A LOW CARBON TRANSPORT FUTURE: THE UK CAPABILITY TO LEAD THE WAY

The LowCVP Annual Conference 2016

#LowCVP16

Consumers, Vehicles and Energy Integration Project:

Achieving the benefits of integrating vehicles into the energy supply system

Nicholas Eraut

Project Manager, The Energy Technologies Institute

@the_ETI

#LowCVP16

Consumers, Vehicles and Energy Integration (CVEI) Project:

Achieving the benefits of integrating vehicles into the energy supply system

Low Carbon Vehicle Partnership Annual Conference, 30th June 2016

Nick Eraut – Project Manager, ETI

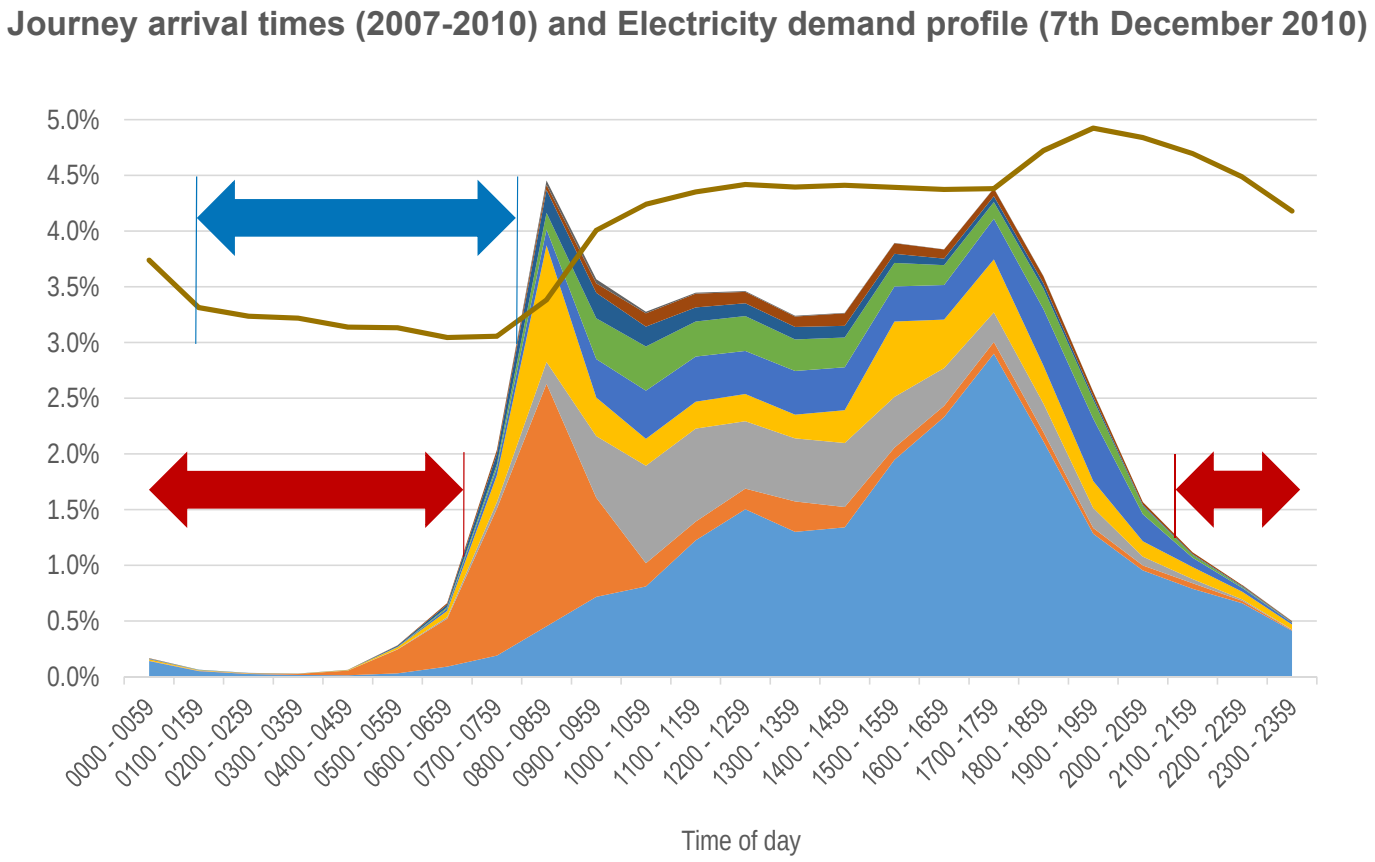
Challenges for low carbon vehicles

- Meeting user energy supply requirements, whilst managing energy capacity constraints
- Implementing intelligent vehicle charging without compromising vehicle / battery utility
- Developing greater understanding as to where and to what extent to invest in network reinforcement
- Integrating liquid and electric “fuel” supply systems for vehicles, and utilising the capability of the liquid fuel system

Plugging vehicles in and charging them

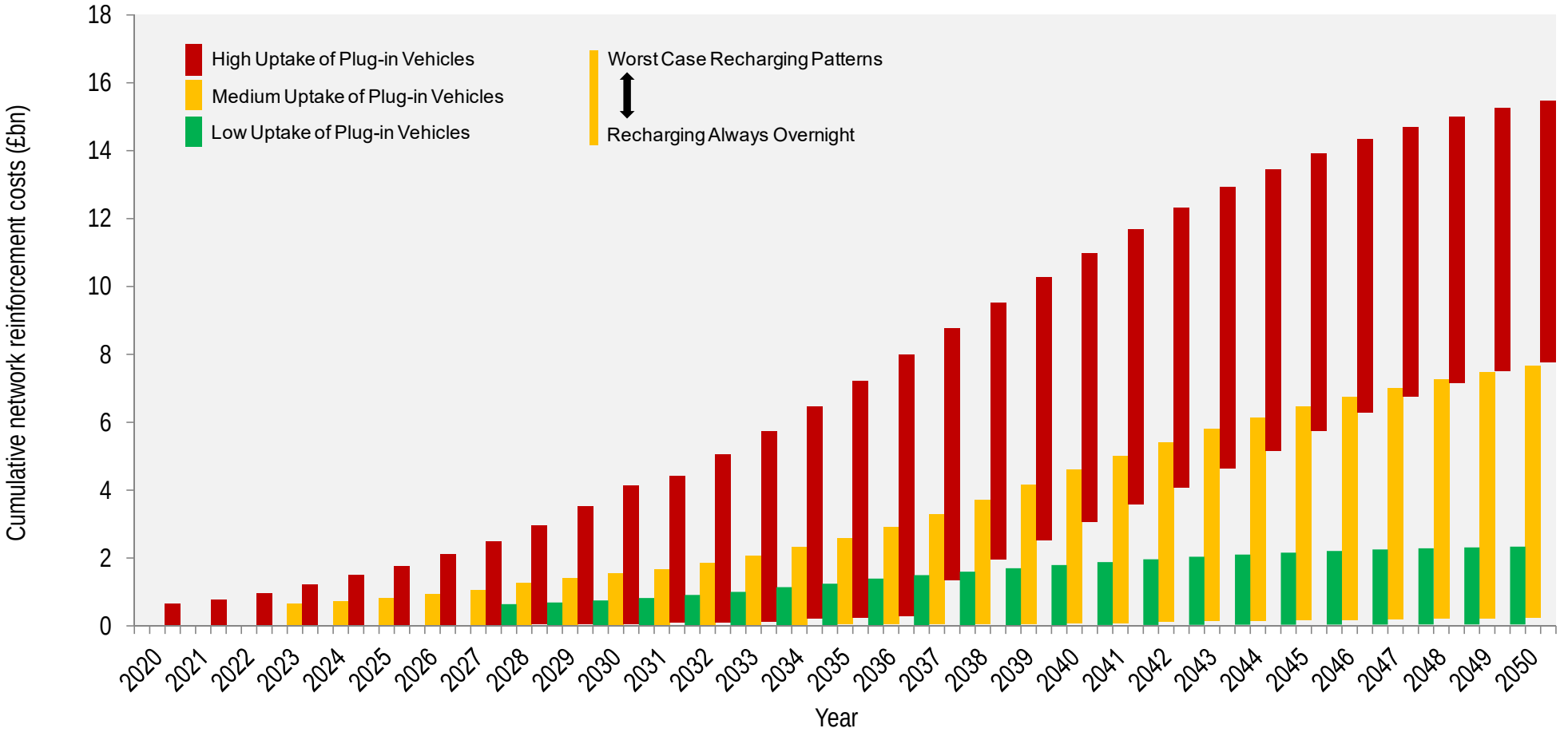
Period when there is greatest spare capacity in the network

Period when majority of vehicles could be plugged in



Compiled using NTS and UKERC data

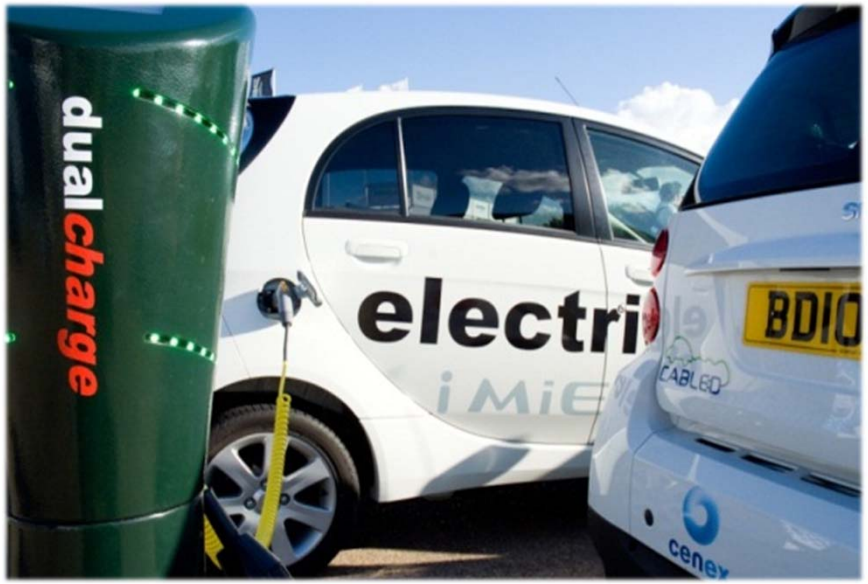
Network reinforcement costs



Consumers, Vehicles and Energy Integration Project

Project aim:

- to address the challenges involved in transitioning to a secure and sustainable low carbon vehicle fleet
- to examine how tighter *integration* of vehicles with the energy supply system can benefit:
  - vehicle users
  - vehicle manufacturers
  - organisations throughout the energy supply chain

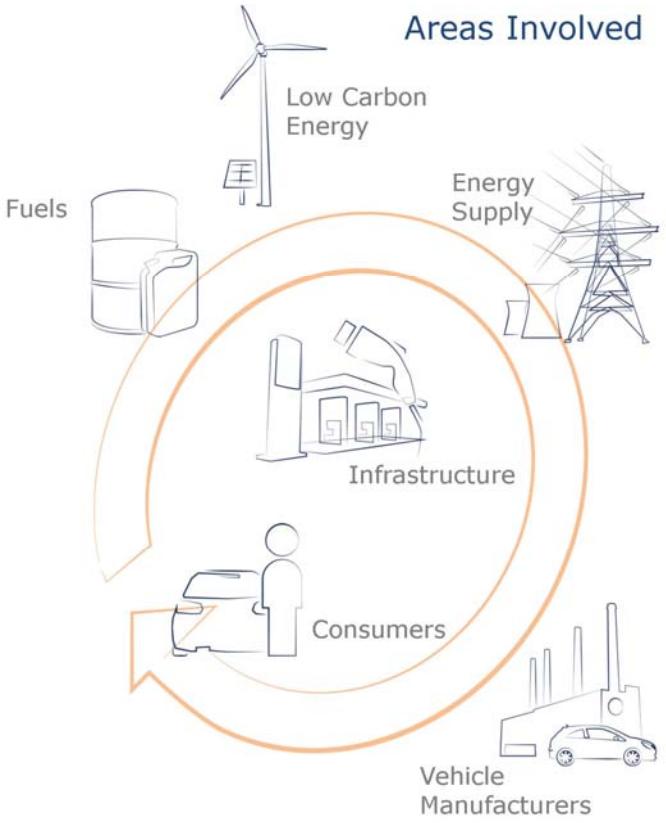


The outputs will:

- help inform UK government (and European?) policy
- help shape energy and automotive industry products

Project overview

- ETI investment of £5 million over two years
- Stage 1: detailed design & analysis to characterise:
  - market, policy and regulatory frameworks
  - business models and customer offerings
  - integrated vehicle and infrastructure systems and technologies for electricity and liquid fuel / hydrogen
  - consumer and fleet attitudes to adoption and usage behaviours
- Stage 2: trial with mass-market consumers, and a corresponding fleet study:
  - to test and validate solutions and assess responses



The project team

TRL

Baringa

elementenergy

Shell

cenex

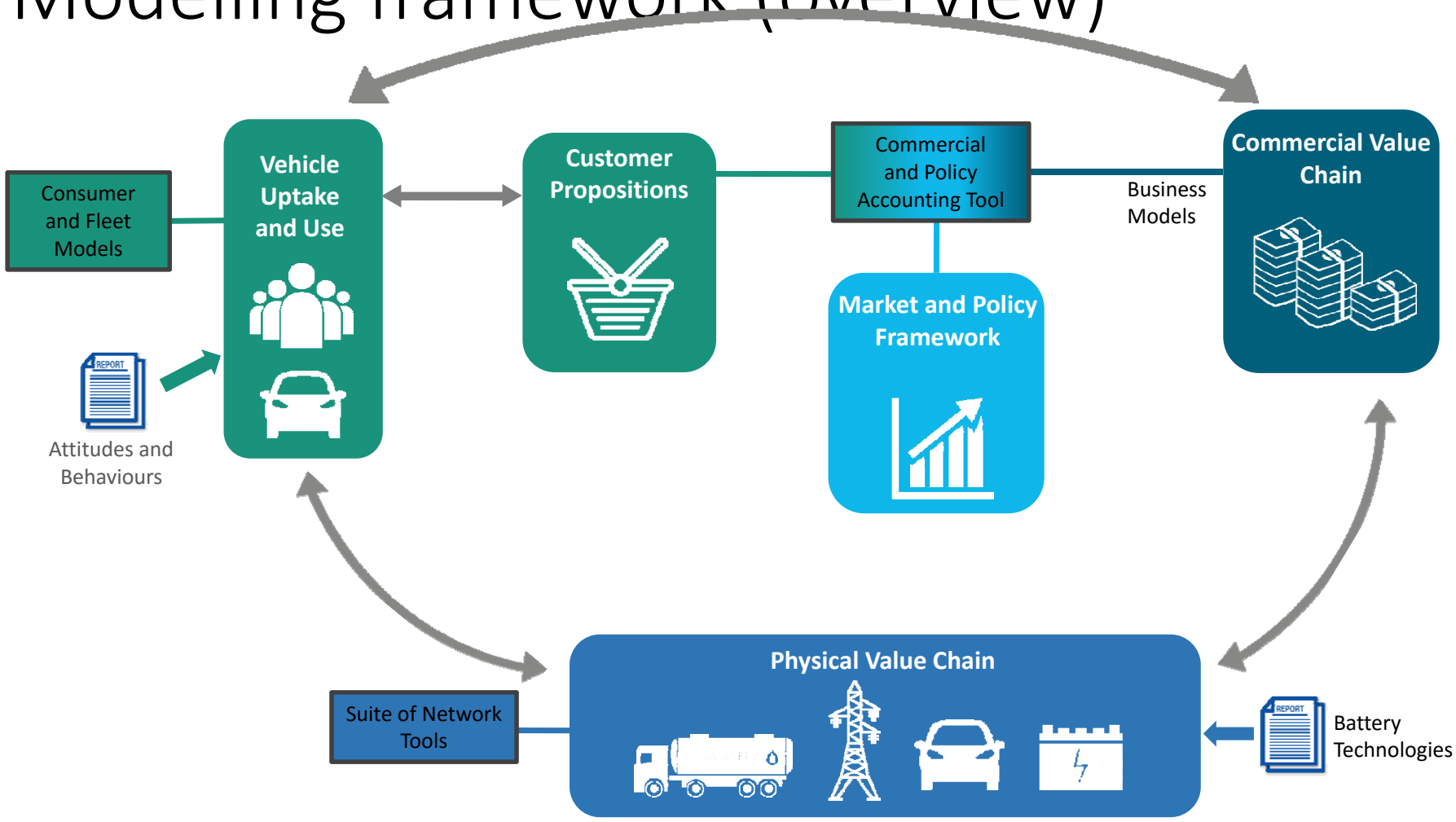
EDF ENERGY

ROUTEMONKEY

THE BEHAVIOURAL INSIGHTS TEAM

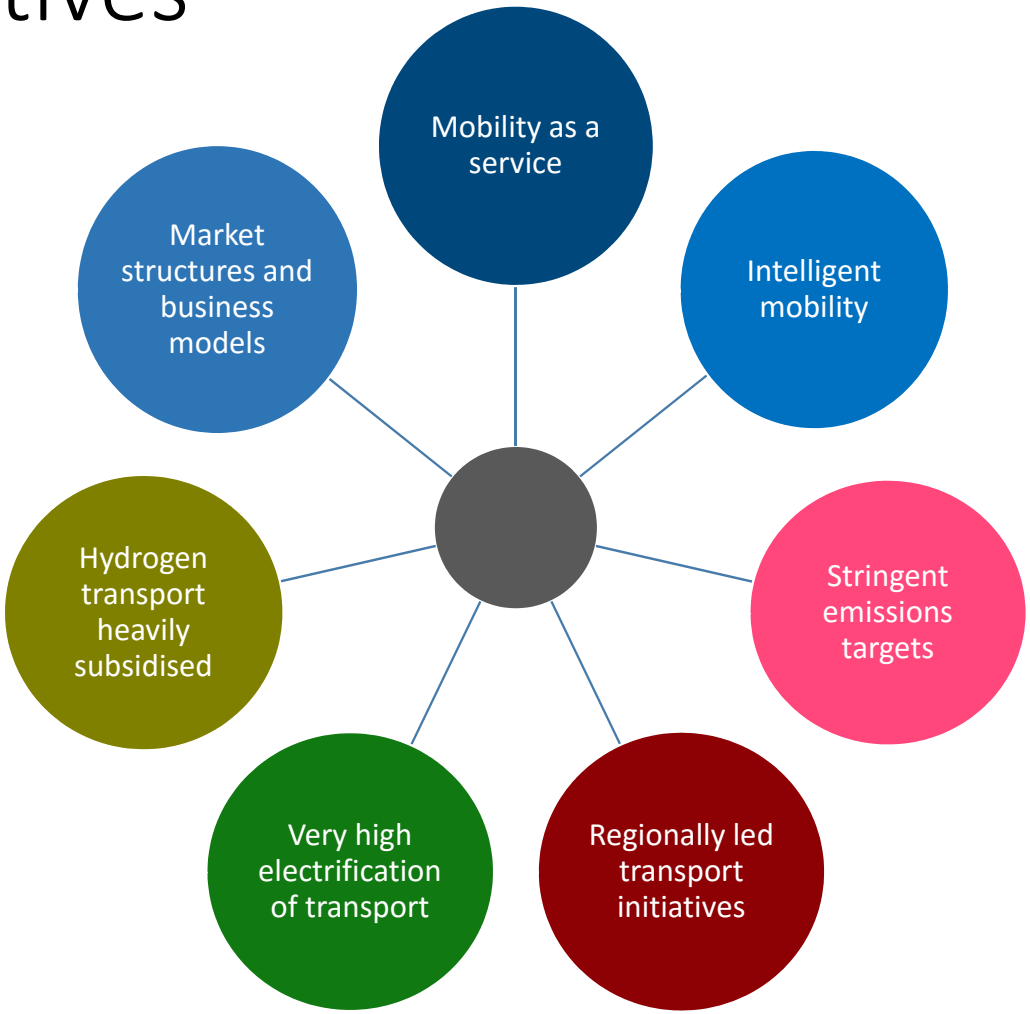
evconnect

Modelling framework (overview)



Development of narratives

- Various “narratives” (scenarios) defined to describe aspects of possible future environments for ULEV deployment and use.
- These are used to “stress test” the effectiveness and robustness of solutions in different futures.
- Each narrative comprises many “building blocks” characterising key aspects of:
  - customer proposition,
  - market & policy framework,
  - physical value chain, and
  - commercial value chain.
- Example factors addressed by the range of narratives are shown here …



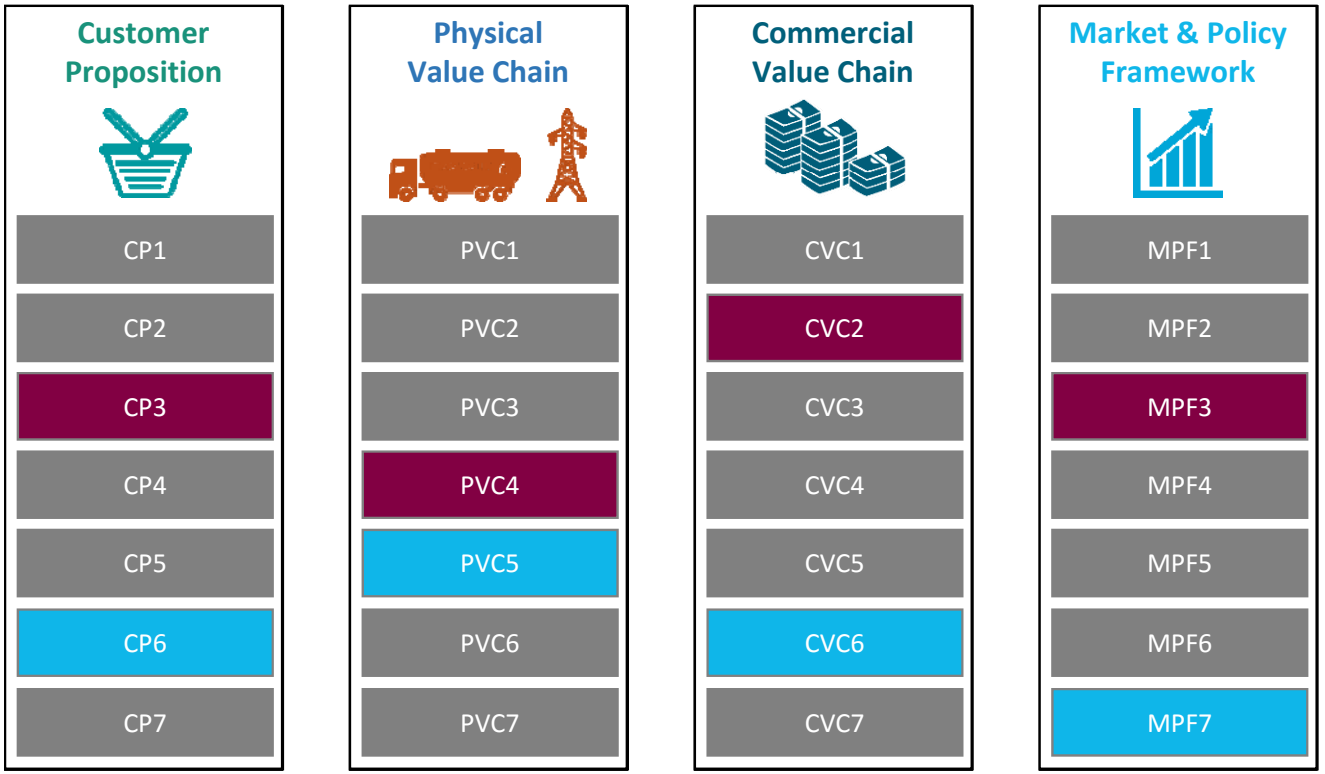
Narratives comprising building blocks

Each narrative comprises many "building blocks" characterising key aspects of:

- customer proposition,
- market & policy framework,
- physical value chain, and
- commercial value chain.

"Transport on Demand" narrative

"Hydrogen Push" narrative



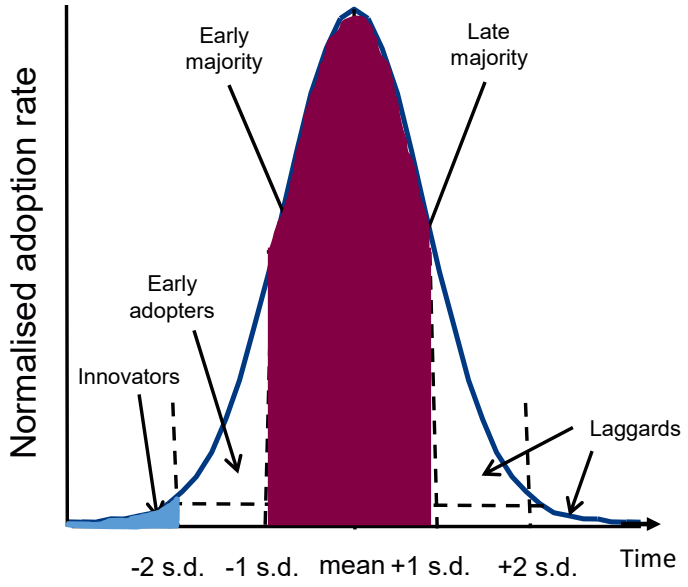
Purpose of Stage 2

- Trial with mass-market users …
- to deliver learning, testing and, so far as possible, validation of …
- the expected impacts of the system solutions and offerings identified in Stage 1 …
- on vehicle users, fleet operators, emissions, market behaviour, system resilience and cost.

Consumer adoption model and “mass-market” consumers

Early stages of adoption

- Users with access to EVs are still classed as ‘Innovators’ (i.e. very early stage of adoption)
- To date, trials have been conducted using only Innovators
- Low numbers of consumers
- Attitudes and behaviours are not representative of the majority of users



Future majority ‘Mass-market’ consumers

- Much larger numbers of users
- These will significantly influence the energy system
- Very different motivations, attitudes and behaviours to those of Innovators
- Unlikely currently to use or own a plug-in vehicle
- Do not generally have specific motivations for early adoption of plug-in vehicles
- Less likely to adapt behaviour (e.g. to accept managed charging) to meet needs of the vehicle or energy system

Unique value of this trial

- Trial with mass-market users
  - i.e. people from the majority of the vehicle user and fleet operator market
- Addressing widely-applicable plug-in vehicles (BEVs and PHEVs)
  - suitable for wide range of users
- Holistic system design

Key components of Stage 2*

Consumer – Vehicle Uptake Trial

➢ to enhance understanding of adoption of EVs

- 200 consumers, given 2 days with each of 3 vehicles in turn (BEV, PHEV, ICE)
- additional questionnaires and choice experiments (with reduced 'psychological distance')
- findings inform analysis on uptake by mainstream consumers under different market and policy frameworks

Consumer – Charging Behaviour Trial

➢ to assess response to market frameworks and policy incentives for demand management

- 240 consumers, given 2 months with a vehicle
- parallel BEV and PHEV trials
- data on use and charging / fuelling, with additional questionnaires and choice experiments
- findings inform analysis of effectiveness of charging solutions and vehicle-energy integration and of system level impacts

Fleet – Uptake and Managed Energy Supply Study

➢ to assess informed response to modelled fleet-wide roll-out

- case studies with selected fleets based on analysis in Stage 1
- some vehicles replaced by ULEVs to provide real experience
- wider fleet roll-out modelled and assessed with operators

Update of Results, Reporting and Dissemination

➢ to complete analysis and communicate results

- capture learning, update frameworks, assumptions, uncertainties and analysis
- derive conclusions re uptake and integration of vehicles into system
- reporting and dissemination

* All details are provisional, subject to detailed trial design to be completed during Stage 1

Key take-home messages today

- There are substantial challenges associated with widespread roll-out of low carbon vehicles, but a paradigm shift from a *"problem for the network"* to an *"opportunity through integration of vehicles as part of a wider system"* can yield benefits for all actors in the system:
    - including increased uptake of low-emission vehicles, managing charging and refuelling, and optimising the system design.

- Analysis and solutions must be holistic (considering all parts of the system together, including users).

- CVEI Project will determine and characterise good system solutions.

- Robust trial in Stage 2 will generate additional data to test solutions and inform analysis, and will add unique value (though use of PHEVs and mass-market consumers in particular).

- Expect to communicate initial results soon:
    - Stage 1 in Sept (at Cenex LCV2016, SMMT, other stakeholder groups, publication of reports, etc)
    - Stage 2 next year.

Registered Office
Energy Technologies Institute
Holywell Building
Holywell Park
Loughborough
LE11 3UZ

For all general enquiries telephone the ETI on 01509 202020.

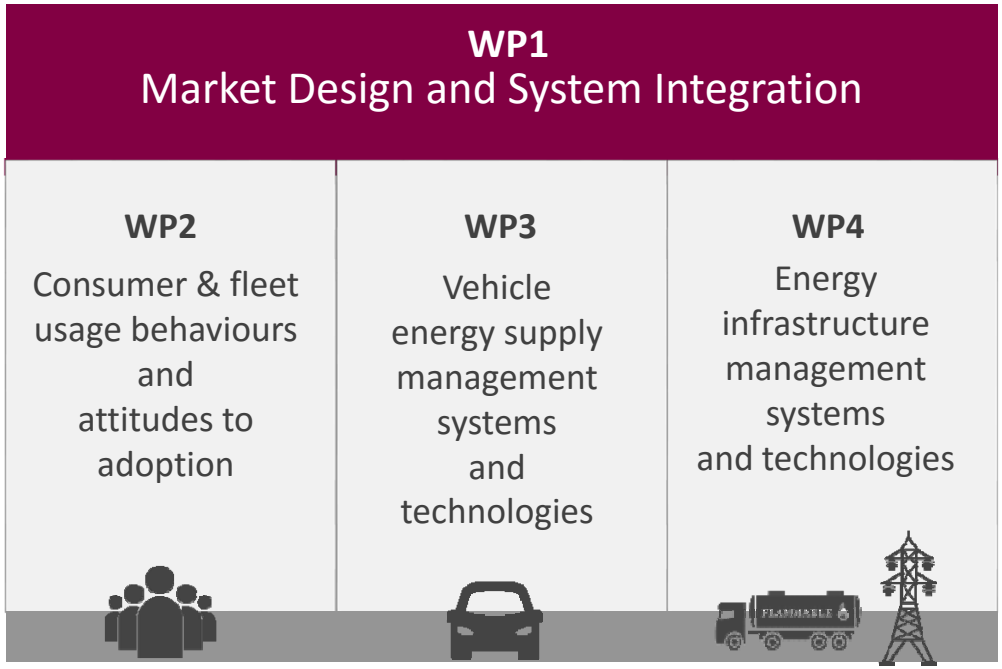
For more information about the ETI visit www.eti.co.uk

For the latest ETI news and announcements email info@eti.co.uk

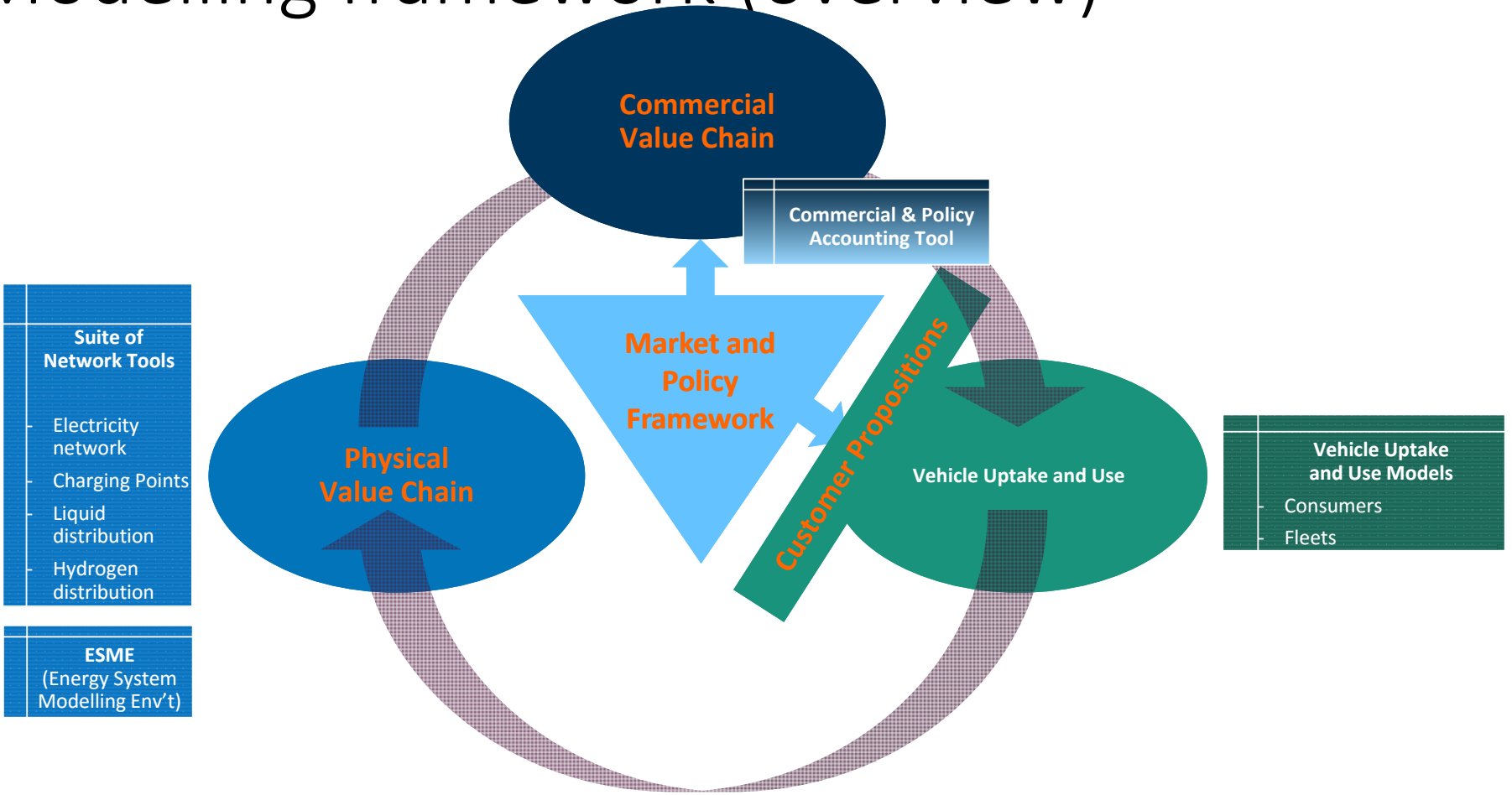
The ETI can also be followed on Twitter @the_ETI

Reserve material

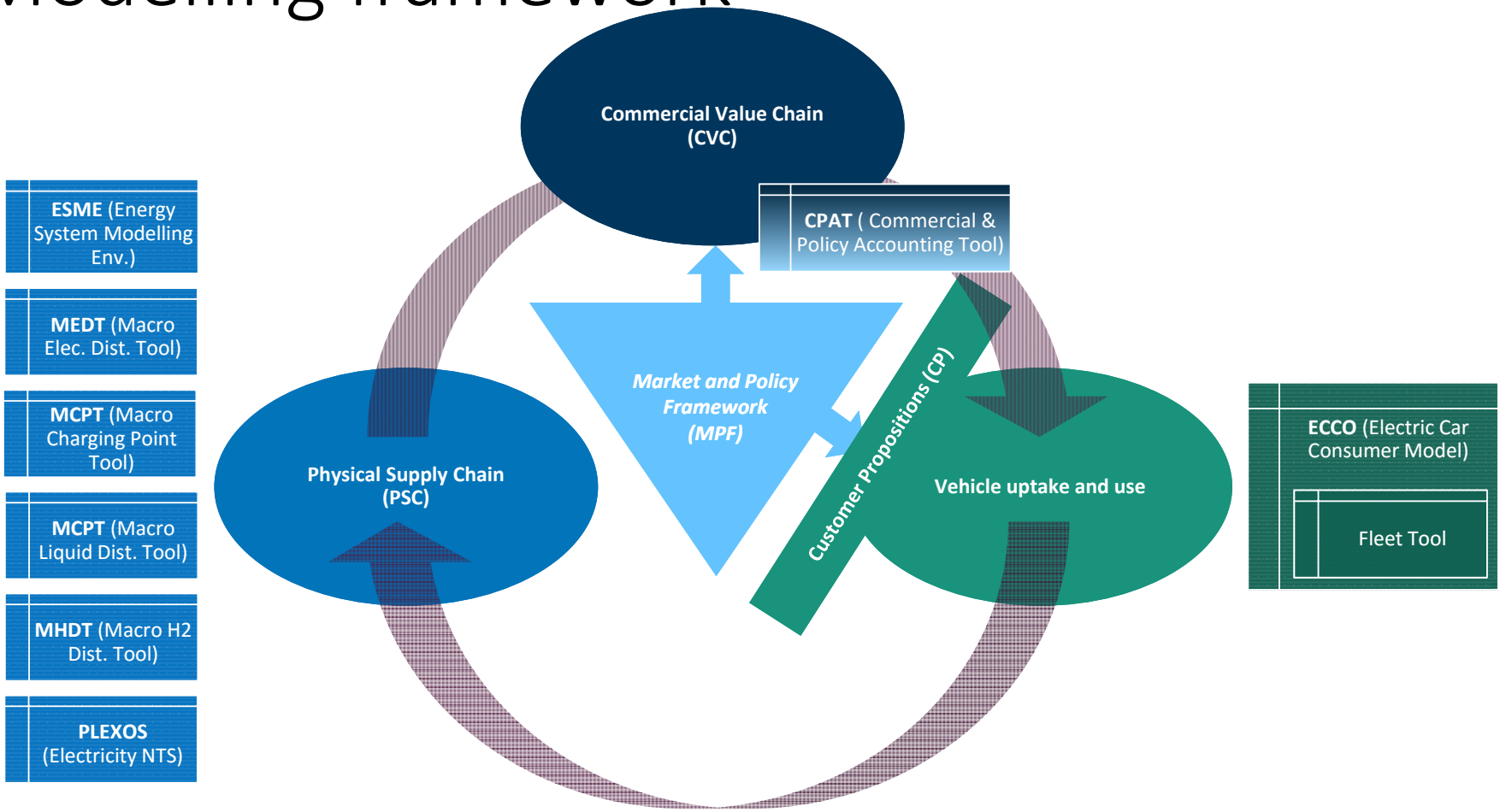
Stage 1 Work Packages



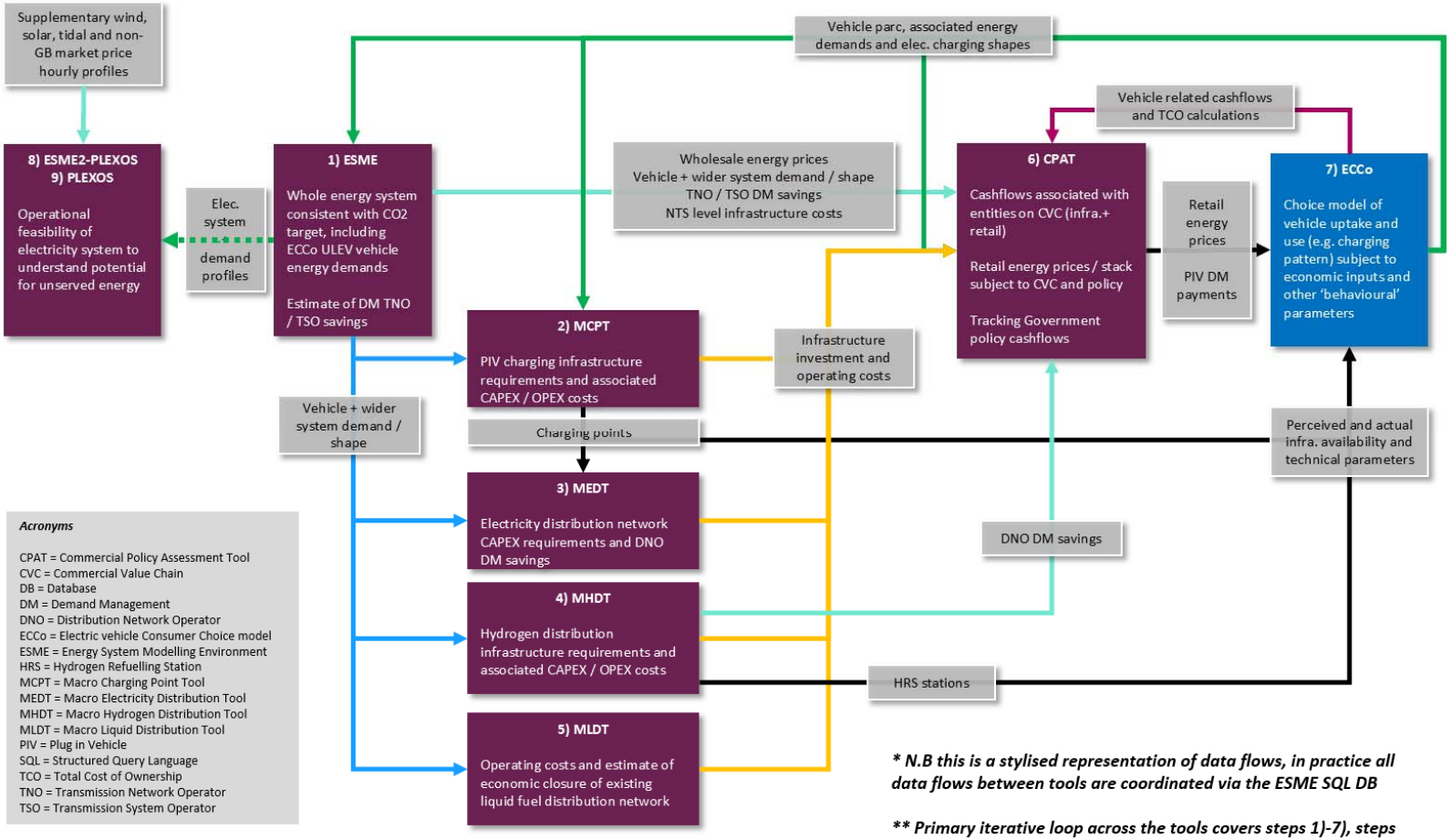
Modelling framework (overview)



Modelling framework



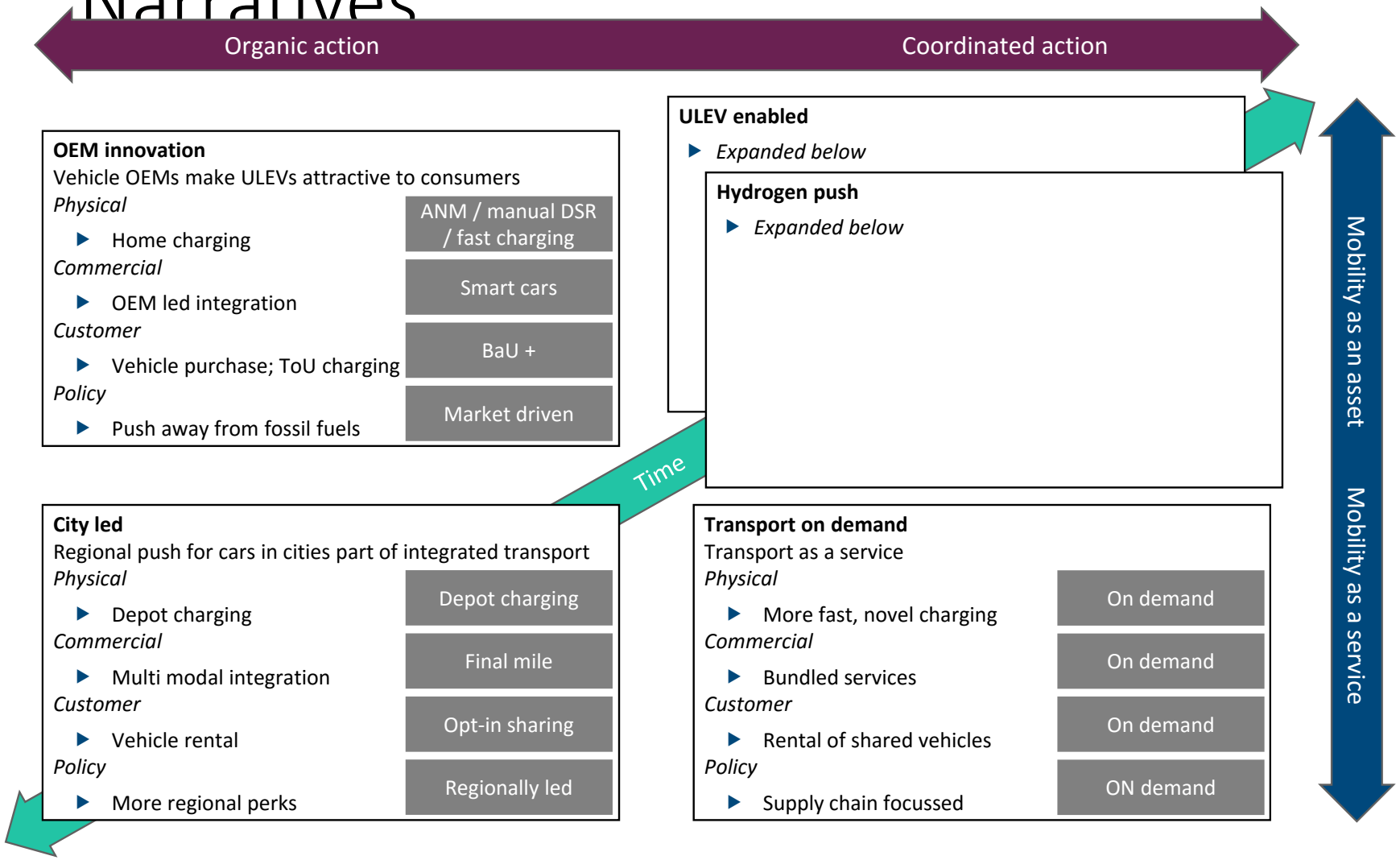
Modelling framework



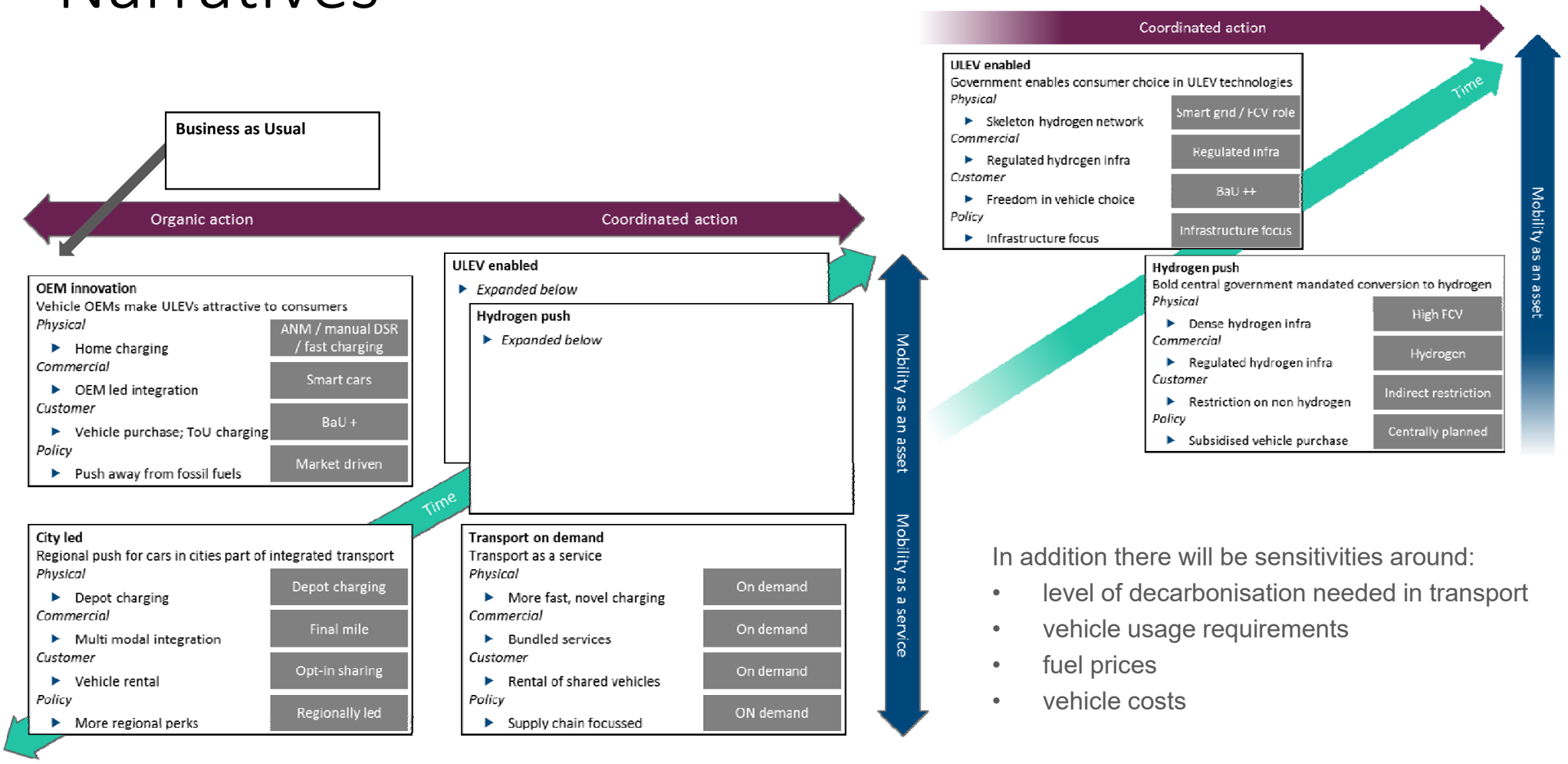
** N.B this is a stylised representation of data flows, in practice all data flows between tools are coordinated via the ESME SQL DB*

*** Primary iterative loop across the tools covers steps 1)-7), steps 8)-9) performed on 'equilibrium' solution*

Narratives


Organic action
Coordinated action
OEM innovation
Vehicle OEMs make ULEVs attractive to consumers
Physical
Home charging
ANM / manual DSR / fast charging
Commercial
OEM led integration
Smart cars
Customer
Vehicle purchase; ToU charging
BaU +
Policy
Push away from fossil fuels
Market driven
ULEV enabled
Expanded below
Hydrogen push
Expanded below
Time
City led
Regional push for cars in cities part of integrated transport
Physical
Depot charging
Depot charging
Commercial
Multi modal integration
Final mile
Customer
Vehicle rental
Opt-in sharing
Policy
More regional perks
Regionally led
Transport on demand
Transport as a service
Physical
More fast, novel charging
On demand
Commercial
Bundled services
On demand
Customer
Rental of shared vehicles
On demand
Policy
Supply chain focussed
ON demand
Mobility as an asset
Mobility as a service

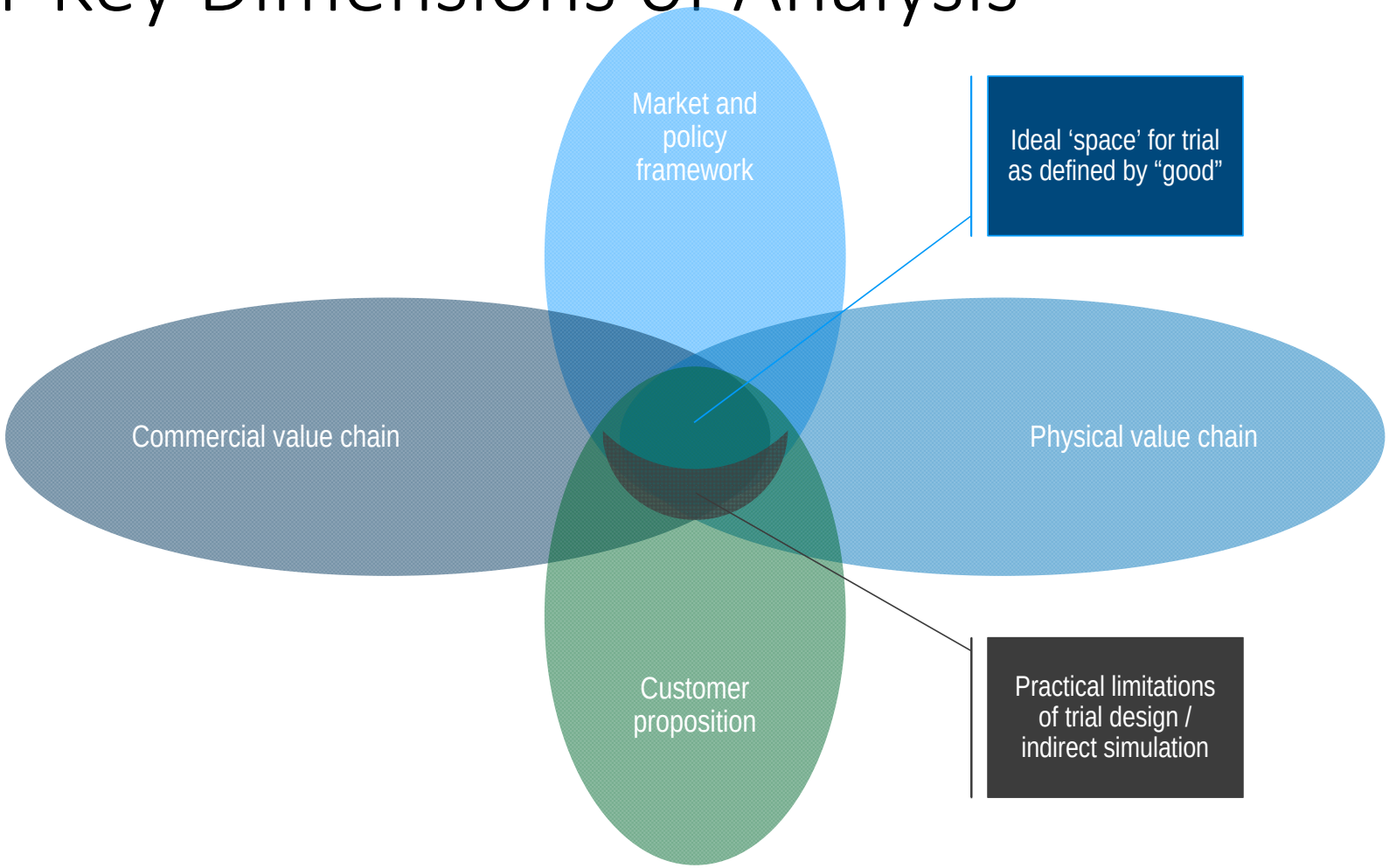
Narratives



In addition there will be sensitivities around:

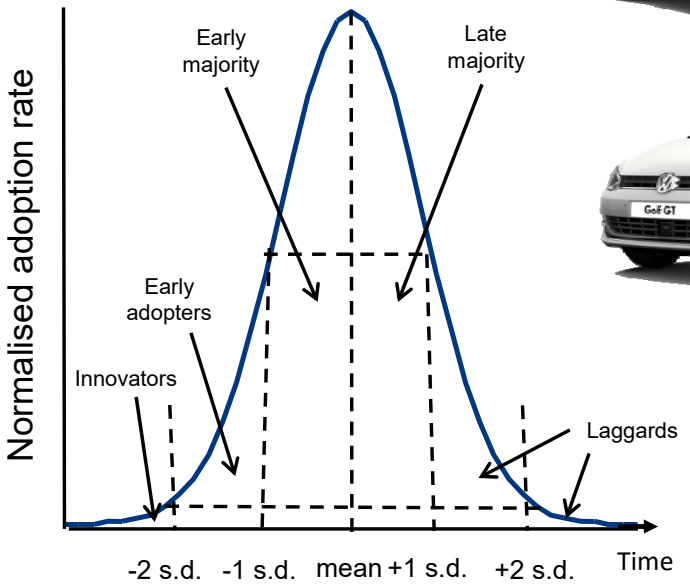
- level of decarbonisation needed in transport
- vehicle usage requirements
- fuel prices
- vehicle costs

Four Key Dimensions of Analysis



Consumer vehicle uptake trial

- Will use three different types of vehicle:
  - a Battery Electric Vehicle (BEV)
  - a Plug-in Hybrid Electric Vehicle (PHEV)
  - an Internal Combustion Engine (ICE) vehicle
- VW Golf
  - Based on existing popular C-segment car and is a top 5 selling car in the UK
  - Identical models of BEV, PHEV and ICE available
- Consumers will be given up to 2 days with each of the 3 vehicles in turn (the order they receive the vehicles will be randomised)
- Having experienced each of the vehicles, participants will be interviewed and take part in choice experiments to deduce attitudes to the different vehicles
- Findings will be fed into ECCo model to inform analysis on uptake of each type of vehicle by mainstream consumers under different market and policy frameworks

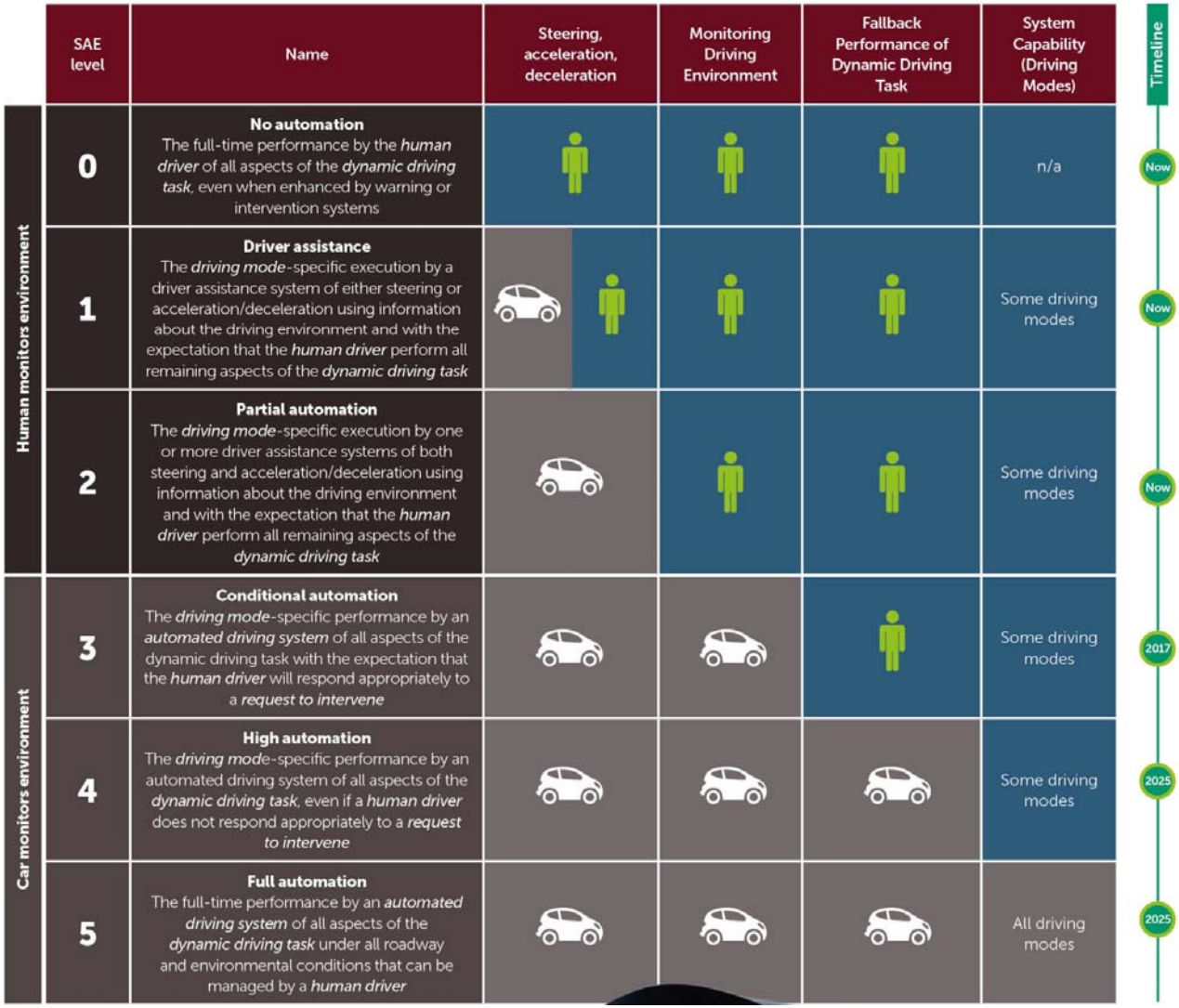


Consumer charging behaviour trial

- Will comprise 2 trials
  - BEV (VW e-Golf) – electric range 118 miles (24.2kWh)
  - PHEV (VW Golf GTE) – electric range 31 miles (8.7kWh)
- Each with 3 test conditions
  - Managed charging – charging will be managed (e.g. by supplier) to minimise charging costs
  - Time of Use tariff – set prices will be offered at different periods during the day to encourage users to charge at certain times
  - Control condition – will charge the vehicle without supplier management or variable pricing
- Participants will be allocated one of the vehicles and will have 8 weeks use of it under one of the 3 conditions
- Trial will measure:
  - Mileage
  - Plug-in and plug-out times
  - Charge times
  - Battery state of charge
- Post-trial interviews and choice experiments will extend the learning around effectiveness of the different options
- Results from the trial and the follow-up will feed into the analysis of the effectiveness of the charging solutions and vehicle-energy integration and system level impacts

Carbon emissions

UNIVERSITY OF LEEDS



Results (USA)

UNIVERSITY OF LEEDS