Mobility of People

System-Level Roadmap

2024

automotive council UK

ADVANCED PROPULSION CENTRE UK

Produced by the Advanced Propulsion Centre UK on behalf of the Automotive Council UK

Information correct at time of publication

Contents

Introduction to the system-level roadmaps

This system-level roadmap responds to a changing automotive environment and provides a resource for the automotive industry to build synergies across the system interfaces with the wider transport eco-system.

The roadmap aims to highlight the current and future mobility landscape and shows which key trends and drivers are expected to shape automotive road transport for the movement of people and goods.

This roadmap details the role the automotive sector plays in delivering a sustainable, net zero transport system.

The roadmaps have been informed by a series of wide-reaching stakeholder consultations to assess the current and future mobility landscape. In total eight technology themed roadmaps and two system-level roadmaps have been created. This document, The Mobility of Goods, is a systems-level roadmap.

The system-level roadmaps are split into these two focus areas to fully assess the needs and requirements for respective products and use-cases. The infrastructure and the regulatory landscape differ considerably between people and goods movement, requiring dedicated roadmaps along with the supporting narrative report.

The narrative report

The narrative report supports the executive roadmap by providing the context behind the product adoption. The narrative considers regulatory and market drivers alongside the work required to develop individual technologies and their supply chain.

System-Level roadmap

Narrative report

Introduction to the system-level roadmaps

This system-level roadmap represents a snapshot-in-time view of the global automotive industry propulsion technology and product forecast for mass-market adoption.

Certainty levels are applied to individual bars within the roadmaps to classify their maturity and rate of mass-market adoption.

Pilot / trial / PoC

Indicates the technology / product is in a demonstration or testing phase, needs more technology and market maturity for market adoption.

Low level of certainty

Indicates there is uncertainty whether the technology / product will be adopted in the timeframe.

High level of certainty

Indicates the technology / product is certain to be mass-adopted in the timeframe.

Product categories

The 2024 Mobility of People Roadmap has advanced the product classification from the previous version (2020).

The Mobility of People Roadmap acknowledges different vehicle applications and use-cases will require a range of powertrain solutions based on their energy and power demand.
The roadmap is split into two parts:

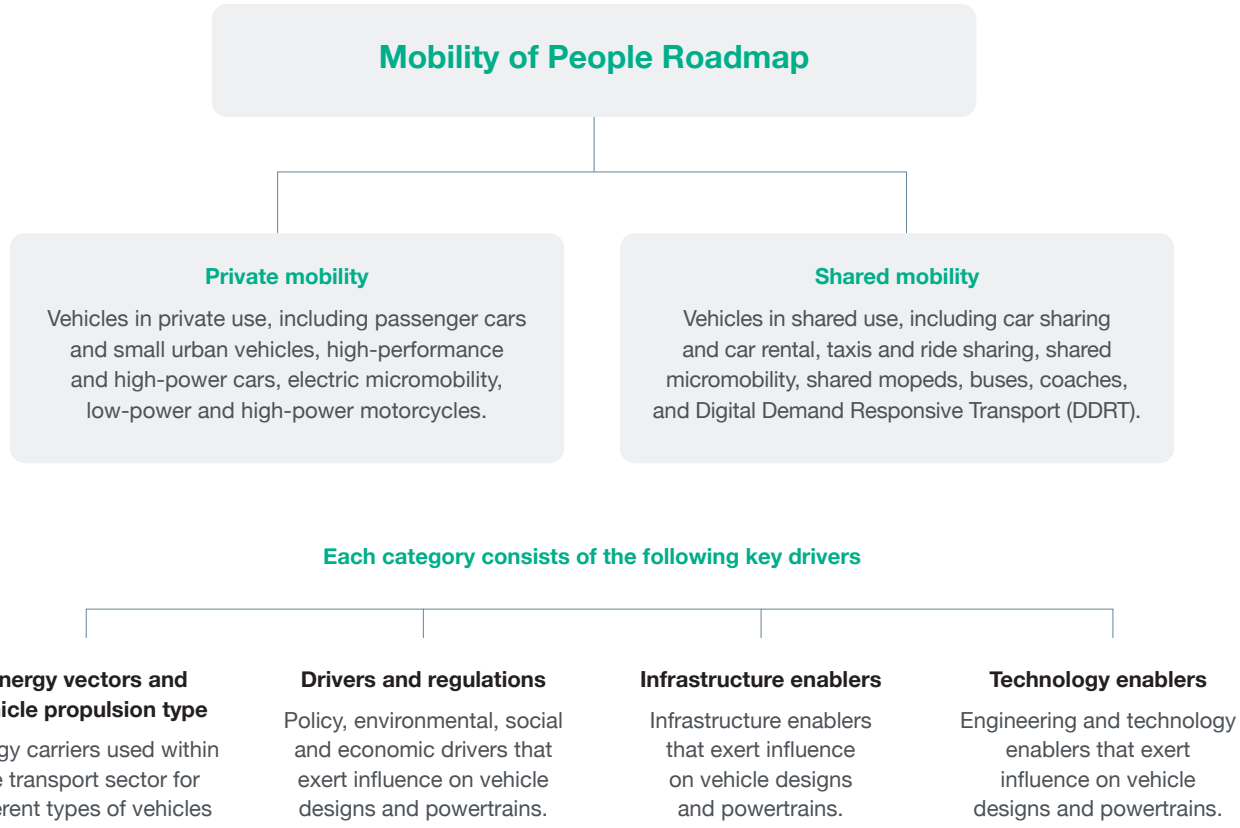
- private mobility
- shared mobility

There is a mass-adoption forecast for each of these product categories which focuses on propulsion technologies and energy vectors that are en-route to market maturity.

Key drivers

The forecast will be evidenced by four key drivers:

- energy vectors and vehicle propulsion type
- drivers and regulations
- infrastructure enablers
- technology enablers



Vehicle classification

Passenger cars

Passenger cars are mainstream vehicles that are common globally and include hatchbacks, family cars and Sports Utility Vehicles (SUVs).

Small urban vehicles

Small urban vehicles include both small passenger cars and emerging dedicated urban BEVs. Zemo Partnership uses the term Powered Light Vehicles (PLVs) for a range of two, three and four-wheeled vehicles for either passenger or cargo use[3]. PLVs will fall under the EU regulation of L-category vehicles. For the purpose of this roadmap, small urban vehicles include micro-cars (L6e and L7e categories).

This emerging sector of micro-cars includes new models of small low-speed electric vehicles for one or two people with three or four wheels, typically weighing between 100 to 500 kg. These vehicles sit between micromobility and passenger cars.

High-performance and high-power cars

High-performance and high-power cars are specialist vehicles that are sold in smaller quantities when compared to passenger cars and include performance and super cars as well as luxury Sport Utility Vehicles (SUVs).

Electric micromobility

Electric micromobility includes a range of small, light, low-speed electric vehicles such as e-bikes, cargo bikes and e-scooters. They operate at speeds typically below 25 km/h (15.5 mph) with a mass typically no more than 500 kg. There are also higher speed vehicles available, e.g. higher speed e-bikes, which can be operated above 25 km/h and below 45 km/h.

Motorcycles

A motorcycle is a powered two-wheeled motor vehicle. These two-wheeled motor vehicles include everything from high-powered sport motorbikes to low-powered mopeds.

Within the roadmap the motorcycle category is split into two parts:

- High-power motorcycles: engine power of more than 50 kW and engine capacity of at least 595 cc;
- Low-power motorcycles: engine power of below 50 kW and engine capacity lower than 595 cc.

New vehicle types

It should be noted that a range of new types of two- and three-wheelers (L2e – L5e) are being developed by the market.

EAPC
pedelec bicycle

L1e
50cc scooter

L2e
Toyota i-Road

L3e
Suzuki Burgman

L4e
G.T.L sidecar

L5e
SAM EV03

L6e
Zagato Volpe

L7e
Aixam Vision

M1
Car

Cars: car sharing and car rental

Car sharing, also known as car clubs in the UK, enables individuals or households to enjoy the benefits of access to a car but reduces the need for ownership and, therefore, ongoing vehicle maintenance.

These services provide members with access to vehicles on a pay-as-you -drive basis with cars sited at various locations. Service users can then access the vehicle via their mobile phone.

There are different types of car sharing models available, including peer-to-peer (P2P), where people offer privately-owned vehicles for rent to others via an online platform which also provides insurance.

Car rental differs in that the hirer has access to a vehicle for a longer period of time (days, weeks, months - all apply) and is typically operated via a rental company's local branch. These are often located near airports or in urban areas.

Cars: taxis, ride-hailing

Traditional taxis can typically be hailed on the street, at ranks or booked by phone or app. Taxi services have long-established regulations.

Ride-hailing is a service provided to users when a personal driver is booked via an online app / platform (an aggregator). The aggregator mediates the service between the driver and the passenger. Ride-hailing services are often subject to differing regulations depending on where they operate. In some cases, maximum taxi fares are set by local authorities while ride-hailing services set their own fares and often offer dynamic pricing, depending on demand.

Shared micromobility

Shared micromobility provides short-term access to vehicles including bikes, e-bikes, e-cargo bikes and e-scooters for one-way trips within a defined operating area, typically via an app. Users pay on a trip-by-trip or a subscription basis.

Shared mopeds

Shared moped schemes provide short-term access to mopeds within a defined operating area, typically via an app. Users pay on a trip-by-trip or subscription basis.

Digital Demand Responsive Transport (DDRT)

DDRT is a flexible service that provides shared transport to users who specify their desired location and time of pick- up and drop-off. It can complement fixed-route public transport services and improve mobility in low-density areas and during off-peak times.

There are many trials and pilots of DDRT around the world, including introducing these services as an alternative to fixed-route buses during off-peak hours, in remote neighbourhoods, or as a replacement for underperforming fixed bus routes.

Bus

Product types range from bus-rapid-transit (BRT) vehicles with dedicated lanes and routes, to medium-duty community vehicles and single-decker and double-decker buses.

Coach

Product types include regional and intercity coaches. These are driven towards net zero emissions, since urban access for such vehicles is either limited, or net zero transport vehicles may be permissible under certain settings.

Typically, coaches are medium-power vehicles and have medium -to high-energy requirements to serve long- range travel including national and international routes.

This roadmap provides a list of relevant energy vectors that support vehicle propulsion technologies. The colour codes are shown against each vehicle application, some propulsion types can be supported by more than one energy vector. Within each roadmap the height of the bar does not necessarily represent the importance of the energy source.

Projected demand for zero emission vehicles in major car markets will have significant implications on energy markets. Oil demand from road transport is expected to peak around 2025 and then gradually decrease due to uptake of electric and hydrogen vehicles.[2]

- ICE led
- Battery led
- Fuel cell led

ICE / hybrid energy sources

In addition to petrol and diesel, this energy vector covers lower carbon ICE fuels, electricity (in terms of hybrid assistance) and hydrogen ICE (ICE that uses hydrogen as fuel). There is expected to be a growing need for very low carbon liquid and gaseous fuels derived from biomass, waste or renewable electricity sources (and combinations of these). Sales of plug-in hybrids featuring net zero fuelled ICE and sustainably sourced electricity, may be possible beyond 2035.

Here is a summary of the lower carbon ICE fuel types:

- Natural gas fuels – there are alternative fuels using compressed natural gas (CNG) or liquefied natural gas (LNG).
- Biofuels – typically derived from vegetable or animal fats and alcohol. It is often considered a net zero emission fuel because the CO_2 released during the combustion is previously absorbed by the plants from the air. Biofuel has a minimal impact on CO_2 emissions.
- Advanced biofuels – these use waste rather than crops and can be used in place of diesel offering reduced CO_2 emissions. Bio-LNG is a sub-type of this fuel, which is made by processing organic waste flows, such as organic household and industrial waste, manure and sewage sludge.
- Synthetic fuels, e-fuels – these are produced using a combination of hydrogen and carbon dioxide. The renewable energy required to produce these fuels is greater than that needed to produce green hydrogen. They are a potentially carbon-neutral fuel type that can be used in an ICE.

BEVs energy sources

In addition to electrification of passenger cars, the expanding product range of urban battery electric vehicles (BEVs), including small urban vehicles, require a sustainable electricity source. The demand for clean grid electricity will rise based on the electrification of passenger cars and growing demand for smaller electric vehicles,
e.g. e-bikes, e-cargo bikes, etc.

Fuel cell energy sources

This category includes fuel cell electric vehicles (FCEVs) and hydrogen fuel cell (HFC), where vehicles make use of a fuel cell to generate electricity to power their onboard electric motor. Hydrogen can be produced through steam methane reformation (SMR), which requires carbon capture and storage to be considered emissions free or electrolysis.

The hydrogen is then stored cryogenically (liquid hydrogen) or at high pressure (gas), and then released through a fuel cell to generate electricity to drive one or more electric motors.

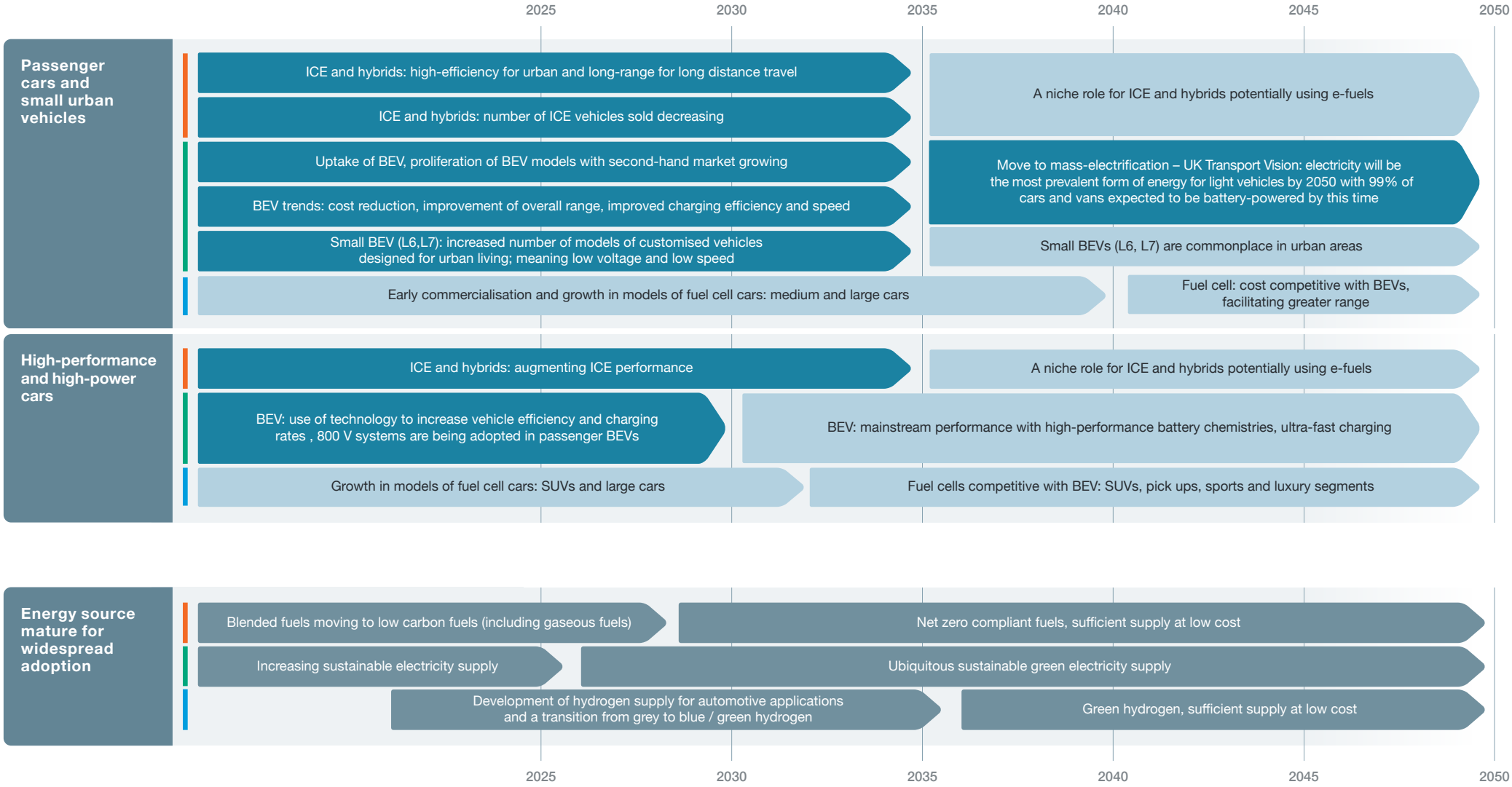
To meet net zero targets, hydrogen fuel cells require low carbon sources of hydrogen, e.g. blue hydrogen (from natural gas with carbon capture and storage technologies) or green hydrogen (from renewable electricity). Solid oxide fuel cells can operate on existing commercial fuels, e.g. blended biofuels

2 Executive summary – Global EV Outlook 2023 – Analysis – IEA

Private mobility

Vehicles in private use, including passenger cars and small urban vehicles, high-performance and high-power cars, electric micromobility, low-power and high-power motorcycles.

Energy vectors and vehicle propulsion type

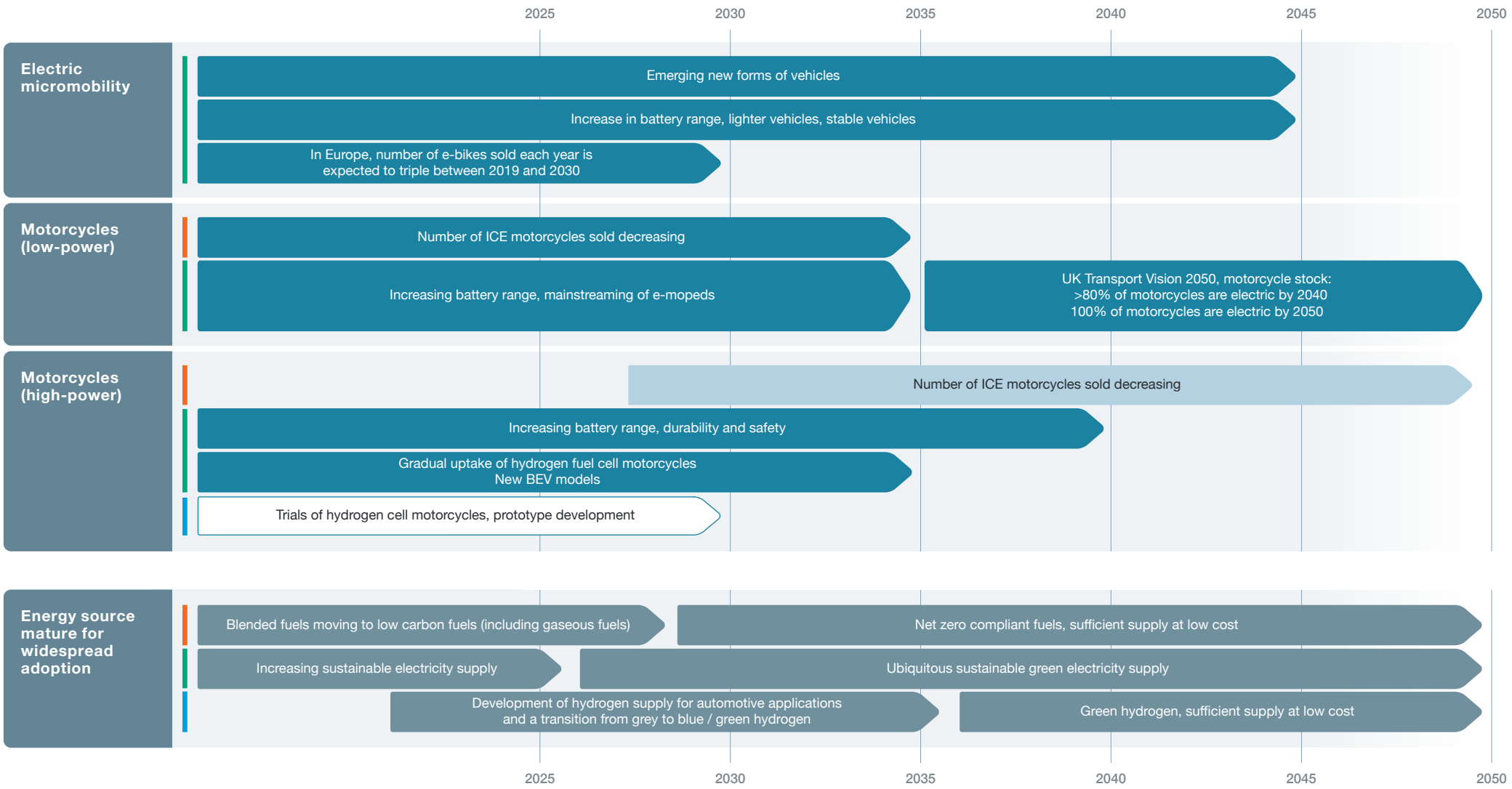


High level of certainty
Lower level of certainty
Pilot / trials / PoCs

Energy source mature for widespread adoption

ICE led
Battery led
Fuel cell led

Energy vectors and vehicle propulsion type



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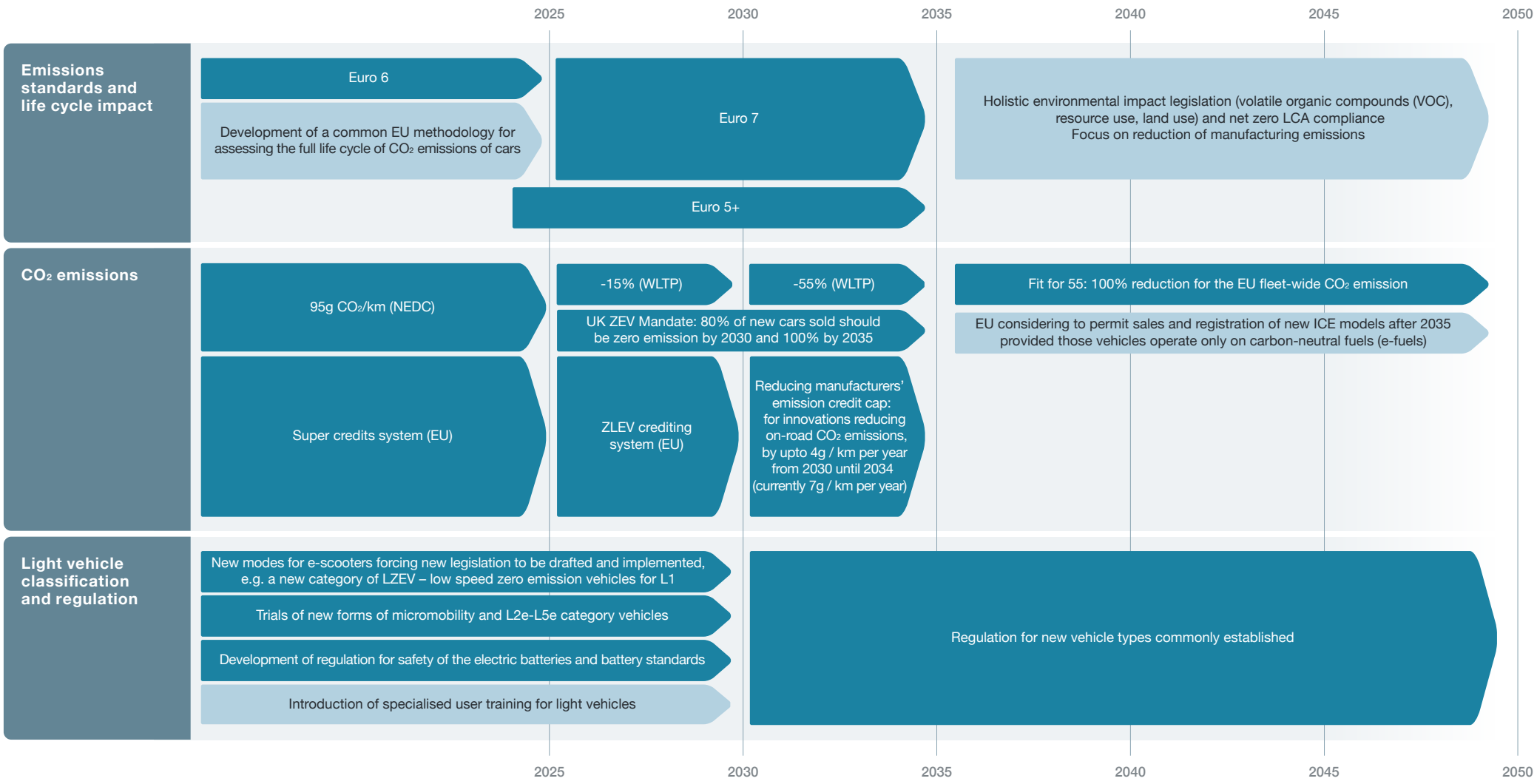
Drivers and regulations



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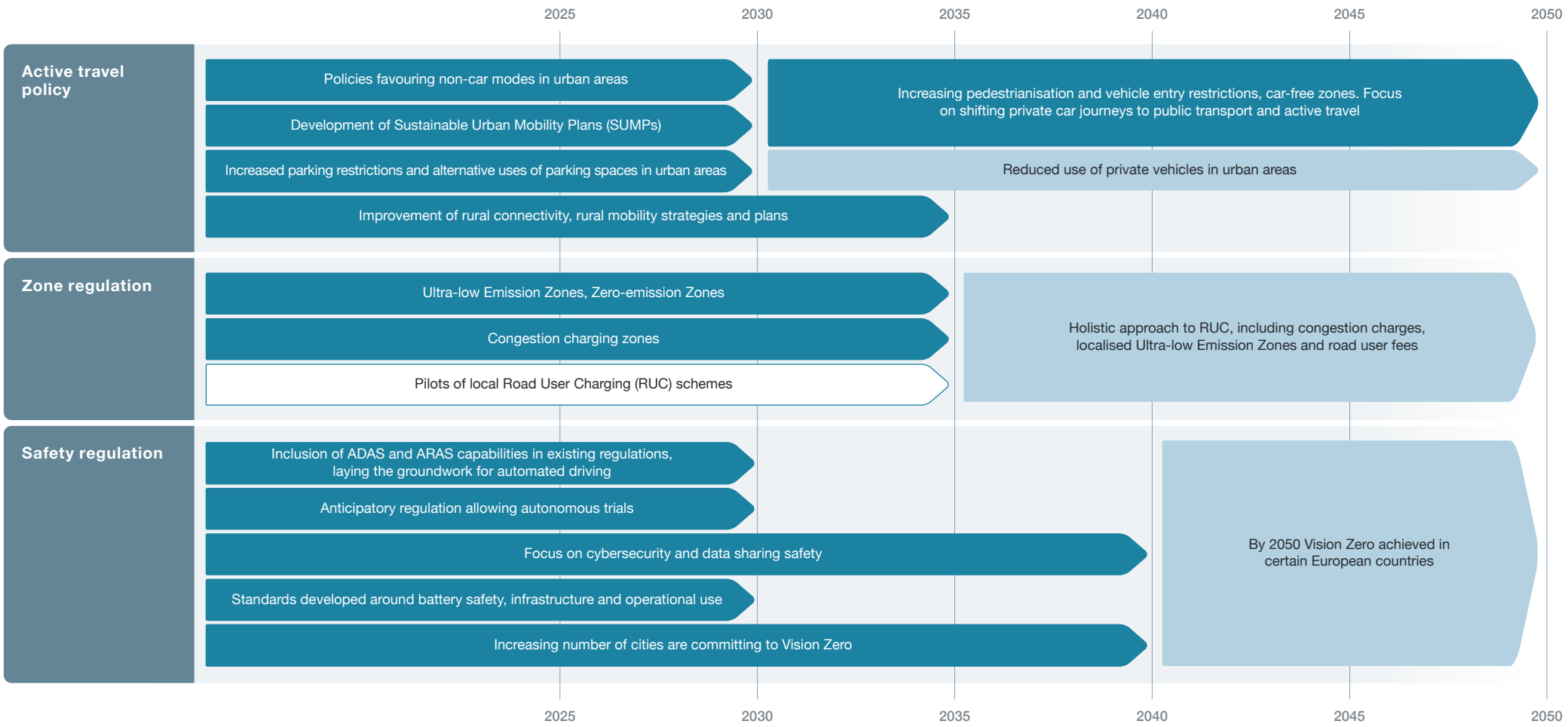

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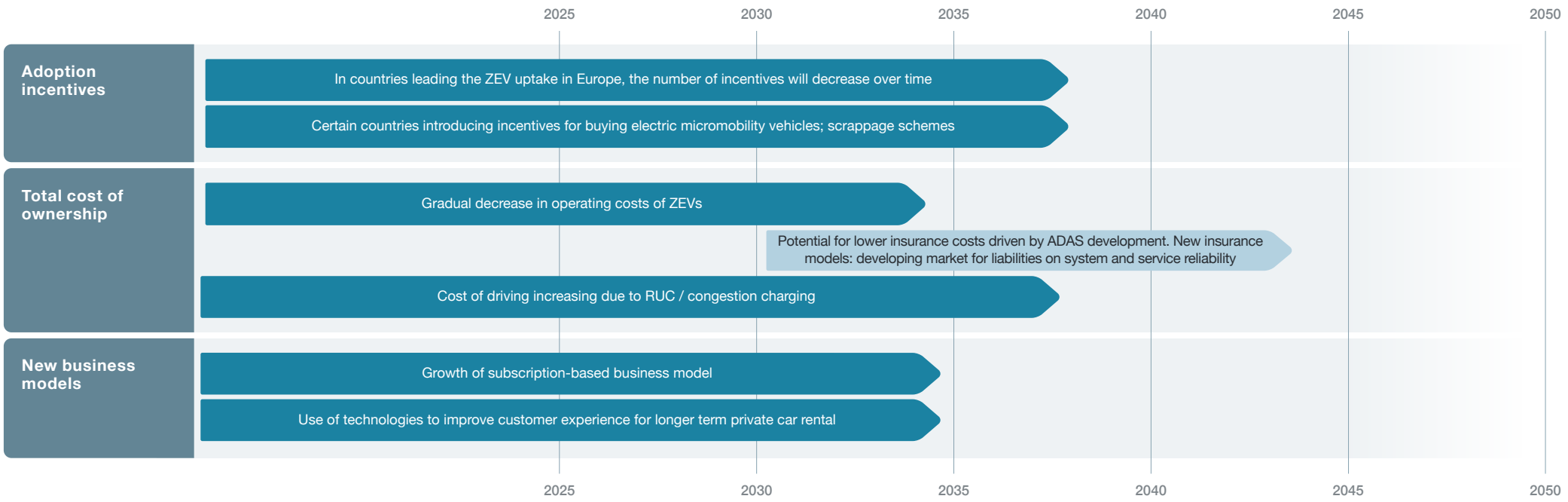

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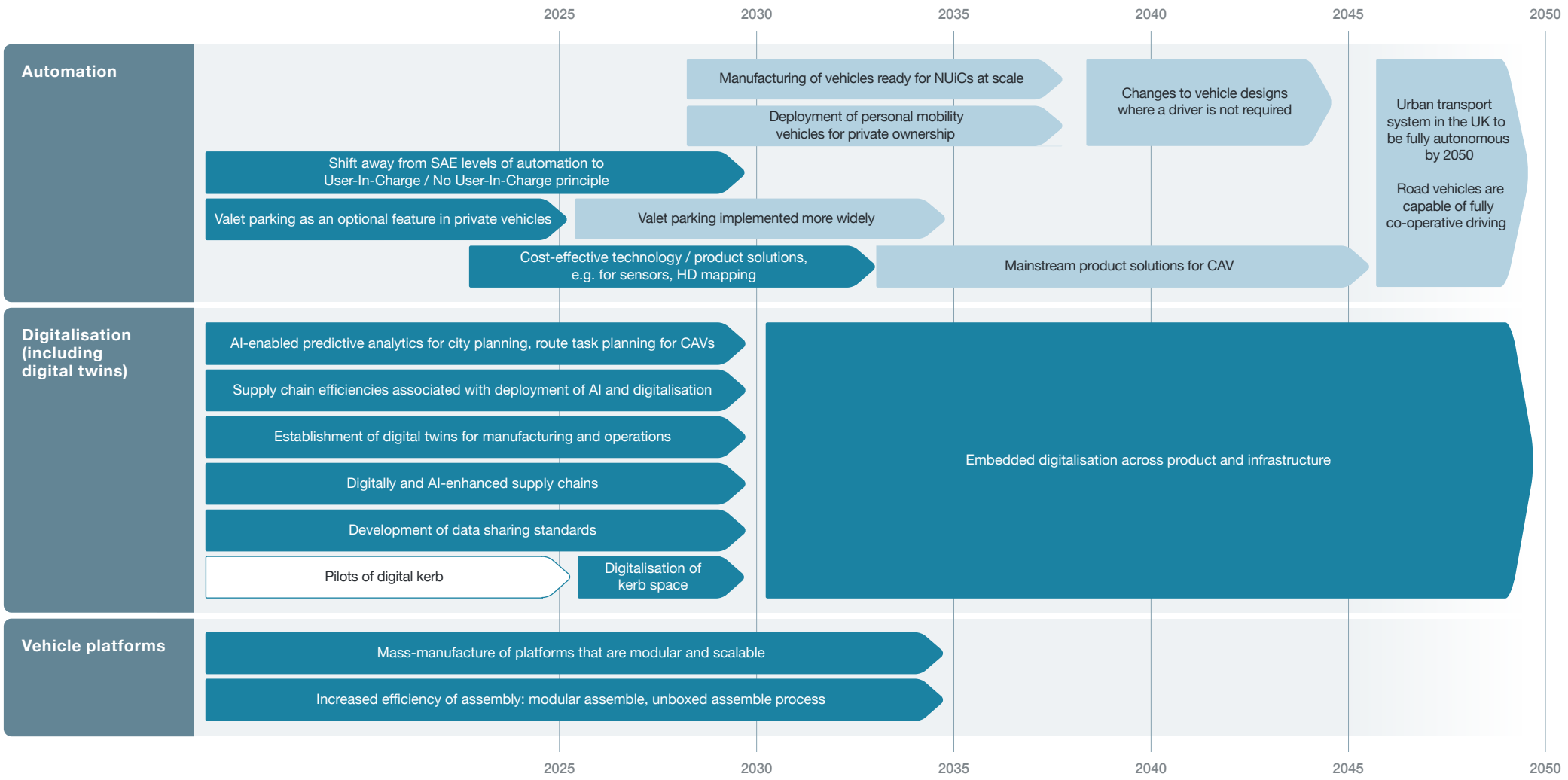
Infrastructure and technology enablers



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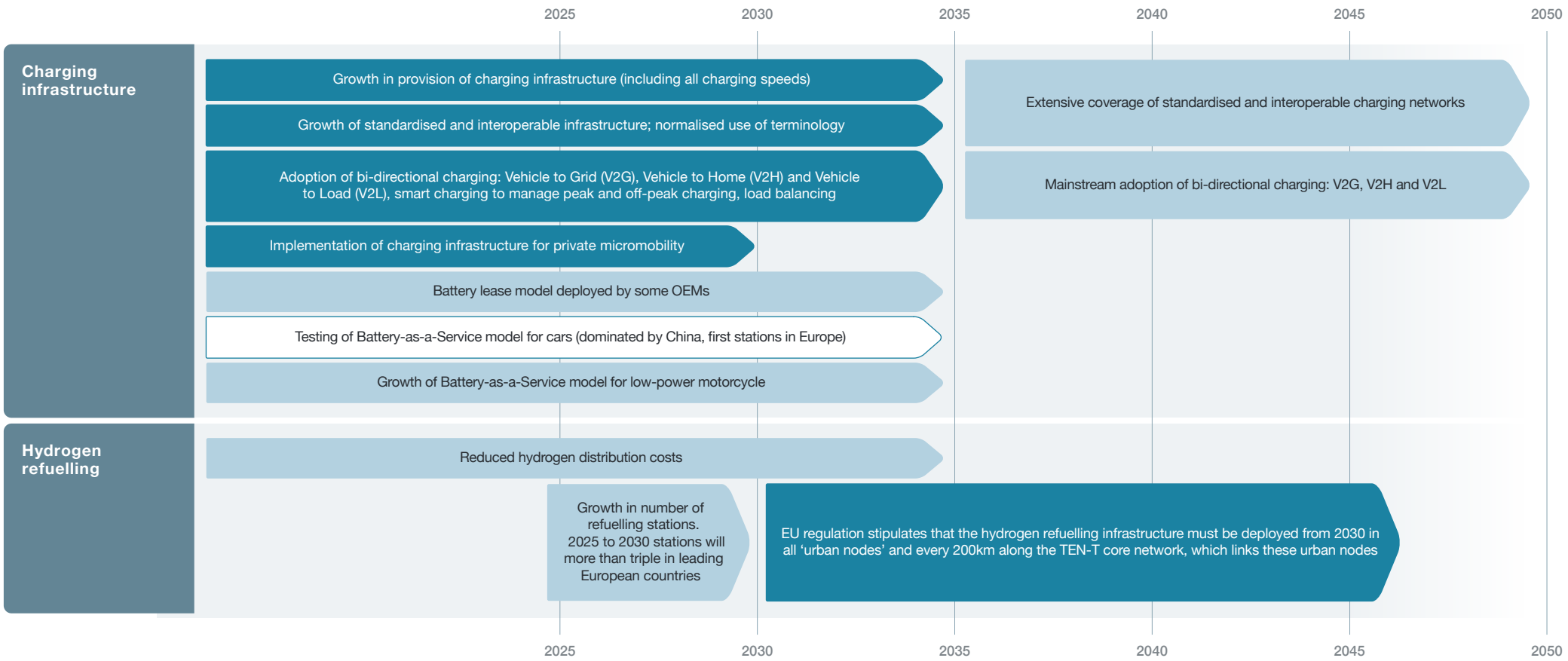

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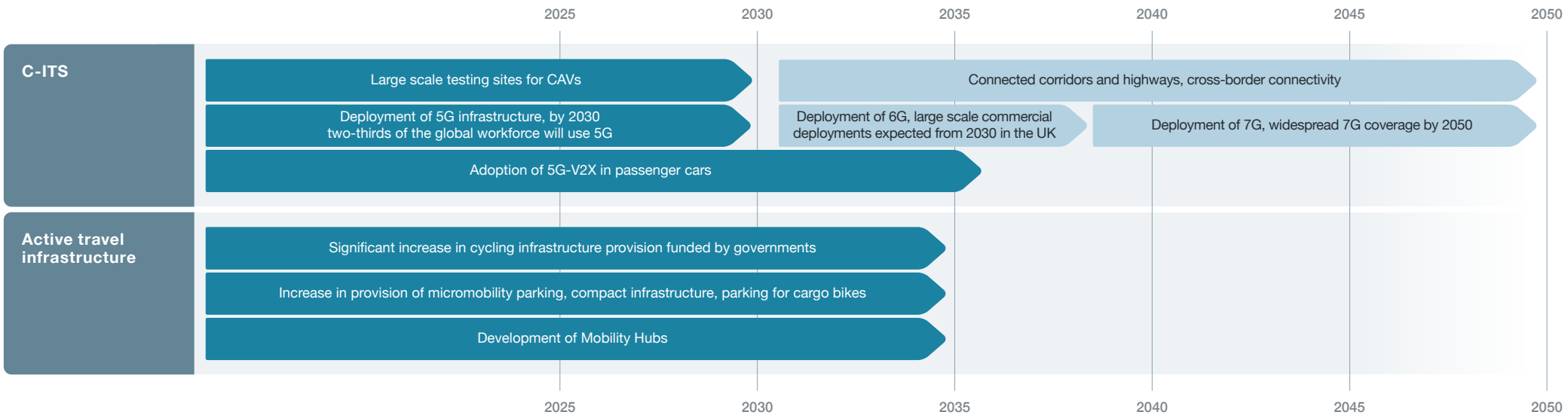

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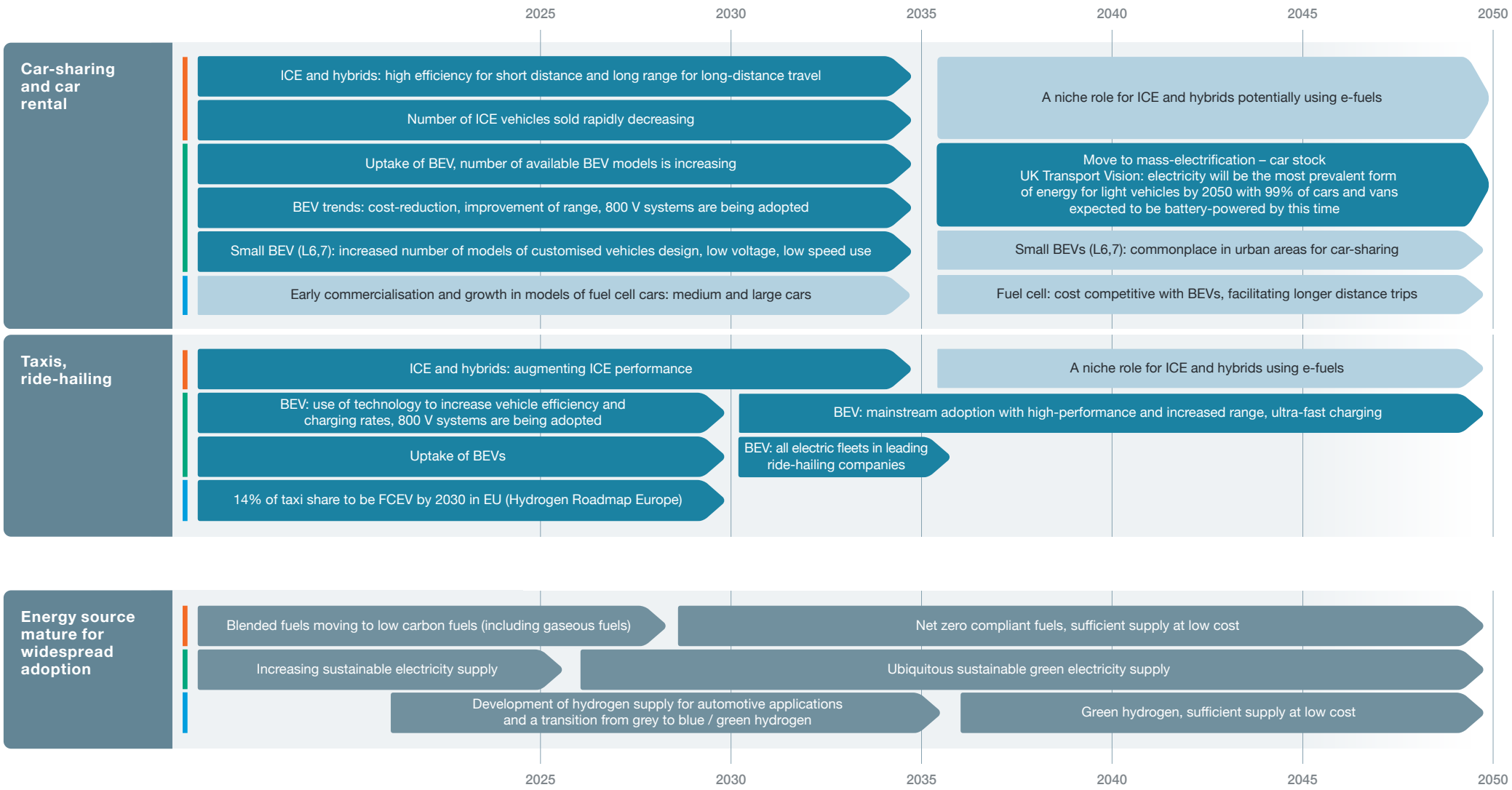
Shared mobility

Vehicles in shared use, includes car sharing and rental, taxis and ride-sharing, shared micromobility, shared mopeds, buses, coaches and Digital Demand Responsive Transport (DDRT).

Energy vectors and vehicle propulsion type



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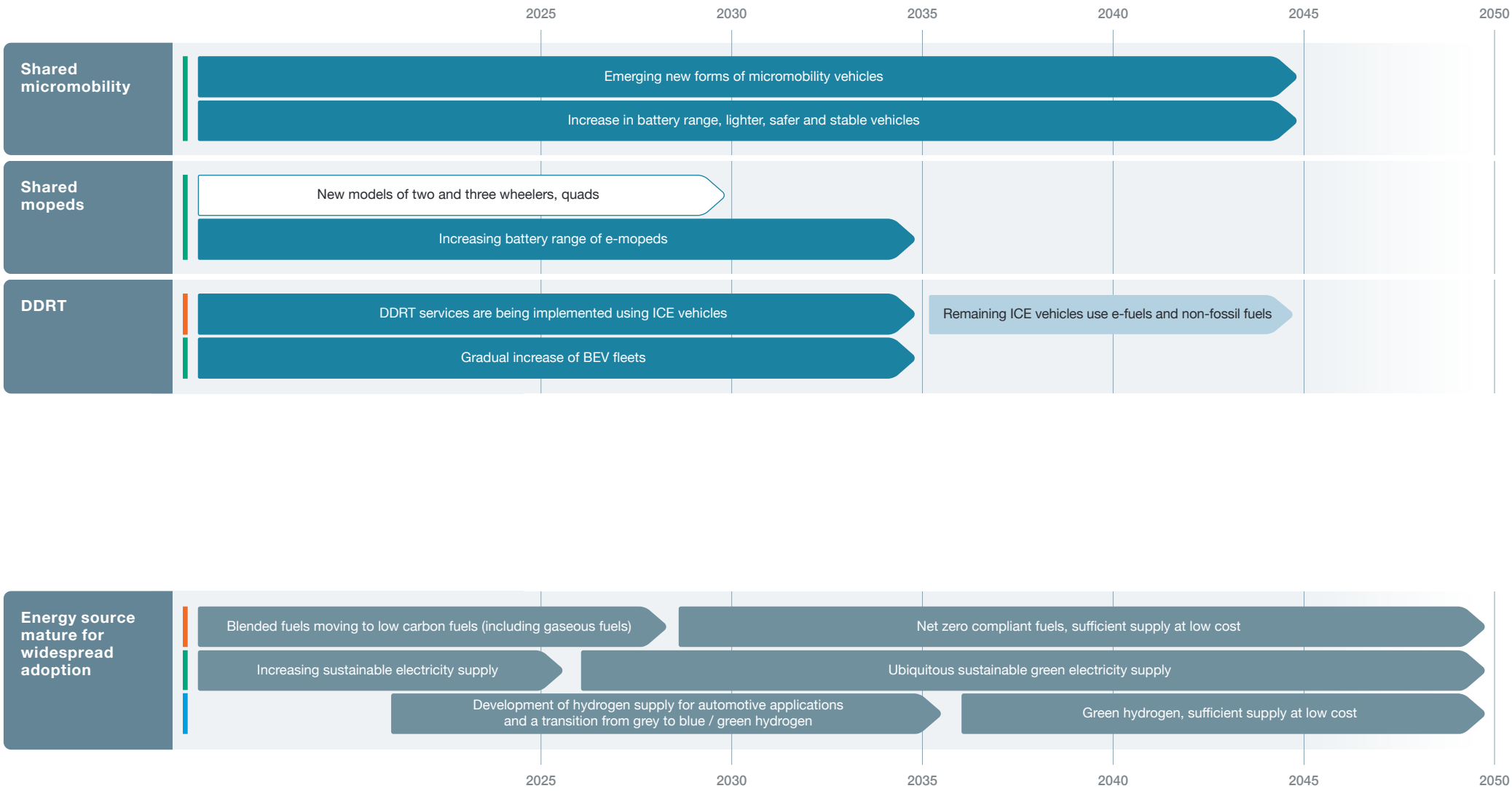

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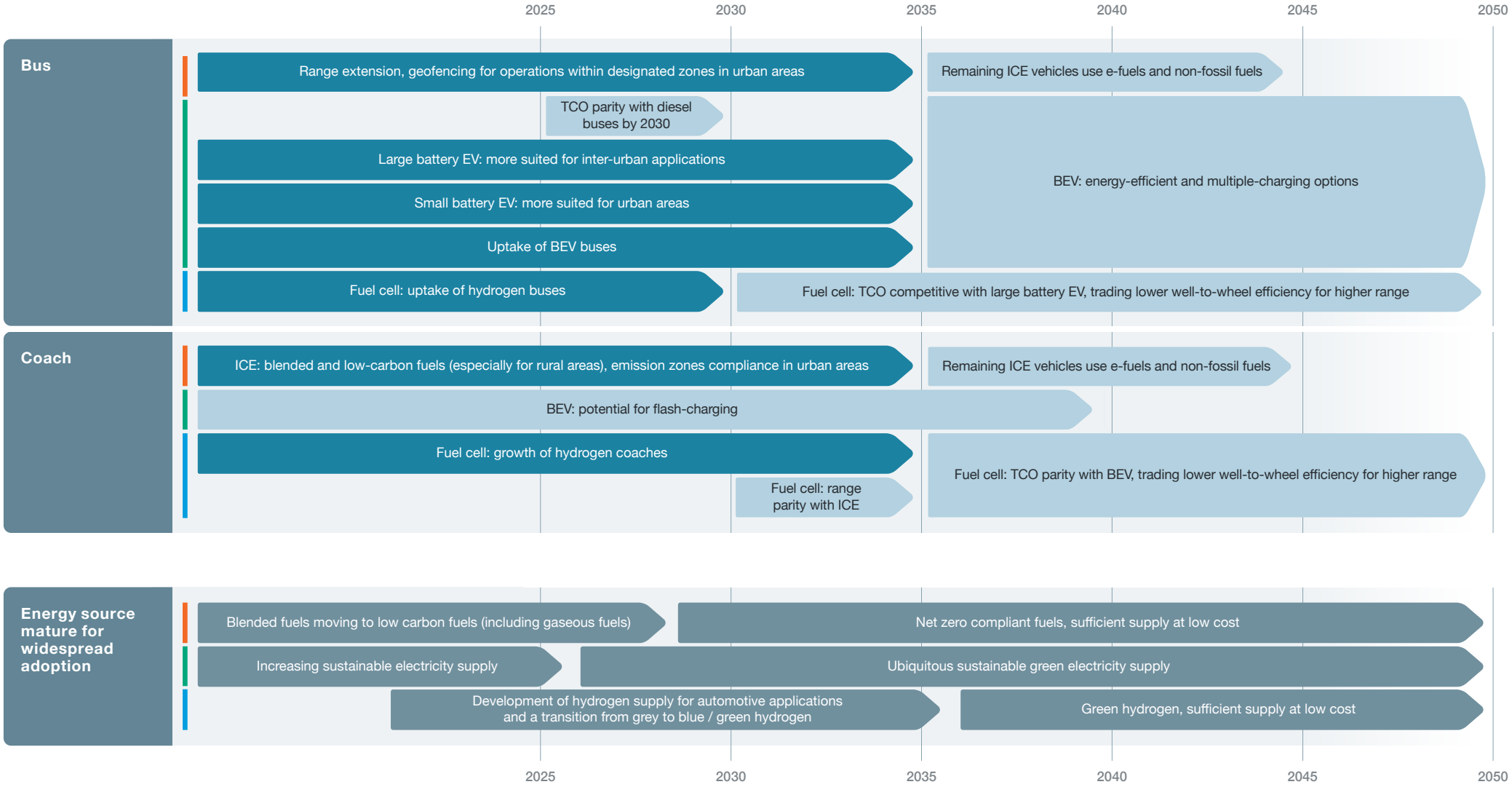

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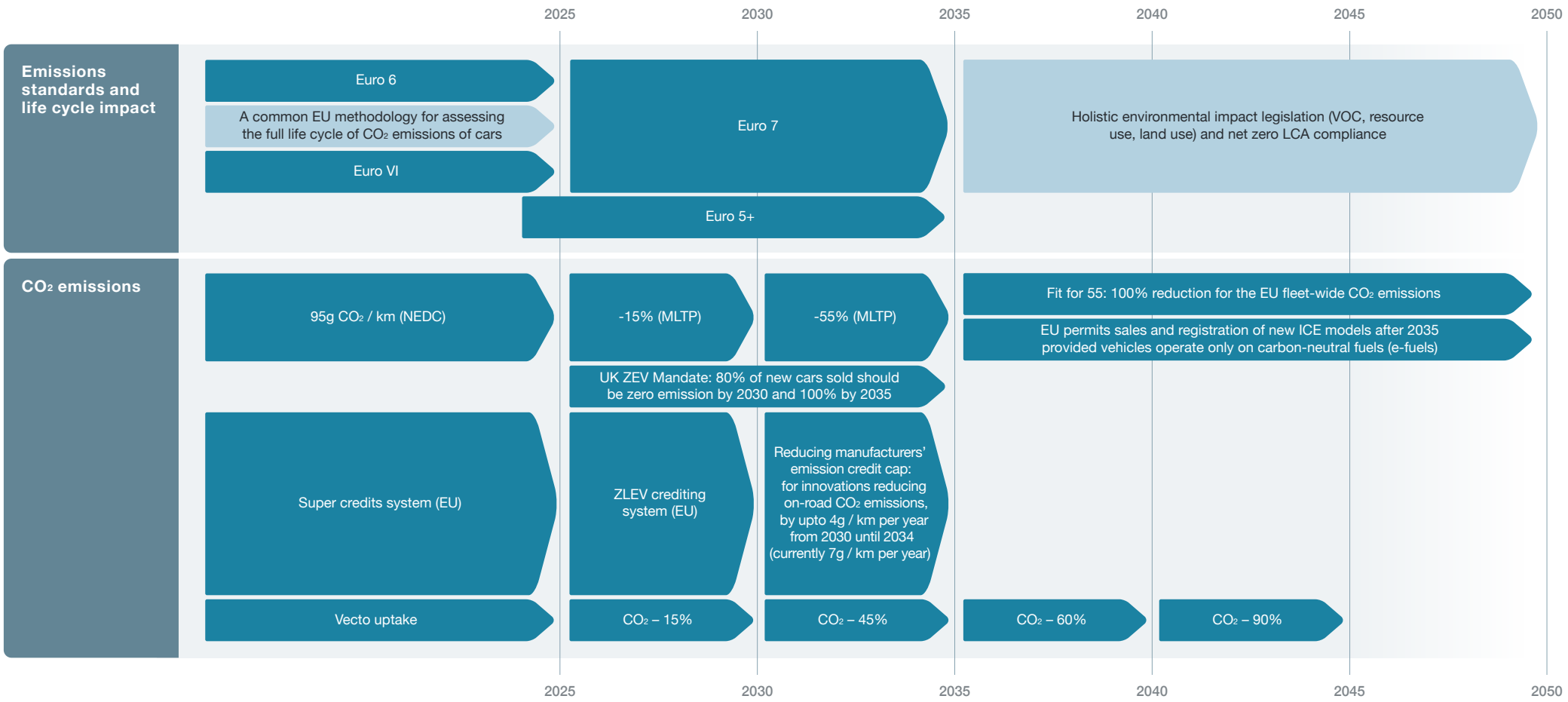

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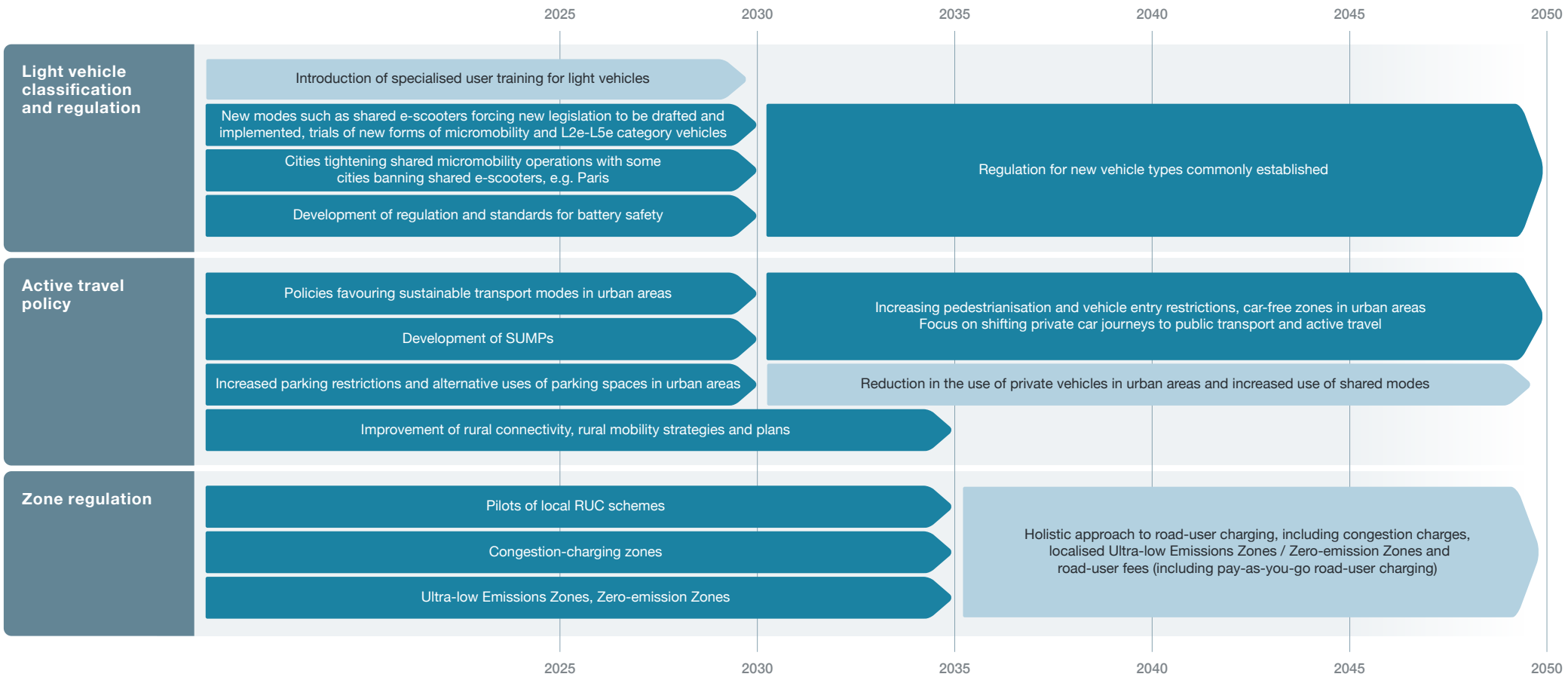

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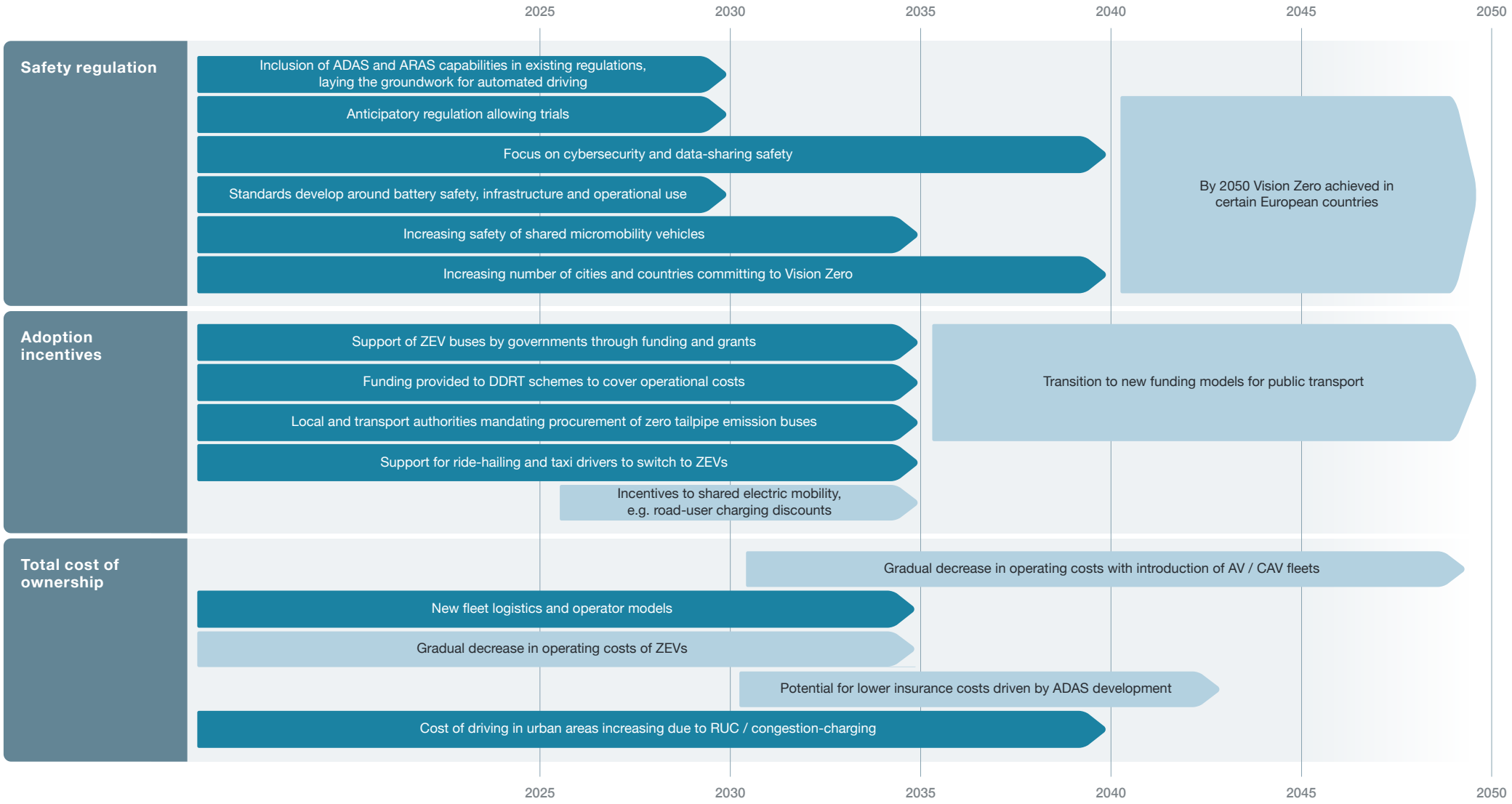

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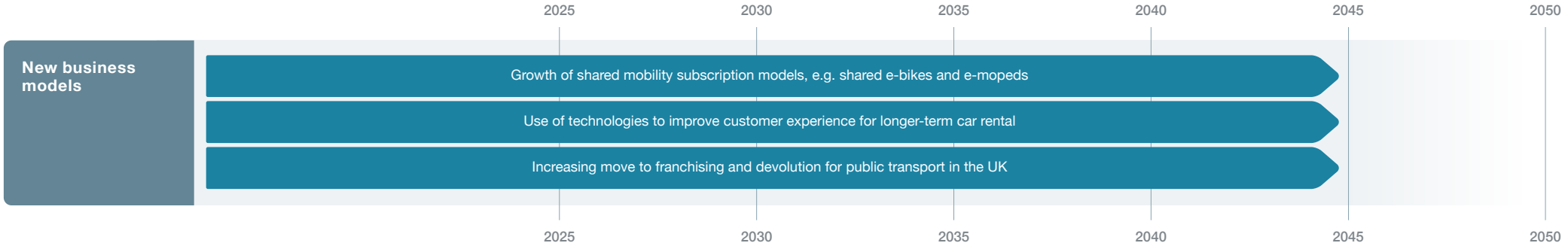

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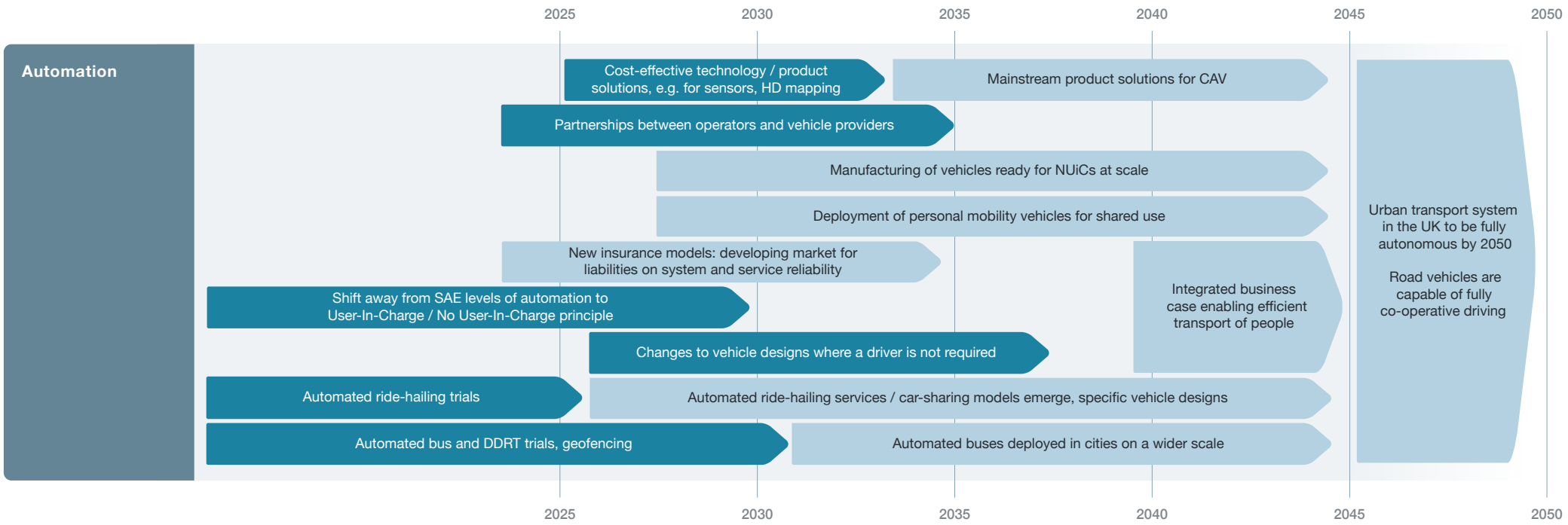
Infrastructure and technology enablers



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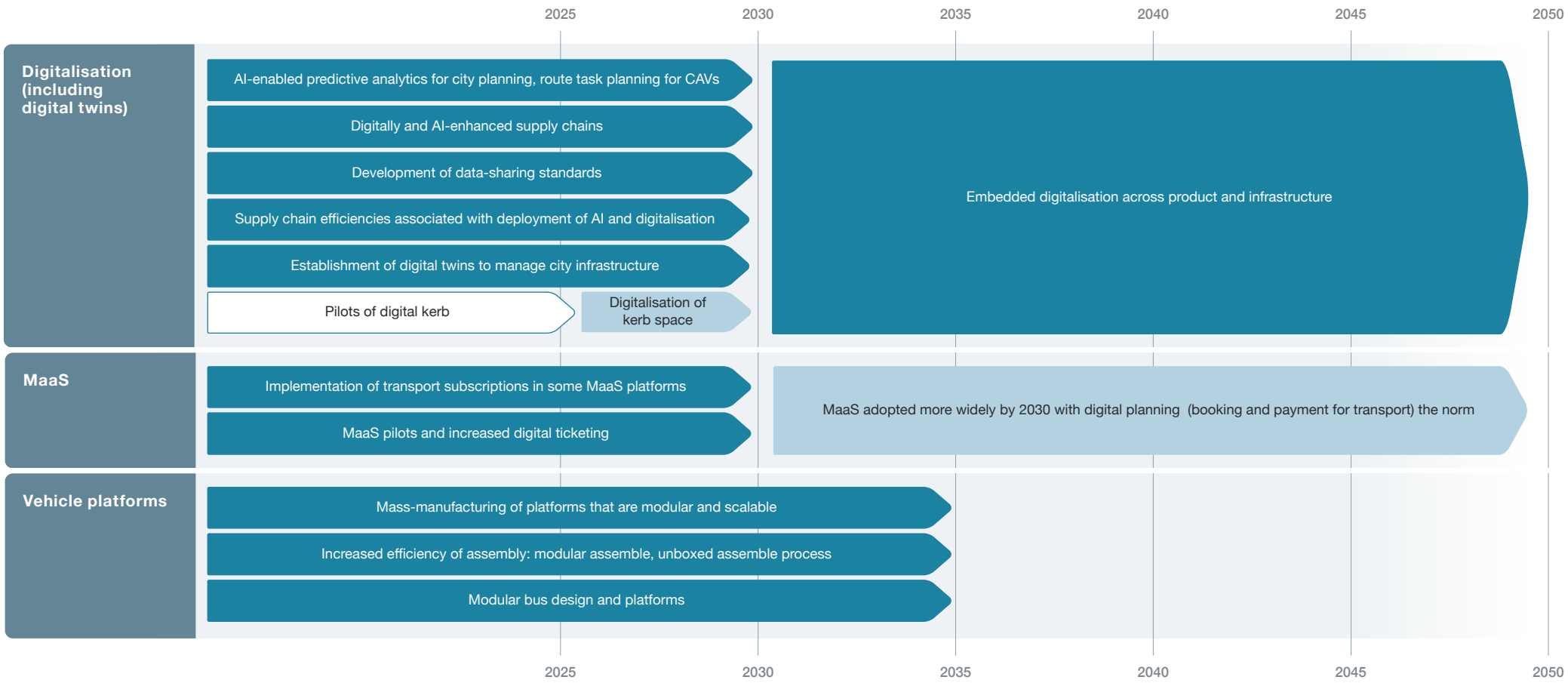

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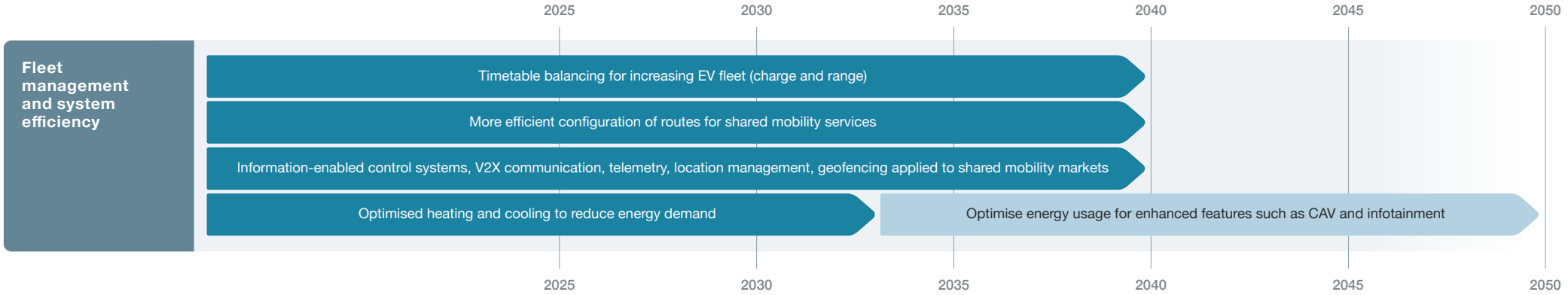

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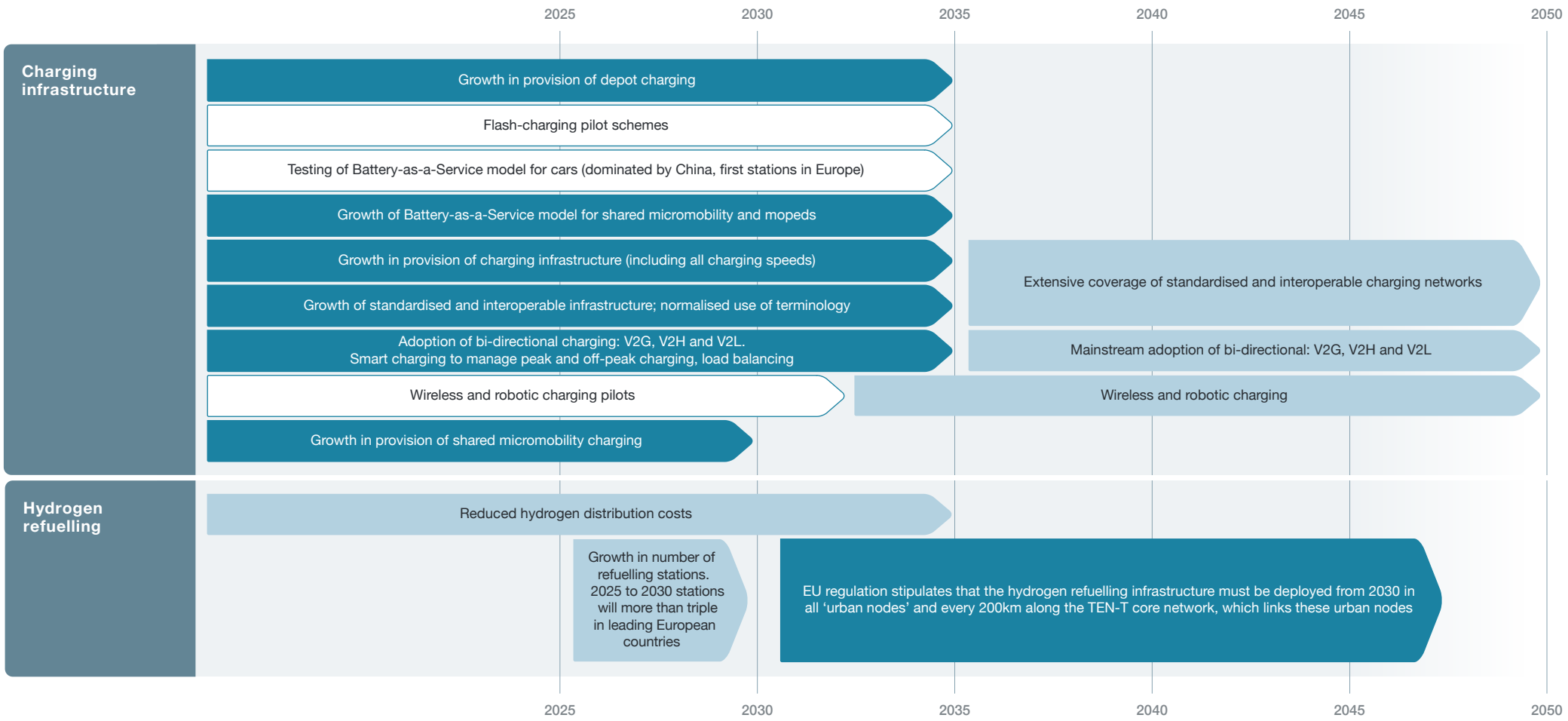

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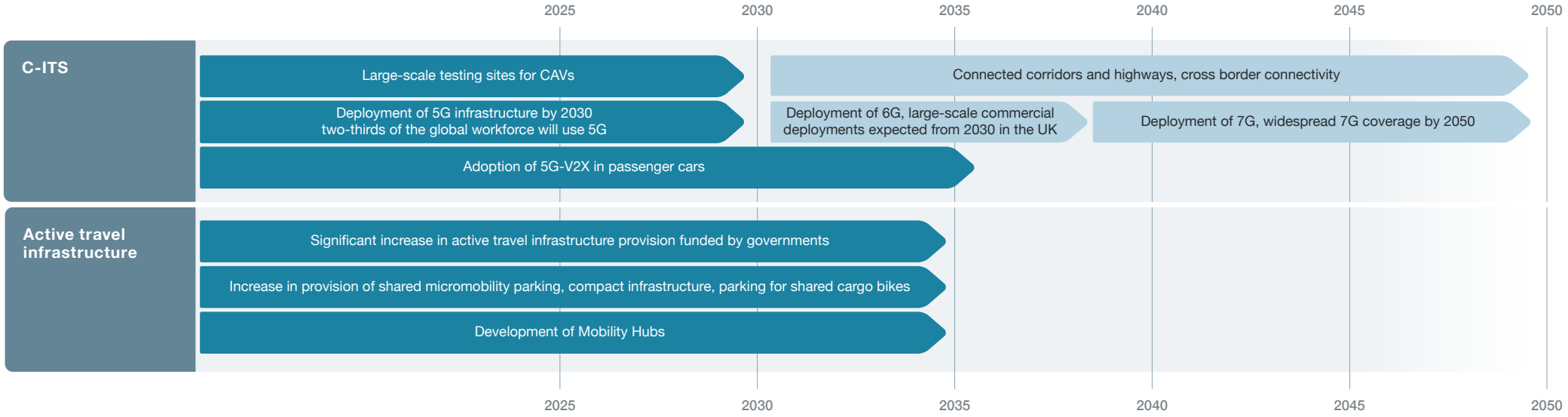

High level of certainty
Lower level of certainty
Pilot/trials/ PoCs

Glossary

AI	Artificial Intelligence
AD	Automated driving
ADAS	Advanced driver assistance system
ADS	Automated driving system
ARAS	Advanced rider assistance systems
BEV	Battery electric vehicle
BRT	Bus rapid transit
CAV	Connected and autonomous vehicle
C-ITS	Co-operative intelligent transport systems
CNG	Compressed natural gas
DfT	Department for transport
DDRT	Digital demand responsive transport
EV	Electric vehicle
EU	European Union
FCEV	Fuel cell electric vehicle
HD	High definition
HGV	Heavy goods vehicle
ICE	Internal combustion engine
LCA	Life cycle assessment
LNG	Liquefied natural gas
MaaS	Mobility-as-a-service
NEDC	New european driving cycle
NUiCs	No-user-in-charge vehicles
PLV	Powered light vehicle
PoC	Proof of concept
RUC	Road user charging
SAE	Society of automotive engineers
SUMP	Sustainable urban mobility plan
SUV	Sports utility vehicle
TCO	Total cost of ownership
UK	United Kingdom
UKRI	UK Research and Innovation
V2G	Vehicle-to-grid
V2H	Vehicle-to-home
V2L	Vehicle-to-load
V2X	Vehicle-to-everything
VECTO	Vehicle energy consumption calculation tool
VOC	Volatile organic compounds
WLTP	Worldwide harmonised light vehicle test procedure
ZEV	Zero emission vehicle
ZLEV	Zero and low emission vehicle

System-Level Roadmaps

- Mobility of People
- Mobility of Goods

Technology Roadmaps

- Electric Machines
- Power Electronics
- Electrical Energy Storage
- Lightweight Vehicle and Powertrain Structures
- Internal Combustion Engines
- Hydrogen Fuel Cell System and Storage

Find all the roadmaps at

www.apcuk.co.uk/technology-roadmaps

automotive council UK

ADVANCED PROPULSION CENTRE UK

Established in 2013, the Advanced Propulsion Centre UK (APC), with the backing of the UK Government's Department for Business and Trade (DBT), has facilitated funding for 304 low-carbon and zero-emission projects involving 538 partners. Working with companies of all sizes, this funding is estimated to have helped to create or safeguard over 59,000 jobs in the UK. The technologies and products that result from these projects are projected to save over 425 million tonnes of CO_2.

The APC would like to acknowledge the extensive support provided by industry and academia in developing and publishing the roadmaps.

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