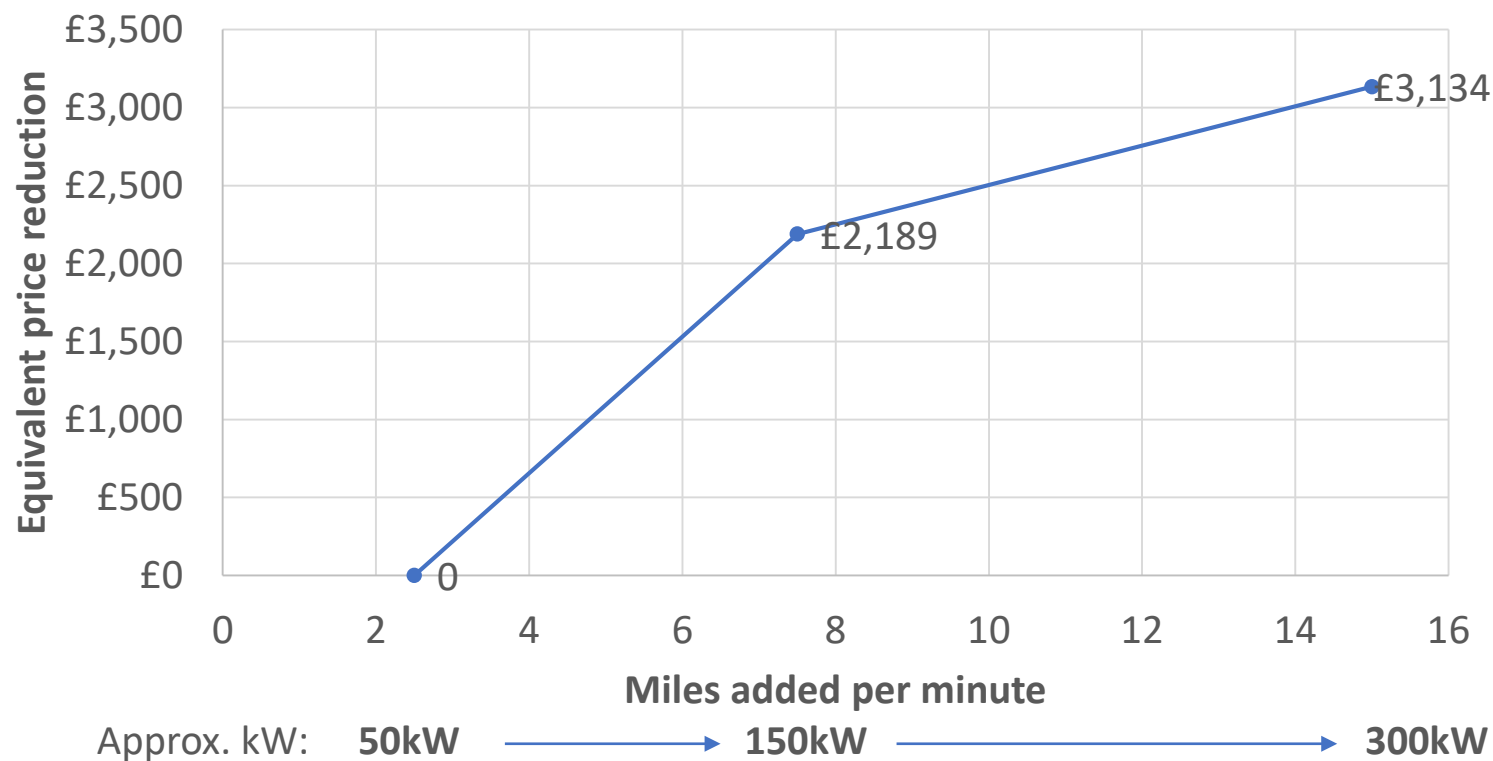
Equivalent BEV price reduction with increasing range above 100 miles



- Increasing a BEV's range from 200 miles to 300 miles (NEDC) equivalent to reducing the price by £3,900
- But increasing from 300 miles to 400 miles (NEDC) equivalent to reducing price by only £1,100

Increasing rapid public charger rates to 150kW will encourage BEV adoption; increasing further has less benefit

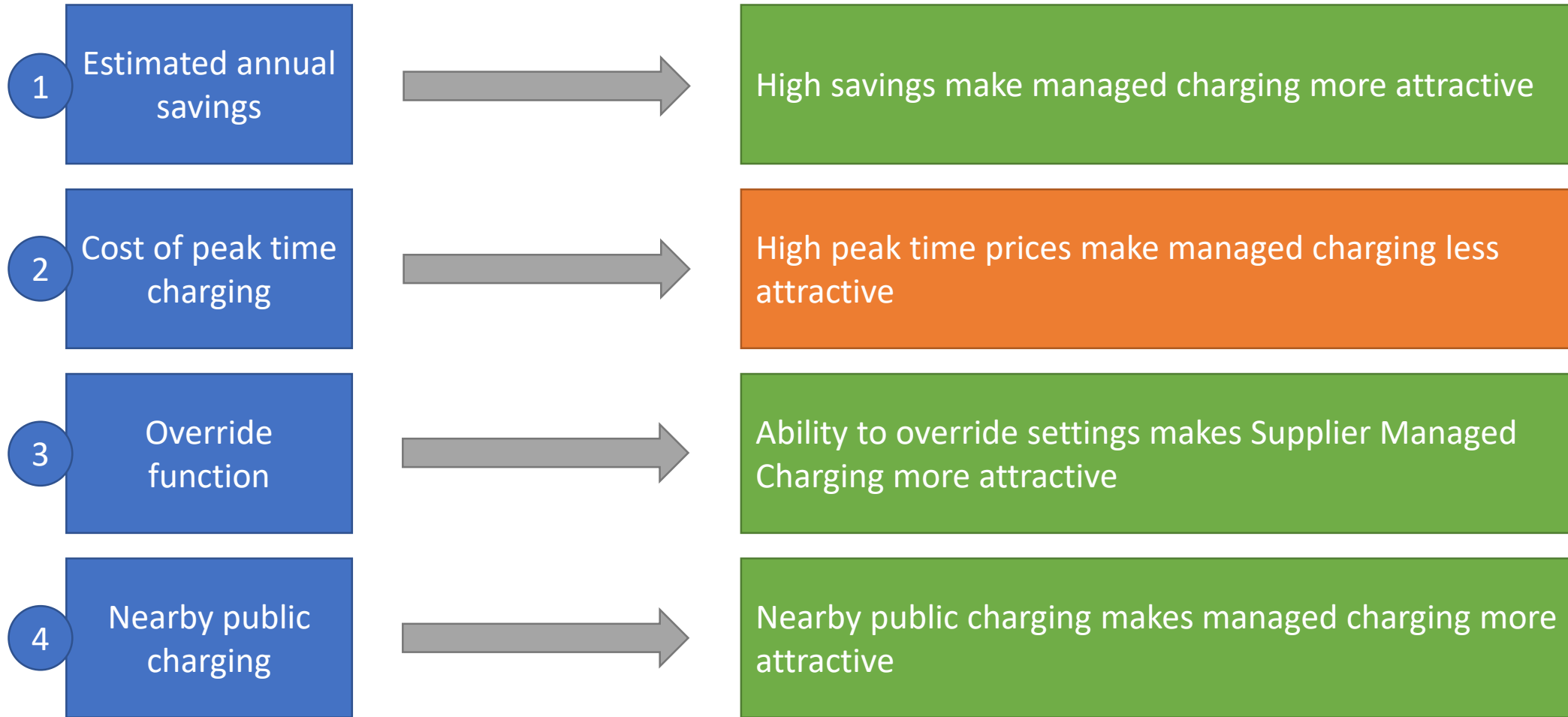
Equivalent BEV price reduction with increasing rapid charging rate



- **Also**, installing public chargers every 20 miles on motorways and A-roads equivalent to decreasing BEV price by £2,200; but increasing density beyond that has no further benefit on uptake
- **This does not account for uptake amongst drivers without access to home charging**

Influence of managed charging attributes on uptake

Influence of managed charging scheme attributes on uptake



Uptake of managed charging is predicted to be high

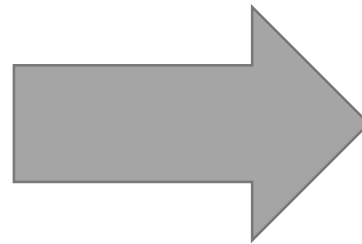
Non-managed charging (NMC)

UMC

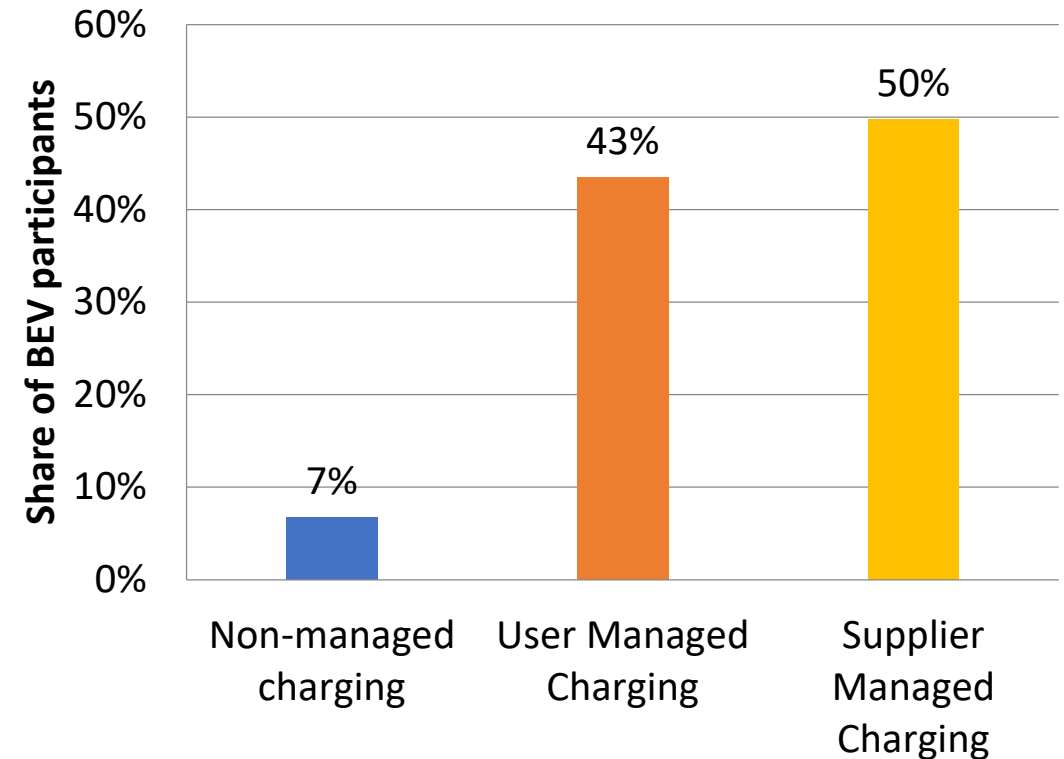
- £100/yr estimated savings
- Peak electricity price 10p/kWh more than NMC

SMC

- £100/yr estimated savings
- Peak electricity price 10p/kWh more than NMC
- Settings can be changed mid-charge, but lose all savings for that event



Predicted choice of charging scheme

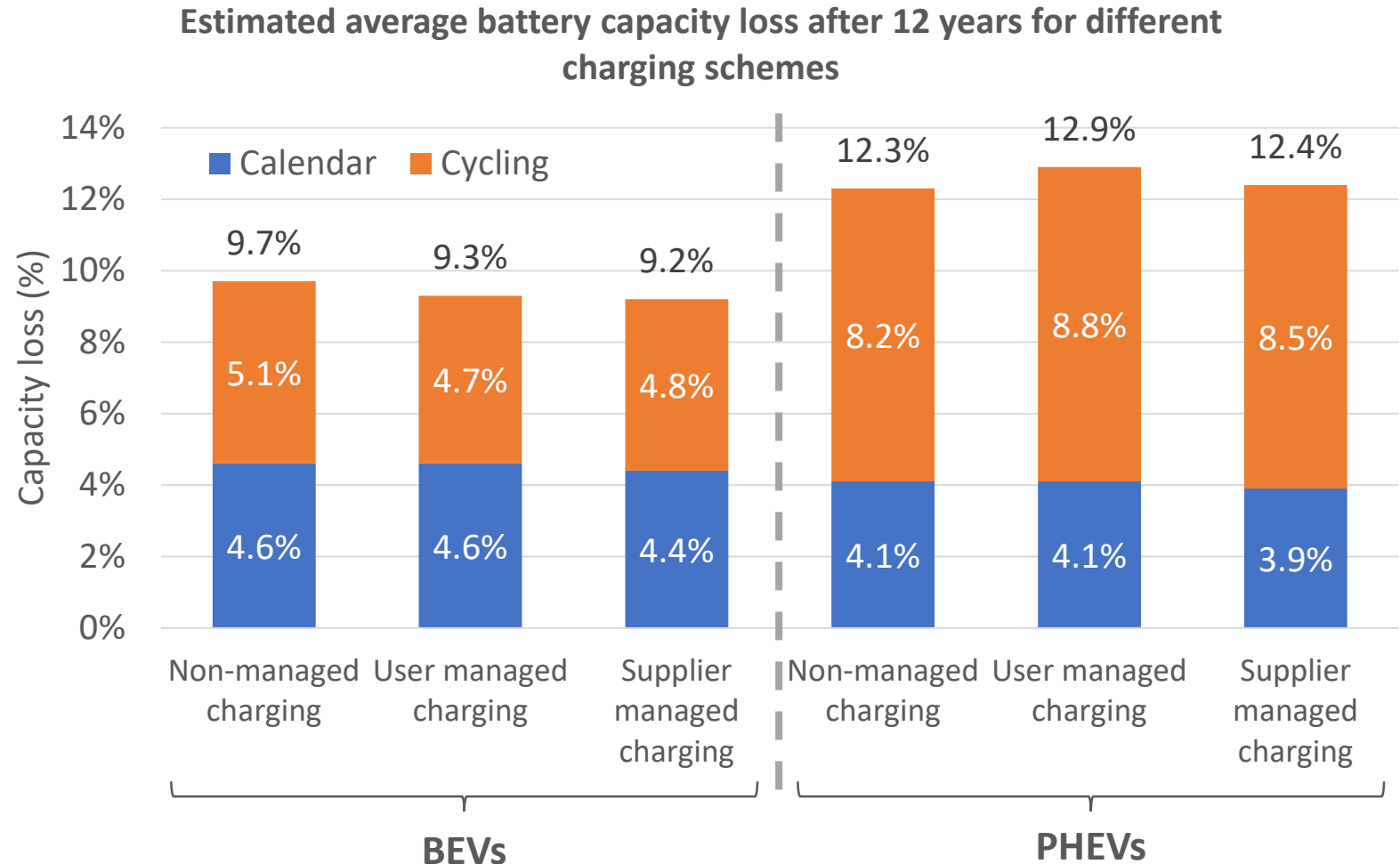


+ Rapid charge point 10 mins from home

Impact of managed charging on battery degradation

Managed charging has very little impact on battery degradation

- Battery degradation modelled for 12 year vehicle lifetime
- Predicted degradation between non-managed charging and UMC and SMC groups was very small.
- In the case of BEVs, UMC and SMC resulted to slightly lower degradation.



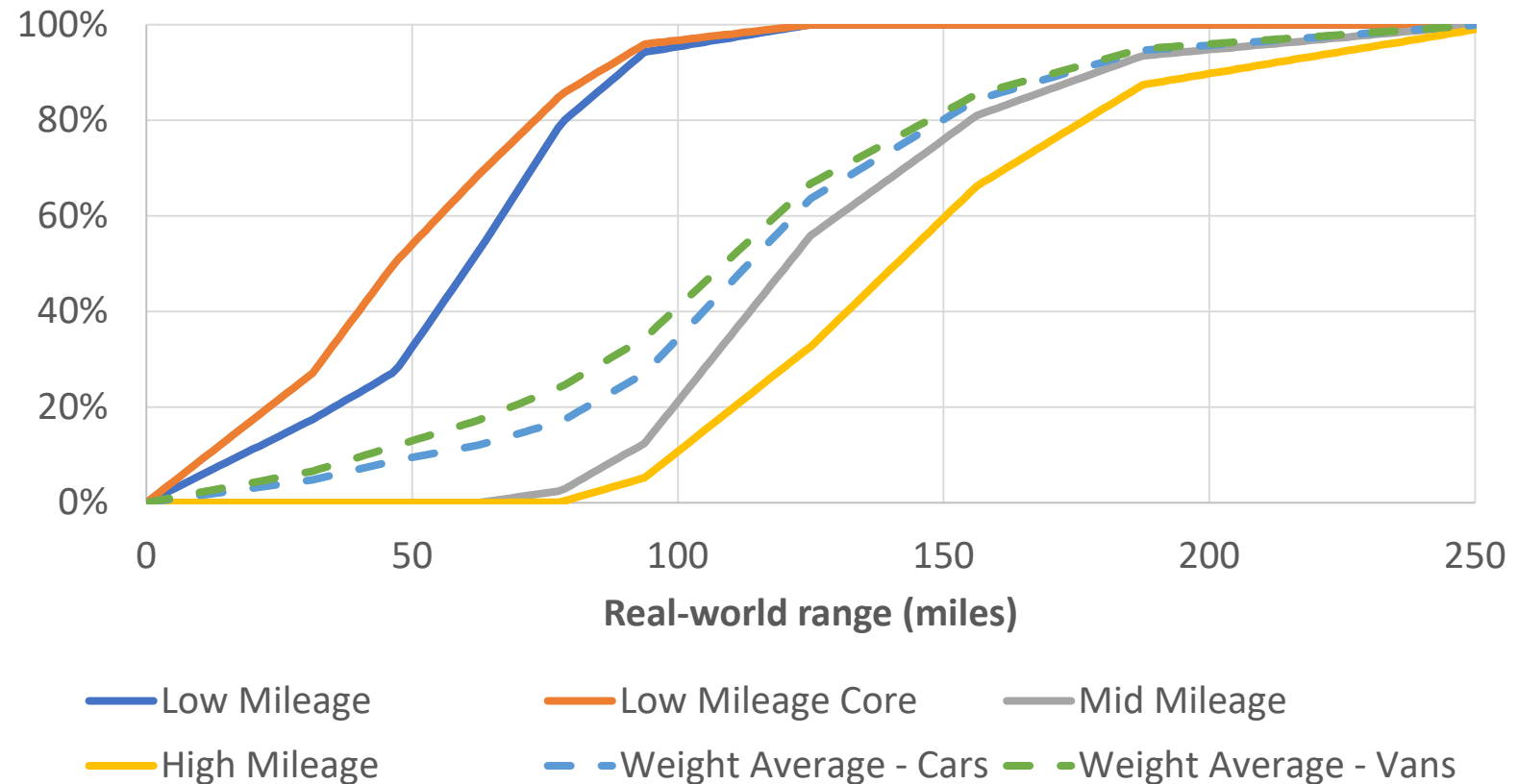
Barriers to EV adoption among fleets

Electric range acts as a significant barrier to BEV adoption among fleets

Major barriers to EV adoption for fleets:

1. Operational suitability
2. Daytime charging unlikely to be possible due to limited time available
3. Cost of ownership (particularly leasing cost and depreciation)
4. Availability of charging at employees' homes

Share of fleet cars & vans which can be replaced by a BEV with a given real world range



Conclusions

Conclusions

1. Increasing range to 300 miles and rapid charging rate to 150kW should significantly increase uptake of BEVs
2. Consumers have a strong appetite for managed charging, as long as it's an available option
3. Supplier-managed and user-managed charging have a negligible impact on battery degradation
4. Operational suitability is a significant barrier to BEV adoption amongst fleets, but higher ranges would allow more fleet buyers to consider them

PANEL

Are consumers going to be flexible about charging their car?

Panel host: Guy Newey, Energy Systems Catapult

BREAK



James Greenleaf

Baringa



Energy System Implications

James Greenleaf (Baringa Partners)



Key questions for 'Market Design and System Integration' analysis

1

Impact on costs & operation of the energy system from ULEVs?

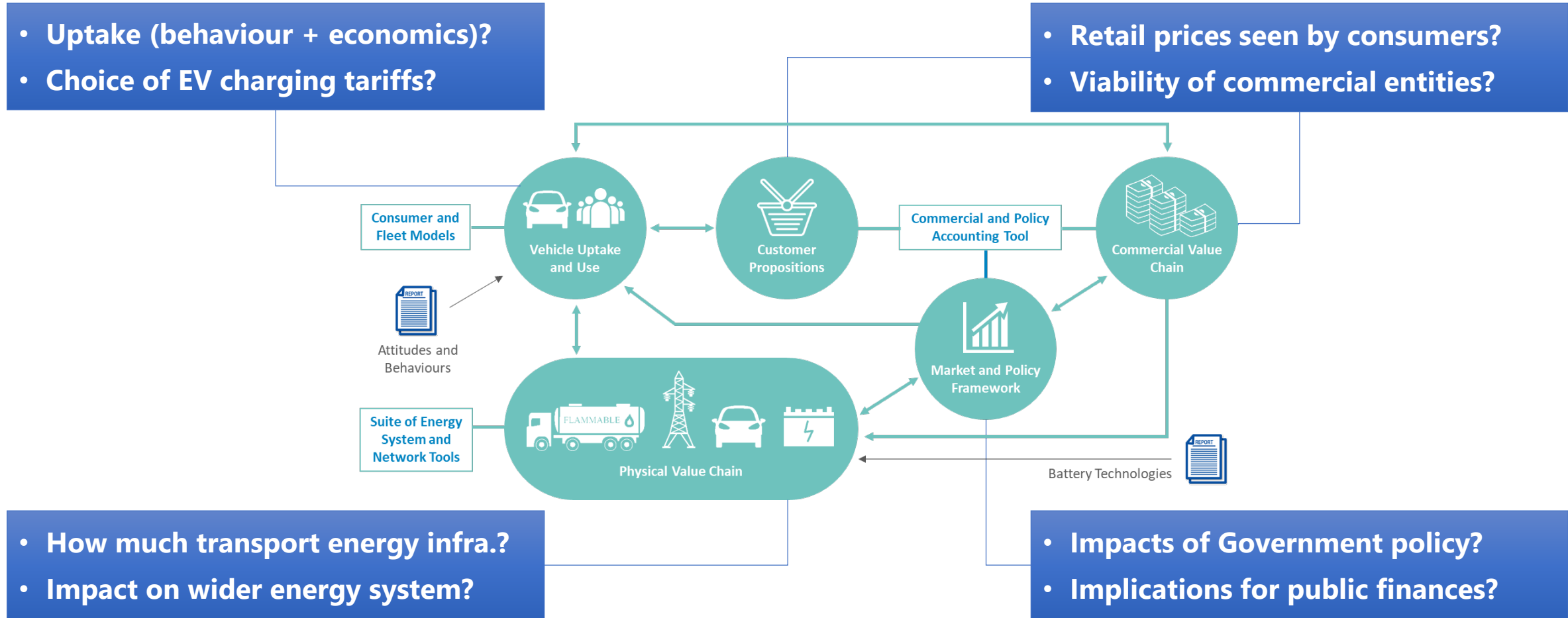
2

Which energy system and policy configurations are better than others?

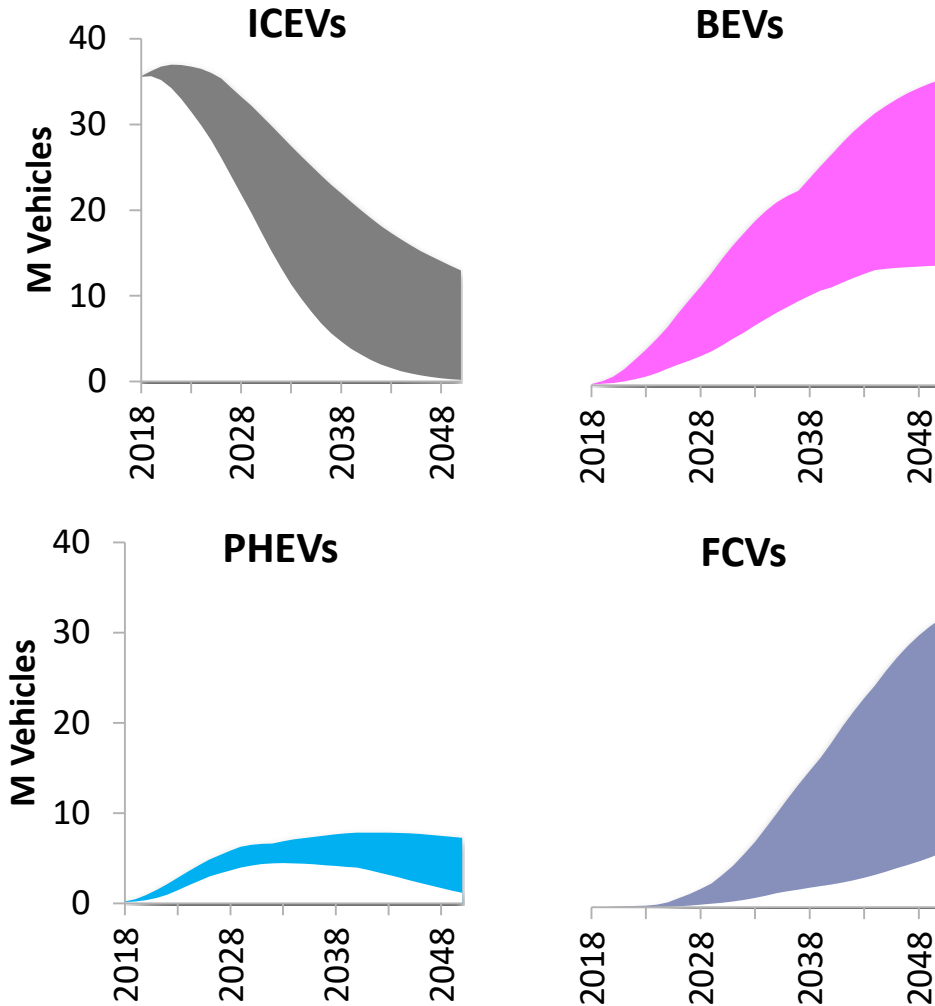
3

How to facilitate effective mass-market uptake and use of ULEVs?

Holistic framework for exploring ULEV uptake and use



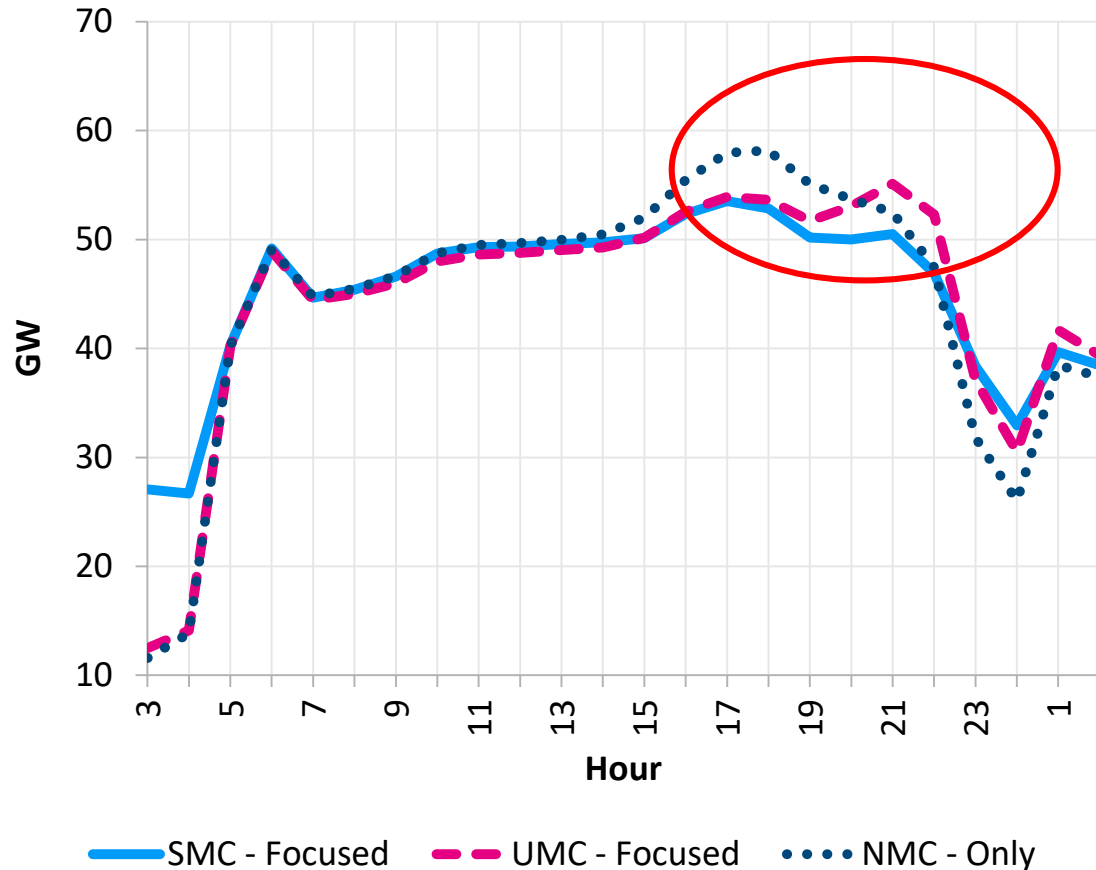
Uptake of cars and vans across scenarios



- Sizeable BEV uptake under BaU, PHEVs transitional
- RtZ needs substantial consumer support + infra.
- FCV RtZ route higher cost cf. BEV

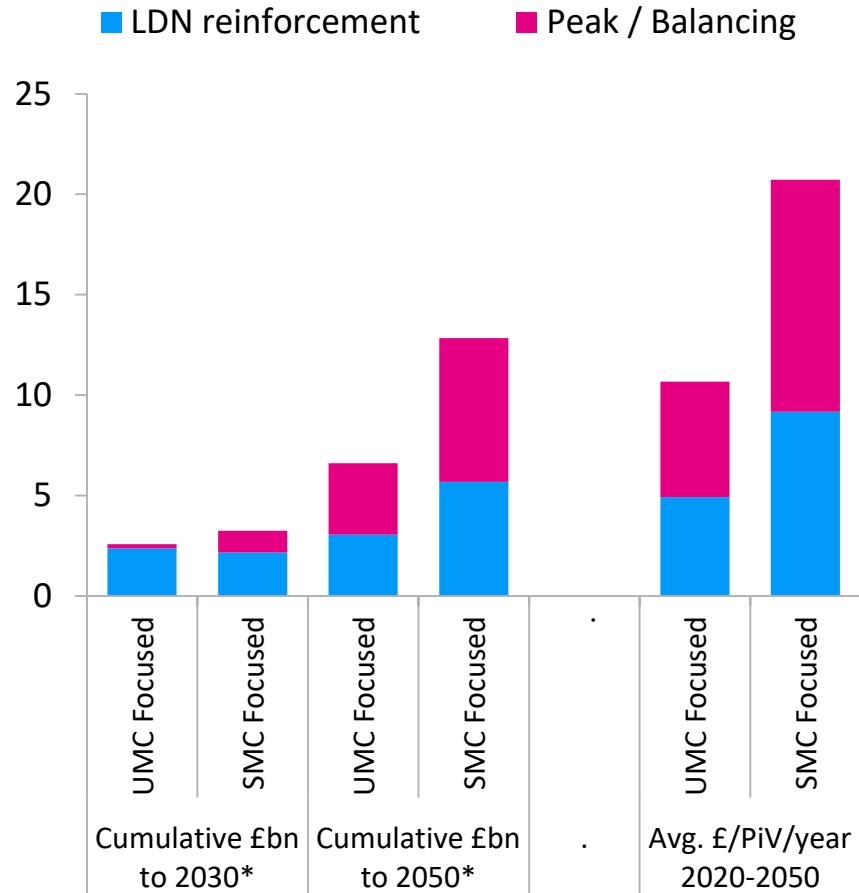
Role of Demand Management

Total demand – winter weekday - 2030



- Trial participants appear responsive to tariffs
- Significant ability to manage load
- Potential UMC 'herding' impacts

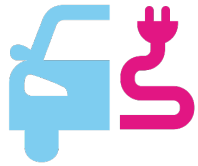
System value of Demand Management



- Higher SMC value, particularly over long-term
- UMC value near term, but 'herding' may offset benefit
- LDN savings intertwined with electrification of heat

* Scaled to equivalent # EVs

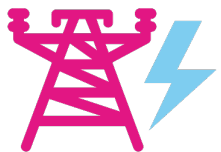
Key energy system takeaways



- Material BEV uptake under BaU, but achieving RtZ will be challenging



- Trial shows 'mass market' consumers provide significant flexibility



- UMC/SMC-based tariffs both important, but latter to maximise system value

Natalie Bird

Baringa



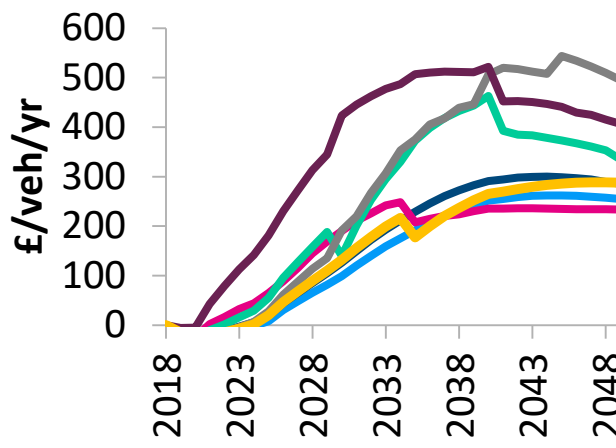
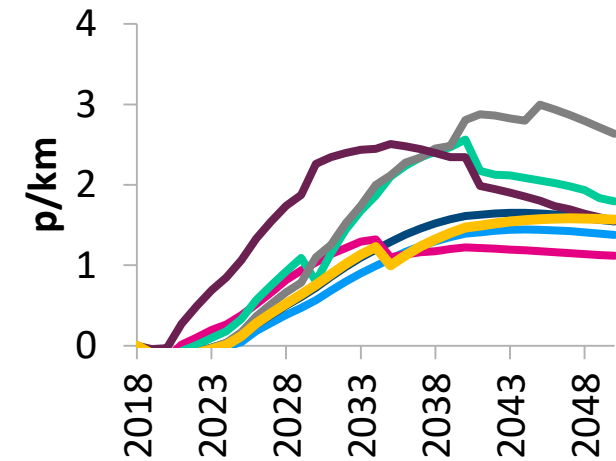
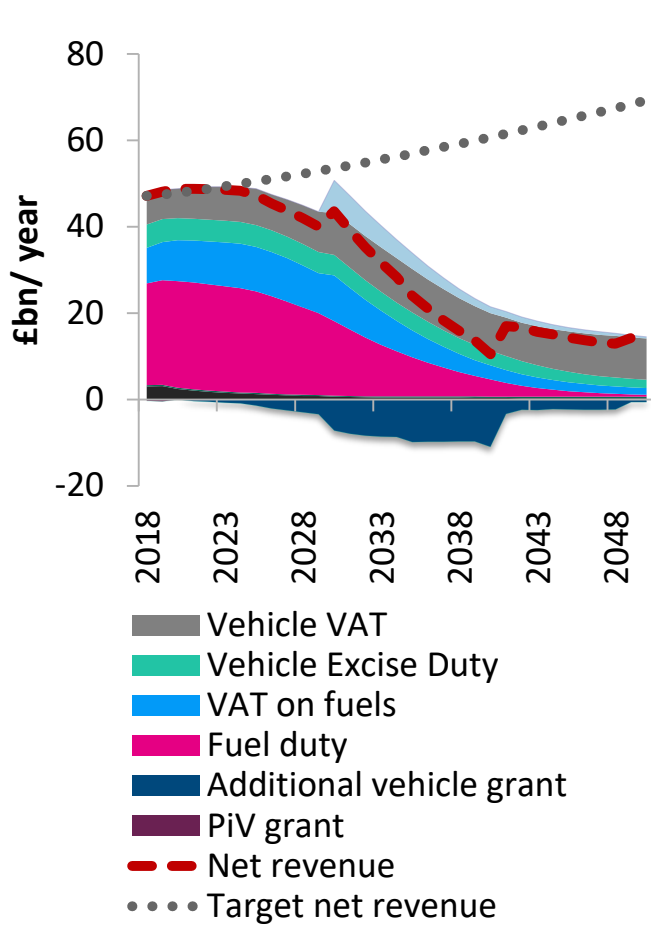
Market, Policy and Commercial Findings

Natalie Bird (Baringa Partners)



Driving ULEV uptake and the impact on Government cash flows

Government cash flows and technology neutral tax to fill the revenue gap across Narratives



Road pricing/ per-vehicle tax

Upfront cost mitigation (modest)

Carbon price for liquid fuels

Removal of ICEVs (RtZ)

EU emissions

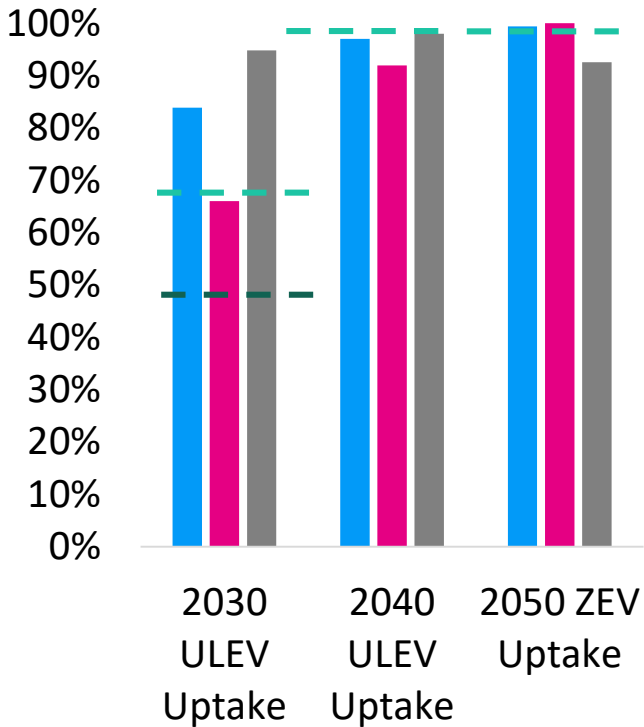
Tightening emissions regs

Meeting the Road to Zero ambitions

Upfront cost mitigation

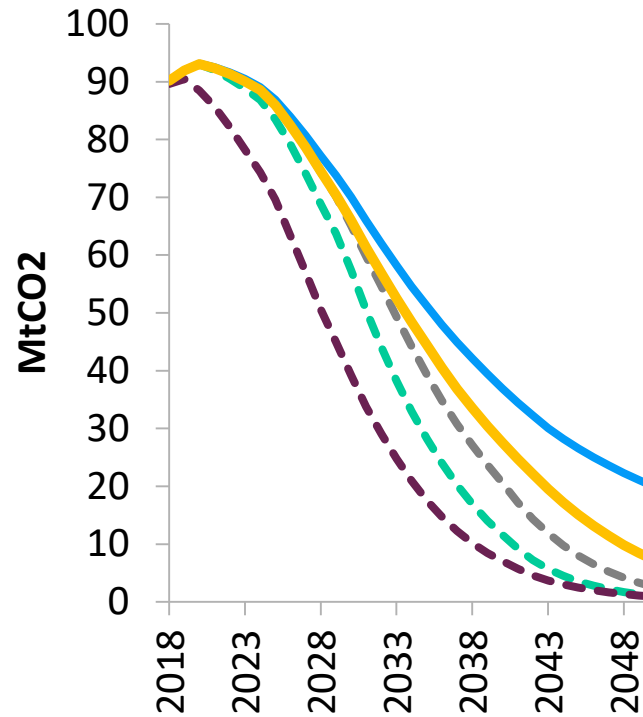
Removal of ICEVs

2030 and 2040 ULEV uptake, 2050 ZEV uptake (% of new sales) for cars

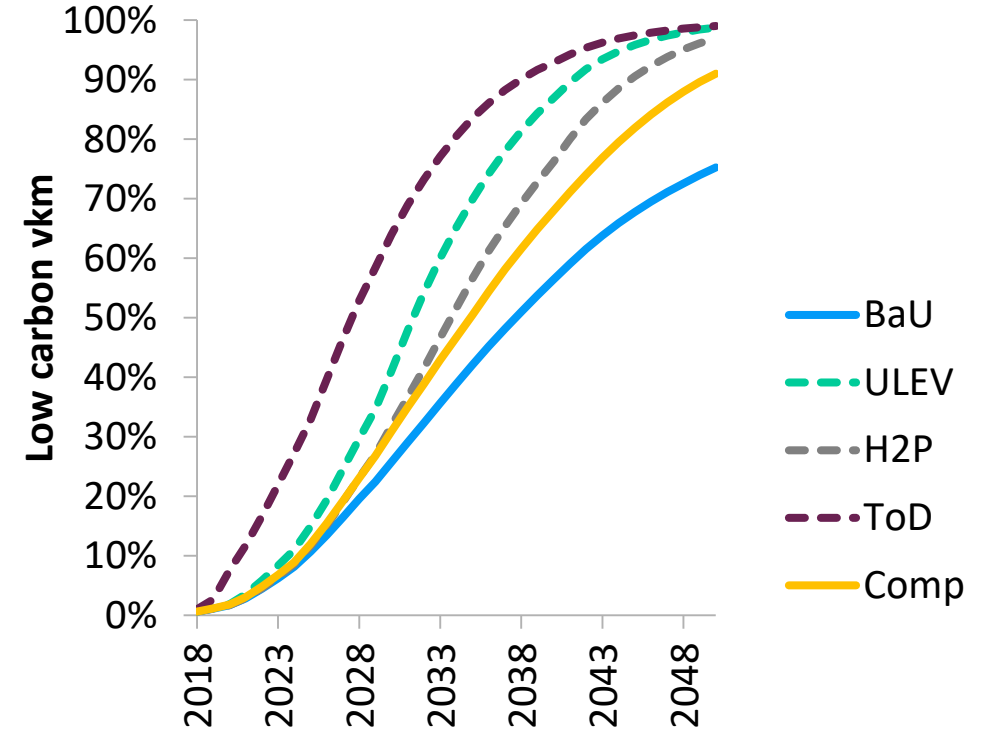


ULEV H2P ToD

CO₂ emissions



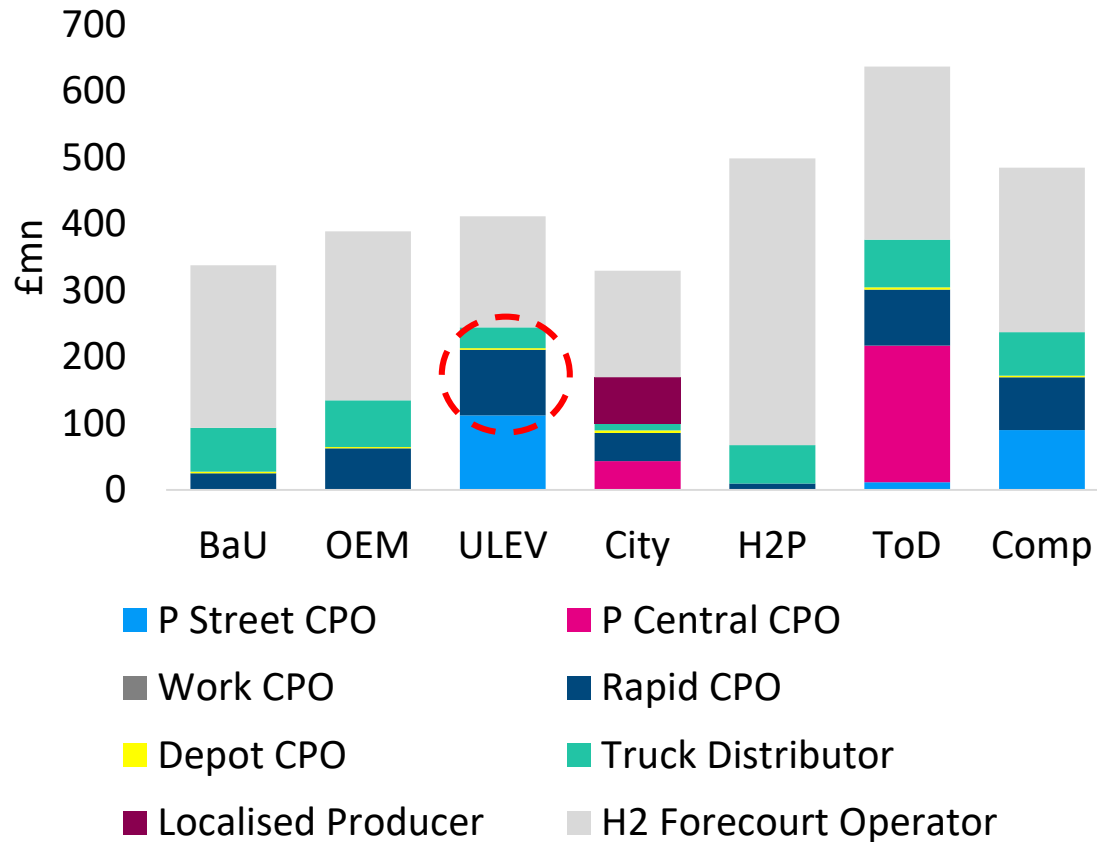
% low carbon vehicle km



BaU
ULEV
H2P
ToD
Comp

Financial support for charging infrastructure

Present value of subsidy required over pathway for entities



Coordination and support for rapid charging

Continued support for public on-street charging

- Rapid charging points are essential in the near to medium-term but may require some de-risking and direct support
- On-street charging points are important for those without off-street parking in order to get to high uptake levels
- Work and public charging have less of a role after 2025-2030, except where public charging is needed to support car sharing

Watching brief on the market for hydrogen vehicles

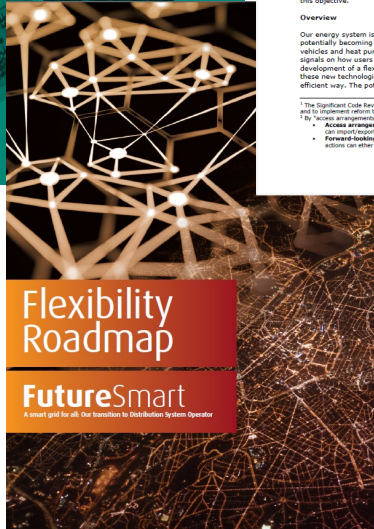
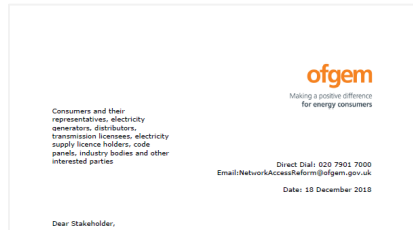
Key quantitative metrics			BaU	ULEV	H2P
Customer	Low carbon vkm 2050	%	75%	99%	97%
Government	PV of net tax and spend gap over pathway (@SDR)	£bn	208	347	411
	<i>of which direct subsidy</i>	£bn/yr	0.6	67	155
To fill PV of MPF gap (@SDR)	Average vehicle tax	£/veh/yr	145	243	286



- A strong coordinated push for hydrogen is expensive in terms of direct support
- Fuel Cell Vehicles appear important in the longer-term, particularly for vans
- Major decisions can be postponed to allow time for costs and uncertainty to reduce
- Depends on the extent of investment by the automotive sector

BaU = Business as Usual, no further grants beyond current schemes
 ULEV = ULEV Enabled, technology neutral support
 H2P = Hydrogen Push, strong coordinated push to hydrogen

Supporting the coordination of flexibility markets



Flex. shared services framework

Coordinated flex. procurement

- Managed Charging delivers substantial network savings
- Time of Use tariffs are a blunt tool; a dynamic approach is needed in short term
- Communication on the additional benefits of Supplier Managed Charging is needed
- Market arrangements need to evolve to ensure clear routes-to-market and market signals that represent the value of flexibility

Formal title: 'Project TERRE implementation into GB market arrangements'

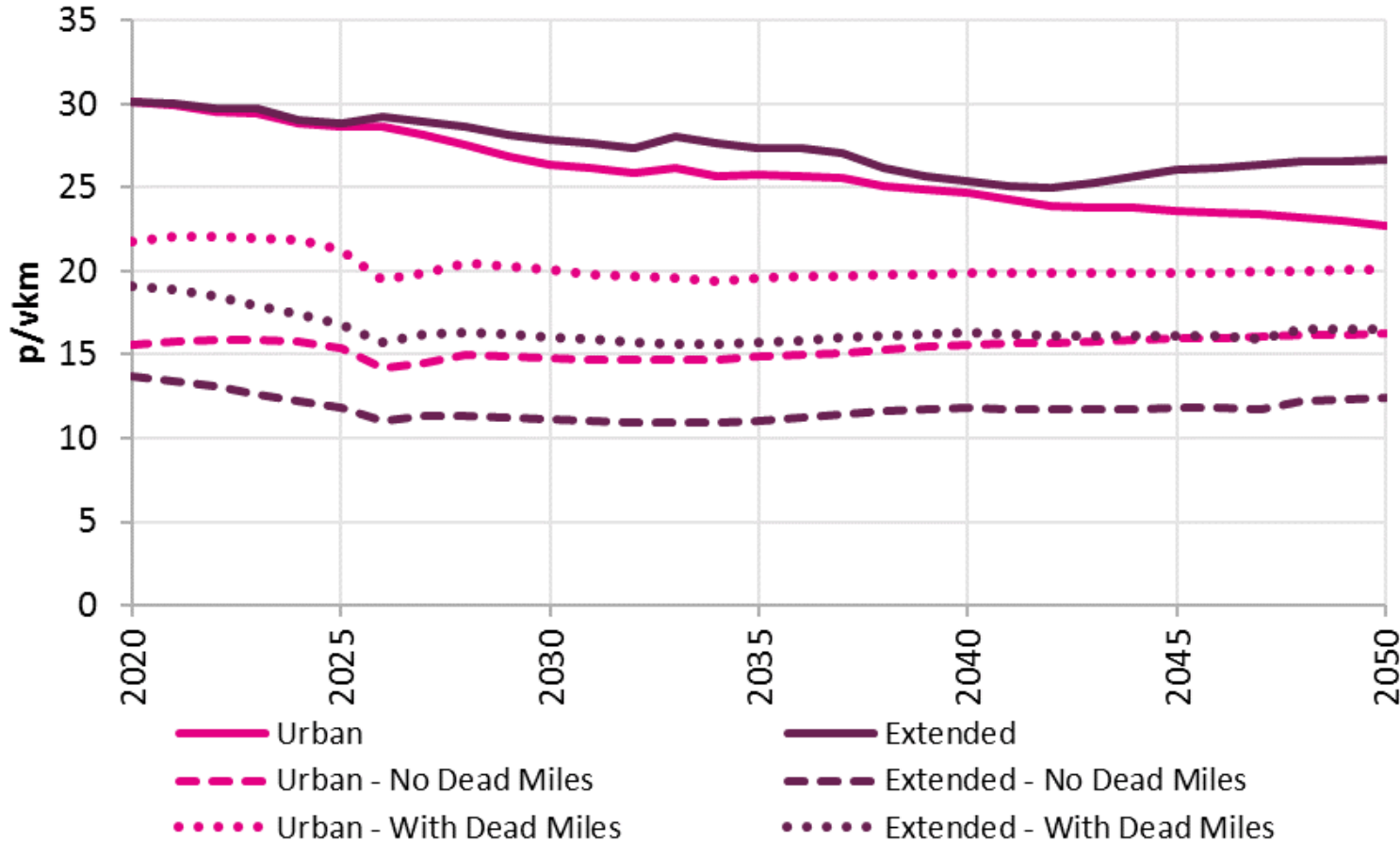


Facilitating “mobility as a service” offerings

Evolution of average parc costs per vkm for shared cars (dashed) and other cars (solid)

Facilitation of urban car sharing

Support for larger scale car sharing



- Policymakers should support efficient use of vehicles (i.e. integrated transport services)
- Public finances largely unaffected depending on the taxation policies

PANEL

Will the market deliver the infrastructure to allow rapid expansion of electric vehicles?

Panel host: Philip New, Energy Systems Catapult

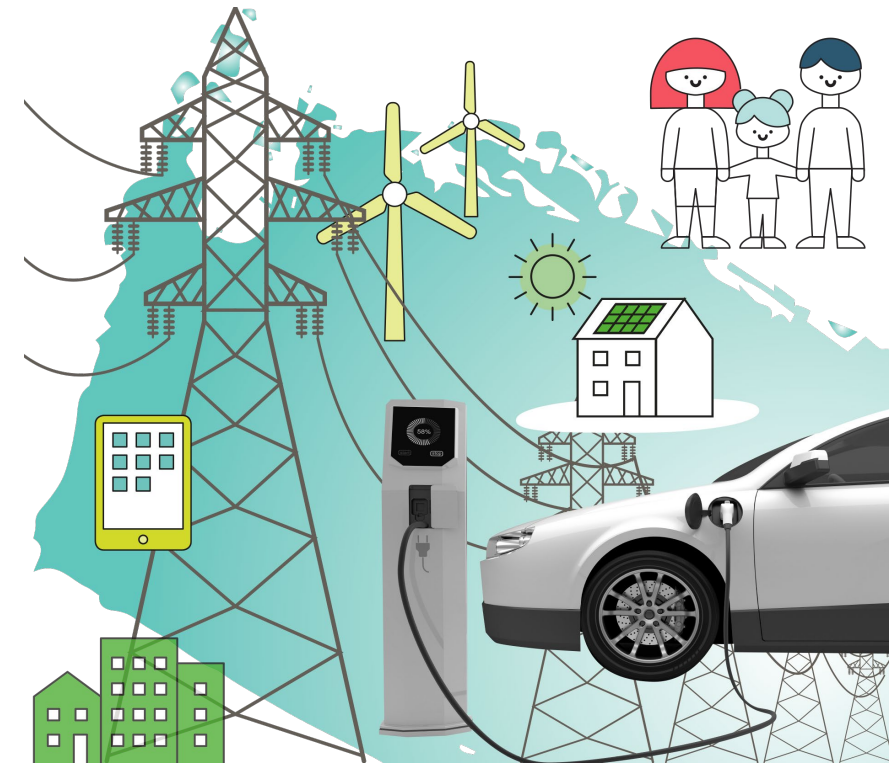
Liam Lidstone

Energy Systems Catapult

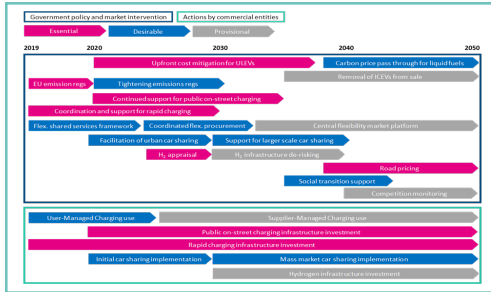


Next steps and recommendations

Liam Lidstone



The project has delivered value across a variety of areas



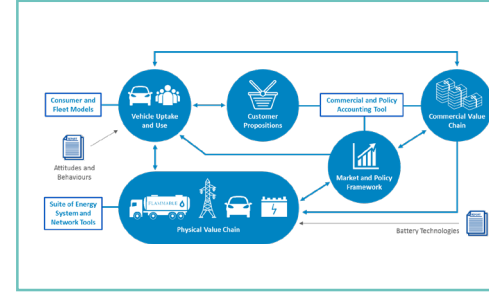
Extensive findings

From assessment of the whole system implications of transitioning to a secure and sustainable low carbon vehicle fleet



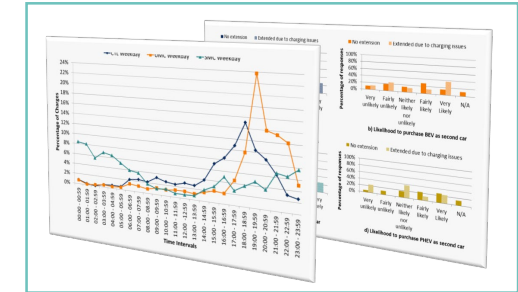
Published evidence

Referenceable material to support informed discussions and decision making across sectors



Integrated modelling toolset

A means of testing further variations in and implications for energy supply, infrastructure, vehicles, users, policy and commercial models

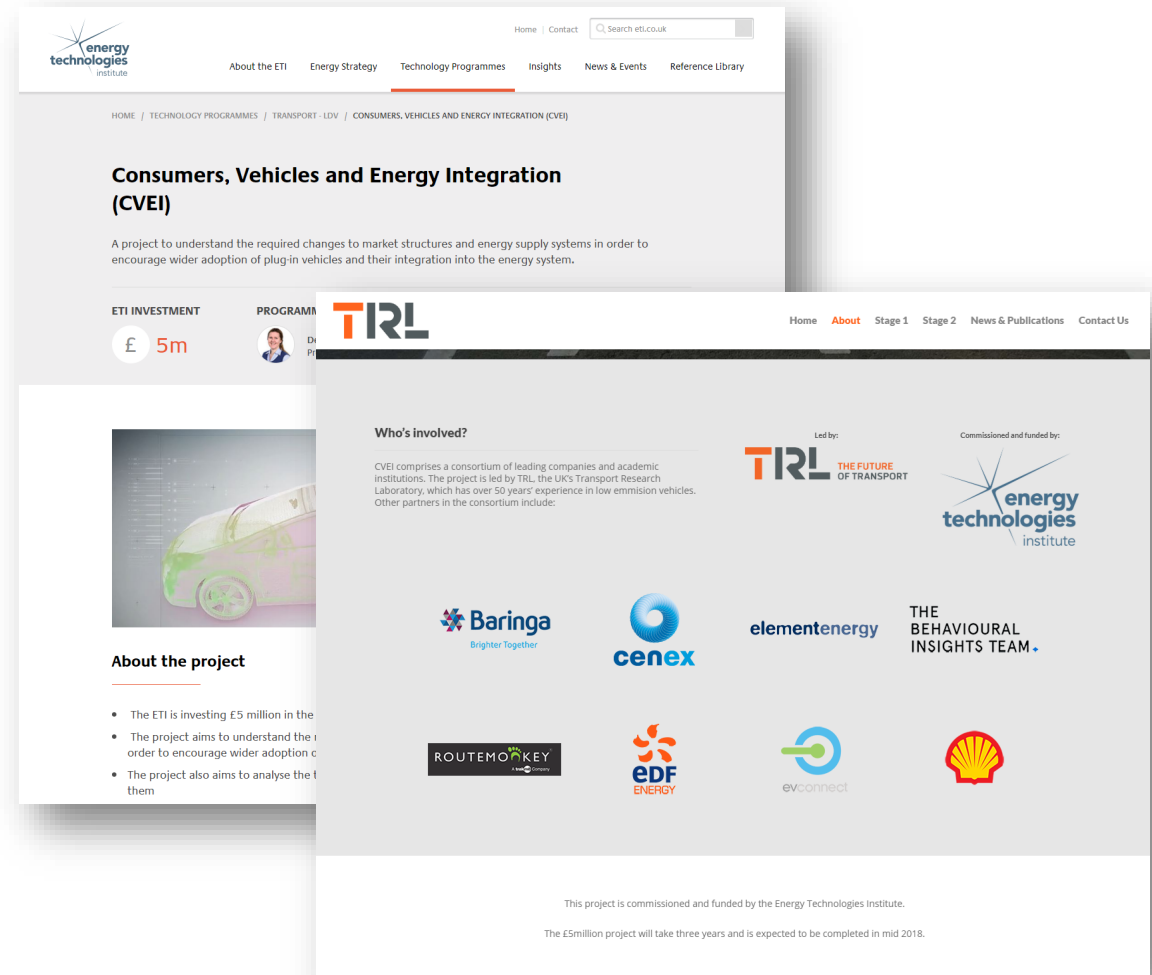
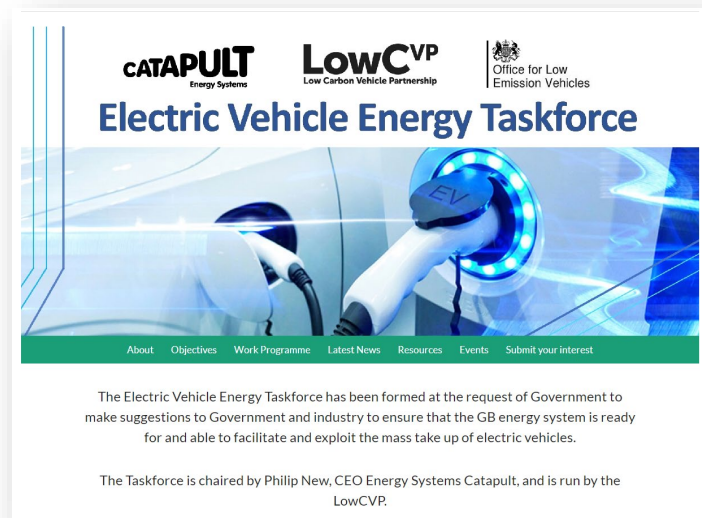


Detailed data

Unique data on mainstream consumers, preferences, use of EVs and interaction with smart charging, added to data on energy and transport sector technologies

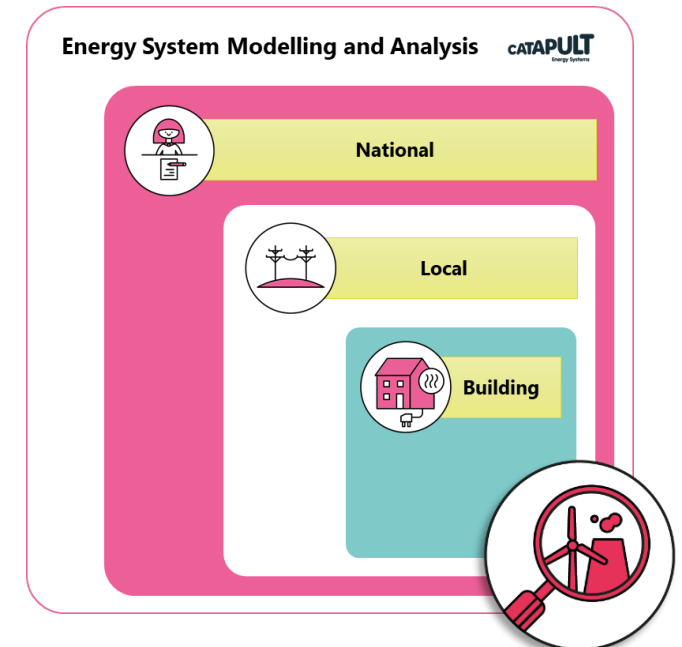
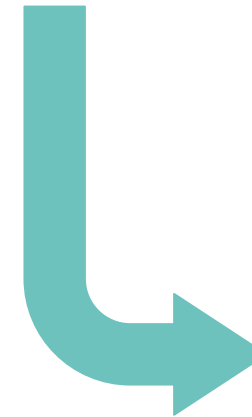
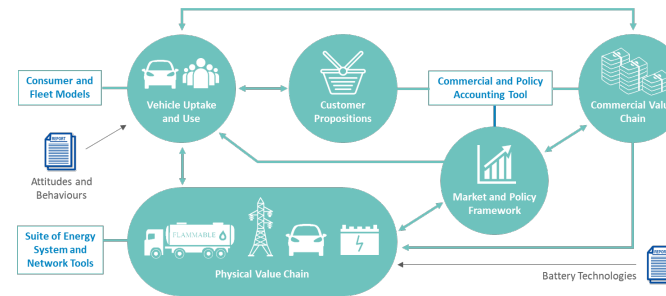
Published evidence

- The reports from the project are being made available on the ETI Knowledge Zone and TRL's website (and soon via the ESC's website)
- The reports are sought as evidence, including by the EV Energy Taskforce



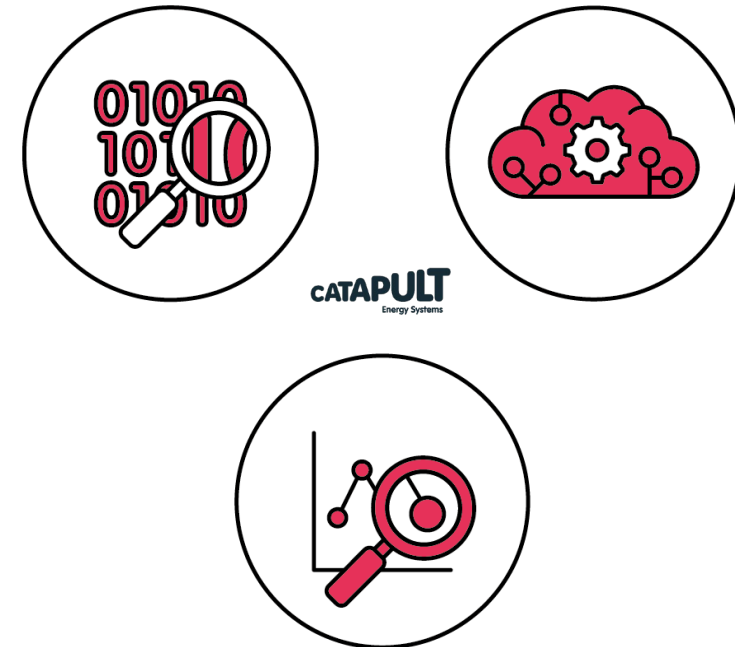
Integrated modelling toolset

- The integrated modelling toolset will be hosted by the Energy Systems Catapult
- Will be **maintained** and **developed** as a part of the energy system modelling and analysis tools
- Made available for partners to collaborate on projects and direct services as required



Detailed data

- Detailed data on Mainstream Consumers with EVs, covering:
 - Journeys
 - Charging behaviour under both “conventional” and smart charging conditions



...for both BEVs and PHEVs

- Informing the ETI’s latest insight: **Smarter Charging – A UK transition to low carbon vehicles**
- Combined with the Energy System Catapult’s data analytics capability, it will be made available for partners to collaborate on projects and direct services as required

Recommendations for future work

- Building a deeper understanding of the best **charging solutions for those without off-street parking**
- Assessing the impact of delivering **net zero emissions by 2050**
- Establishing a strategy for **the role and deployment of FCEVs**
- Further research on **the effects of Connected and Autonomous Vehicles (CAVs)** on the ULEV market and wider energy system
- Additional recommendations in the reports include, more detailed examination of:
 - *Vehicle and charging dynamics in multi-car households;*
 - *Getting the most benefit from PHEVs*
 - *Optimising the mechanisms for achieving the Road to Zero ambitions*

Thank you for attending

Please complete your feedback forms

