



Mobility of Goods

System-Level Roadmap

2024



Produced by the Advanced Propulsion Centre UK on behalf of the Automotive Council UK
Information correct at time of publication



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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



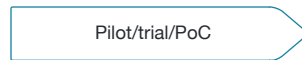
Narrative report

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 Goods Roadmap has advanced the product classification from the previous version (2020) and is now split into three categories:

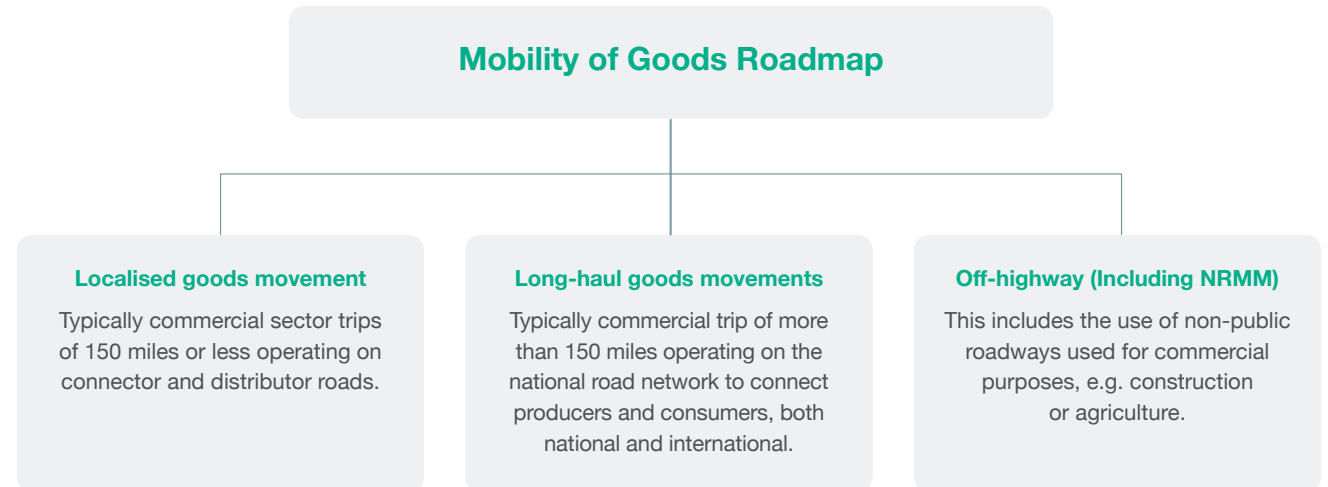
- localised goods movement
- long-haul goods movements
- Off-highway including Non-Road Mobile Machinery (NRMM)

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.

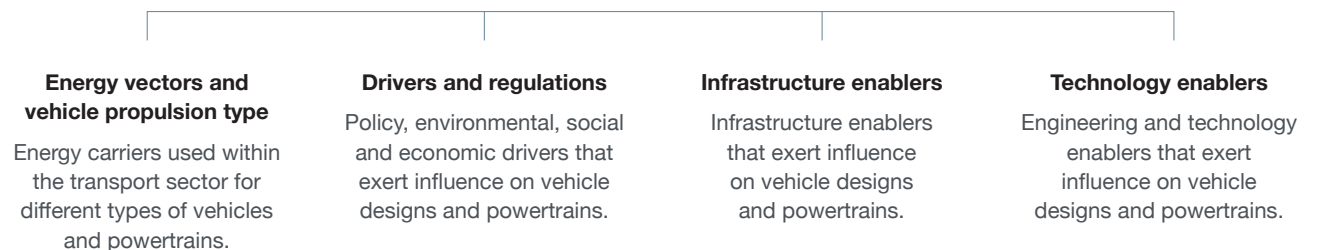
Key drivers

The forecast will be evidenced by four key drivers:

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



Each category consists of the following key drivers



Small urban vehicles

These are typically low-peak power due to modest weight and acceleration requirements. Low- to medium-onboard energy is required as, in most cases, range needs are constrained by urban usage. Product types vary from small passenger cars, which are often produced by global original equipment manufacturers (OEMs), to emerging concepts that are dedicated urban battery electric vehicles (BEVs), some from new market entrants. For the purpose of this roadmap, small urban vehicles include micro cars (L6e and L7e categories).

Ultra-Light Goods Vehicles (ULGVs)

Ultra-Light Goods Vehicles (ULGVs) include a range of vehicles used for the mobility of goods and are lighter than typical Light Goods Vehicles, e.g. all vehicles used for goods smaller than a car or van. Vehicles in this category have significant variance in form and includes Powered Light Vehicles (PLVs) / Electric Assist Vehicles (EAVs), e-bikes, cargo bikes, unmanned aerial vehicles (UAVs), autonomous pavement robots, motorcycles and mopeds.

Motorcycles include both high-power (sport motorbikes) and low-power (mopeds). A moped would normally have an engine capacity no greater than 50 cc and a max speed of 28 mph.

Light Goods Vehicles (LGVs)

An LGV, or a light commercial vehicle (LCV) in the European Union, Australia and New Zealand, is a commercial carrier vehicle with a gross vehicle weight of up to 3.5 tonnes or up to 4.25 tonnes for electric vehicles. This classification includes cars. Whilst cars have typically been associated with the movement of people / passengers rather than goods and products, there are the occasions now where on-demand delivery companies use cars to deliver items in constrained urban environments as opposed to more traditional delivery modes, e.g. Medium Duty Vehicles (MDVs).

Heavy Goods Vehicles (HGVs)

An HGV is a 2-axle to 6-axle commercial carrier vehicle with a gross vehicle weight of at least 3.5 tonnes. Within the localised Mobility of Goods category, this typically includes the following types of vehicles:

- Smaller 2-axle lorries (maximum tonnage of 3.5 – 7.5 tonnes)
- Larger 2-axle lorries (maximum tonnage of 7.5 - 18 tonnes)
- 3-axle lorries (maximum tonnage of 18 - 26 tonnes)
- 4 / 5 / 6-axle lorries (26 tonnes plus)

Off-highway (Including NRMM)

Off-highway activity is defined as any mobile machine, transportable equipment, or vehicle with or without bodywork or wheels, which is not intended for carrying passengers or goods on the road. Examples include:

- construction machinery (excavators, loaders, bulldozers, etc.)
- agricultural and farming machinery (harvesters, cultivators, etc.).

Typical vehicle types include smaller excavators, dumpers, telehandlers, as well as most ATVs, tractors, and forklifts, heavier excavators, dumpers, telehandlers, as well as cranes, haul trucks and large agricultural vehicles, e.g. combine harvesters. NRMMs can reach very large vehicle and capacity weights in the hundreds of tonnes, e.g. large quarry haul trucks.

For the purposes of developing these roadmaps, this product type excludes:

- small gardening and handheld equipment (lawn mowers, chainsaws, etc.)
- military and recreational craft
- railcars, freight trains, water and air-based vehicles.

This roadmap provides a list of relevant energy carriers that support vehicle propulsion technologies. The colour codes (orange, green and blue) are shown against each vehicle application, some of which can be supported by more than one energy carrier. Within the roadmap, the height of the bar does not necessarily represent the importance of the energy carrier.

- 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 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:

- Advanced biofuels – these use waste rather than crops, can be used in place of diesel, and provide reductions in CO₂ 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.
- Biofuels – typically derived from vegetable or animal fats and alcohol. It is often considered a net zero emission fuel because the CO₂ released during the combustion is previously absorbed by the plants from the air. Biofuel has a minimal impact on CO₂ emissions.
- Natural gas fuels – there are alternative fuels using compressed natural gas (CNG) or liquefied natural gas (LNG).
- Synthetic fuels, efuels – 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 carbon-neutral fuel type that can be used in an ICE.

BEVs energy sources

In addition to cars, the expanding product range of urban BEVs, including new urban mobility vehicles, require a sustainable electricity source. The demand for clean grid electricity will rise as the electrification of cars and LGVs is complemented by increasing numbers of low-speed, power-efficient urban solutions appearing in the market. This category also includes external electricity sources, like overhead catenary systems.

Fuel cell energy sources

This category includes fuel cell electric vehicles (FCEVs) or hydrogen fuel cell (HFC), where vehicles make use of a fuel cell to generate electricity to power their onboard electric motor.

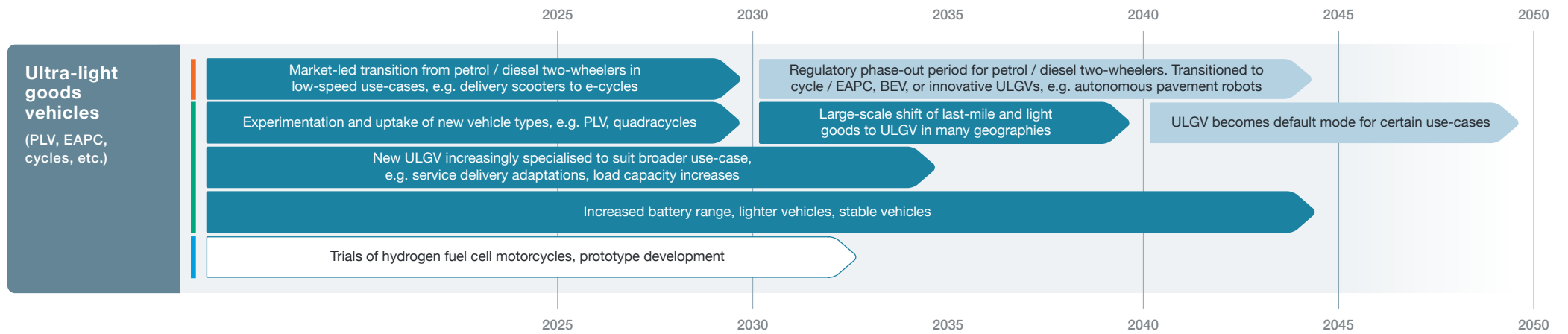
To meet net zero targets, hydrogen fuel cells require low-carbon sources of hydrogen, e.g. blue hydrogen (from natural gas with carbon capture and storage technologies) or green hydrogen (from renewable electricity). Solid-oxide fuel cells can operate on existing commercial fuel, e.g. blended biofuels



Localised goods movements

Typically commercial sector trips of 150 miles or less operating on connector and distributor roads.

Energy vectors and vehicle propulsion type



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

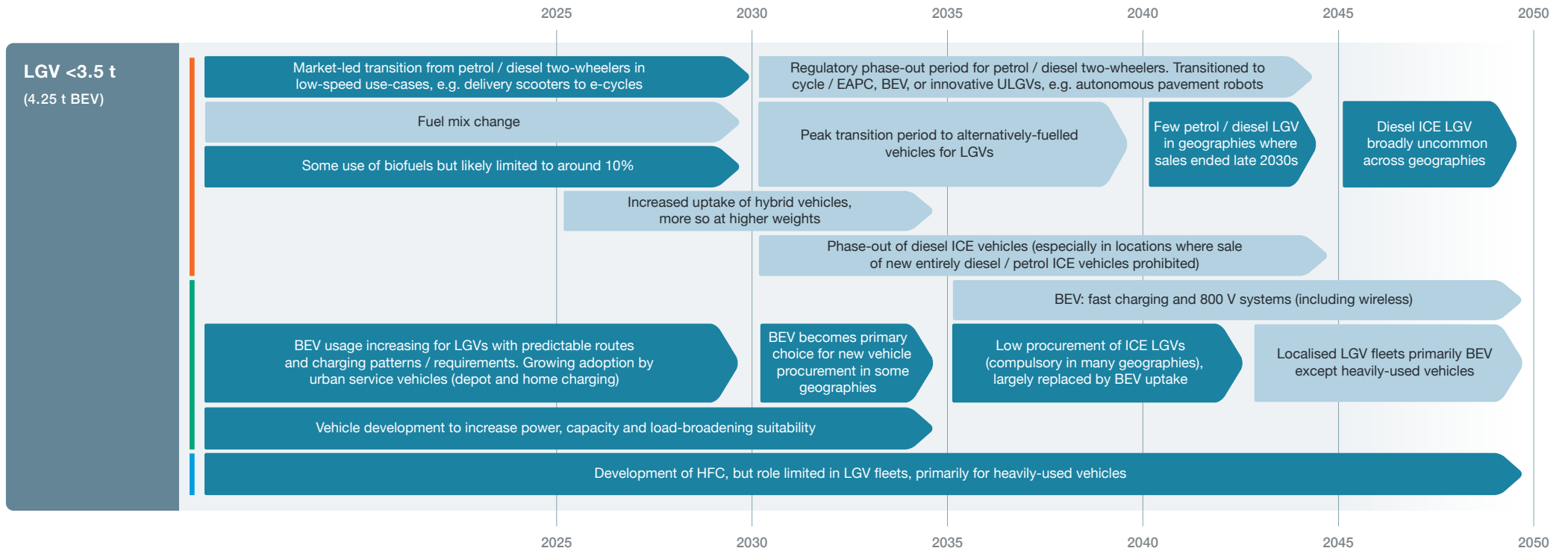
— ICE led
— Battery led
— Fuel cell led

ICE Internal Combustion Engine
BEV Battery electric vehicle
HFC Hydrogen fuel cell (HFC)

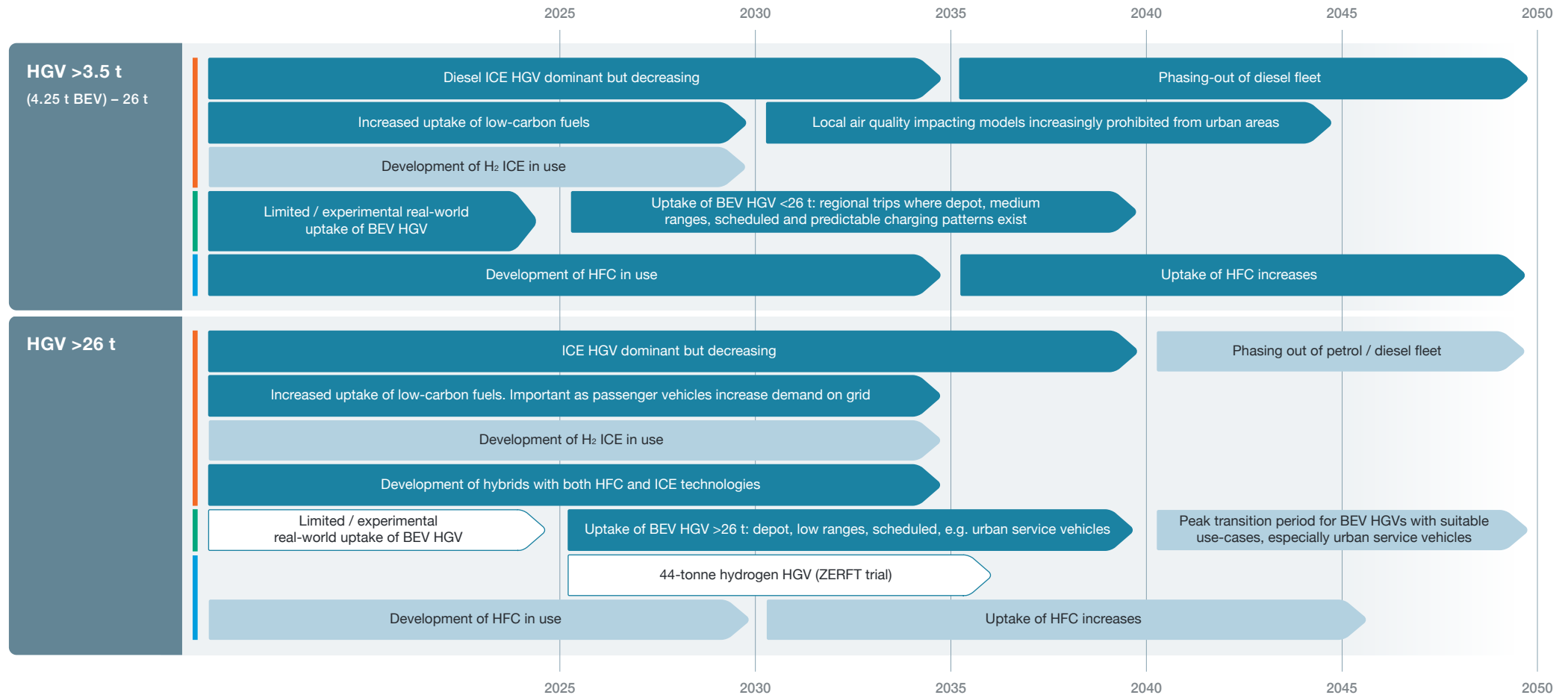
EAPC Electrically assisted pedal cycles
PLV Powered Light Vehicle

ULGV Ultra Light Goods Vehicle
LGV Light Goods Vehicle

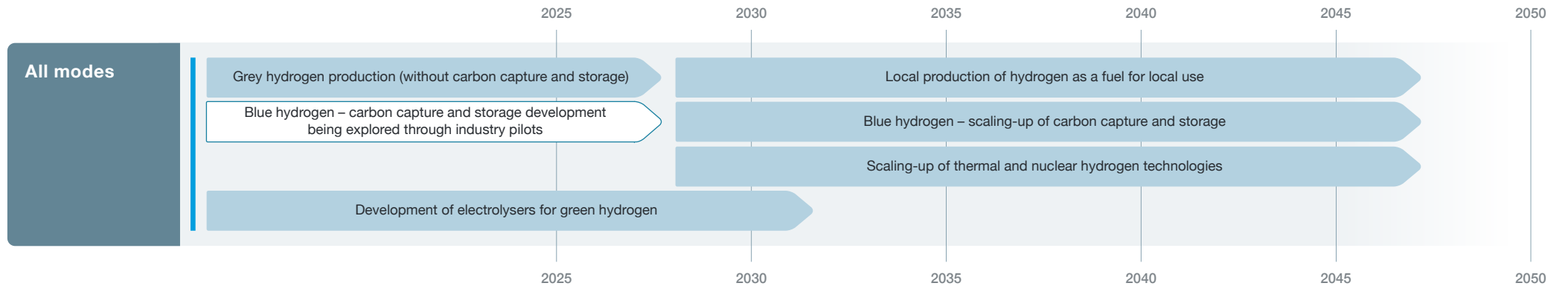
Energy vectors and vehicle propulsion type



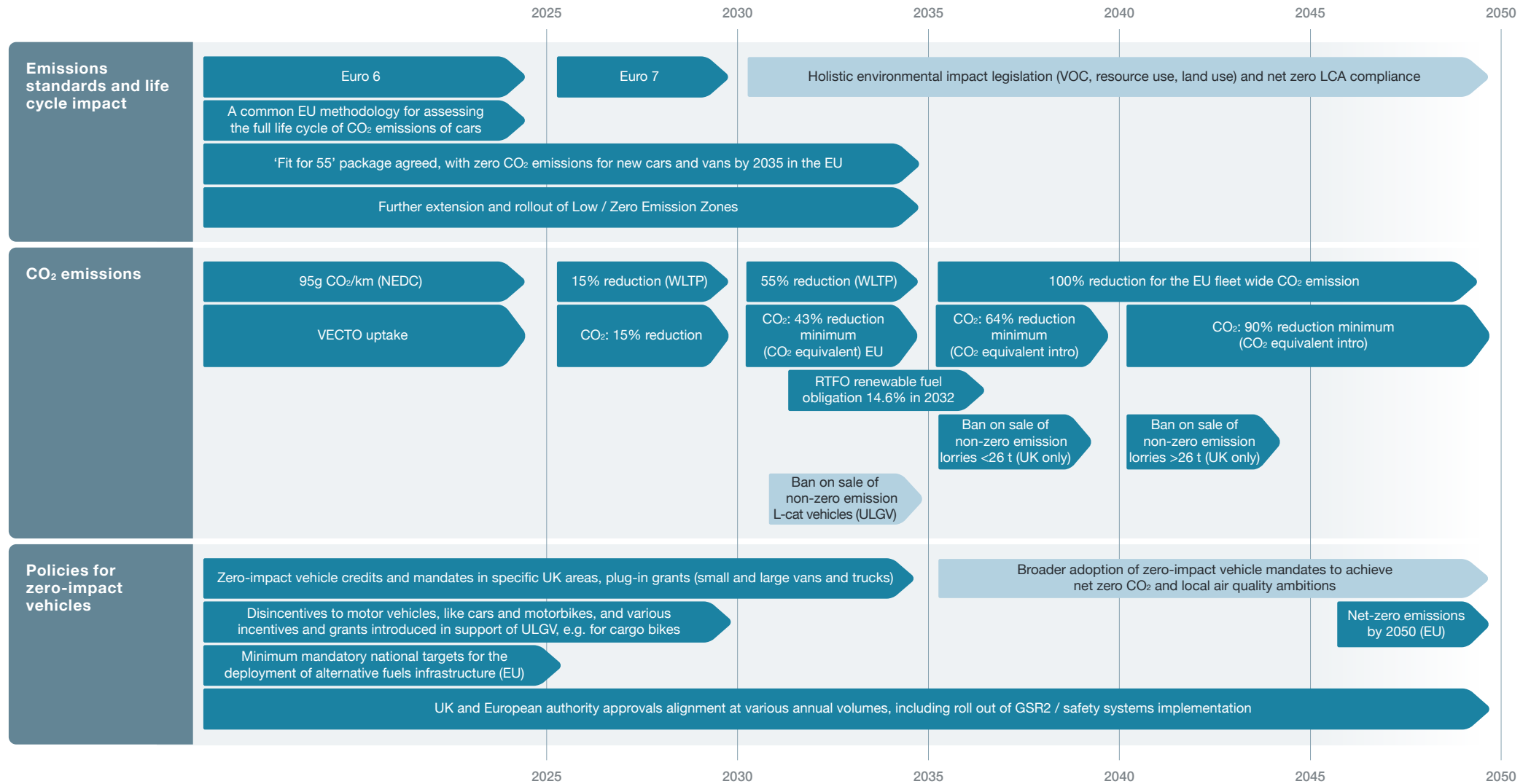
Energy vectors and vehicle propulsion type



Energy vectors and vehicle propulsion type



Drivers and regulations



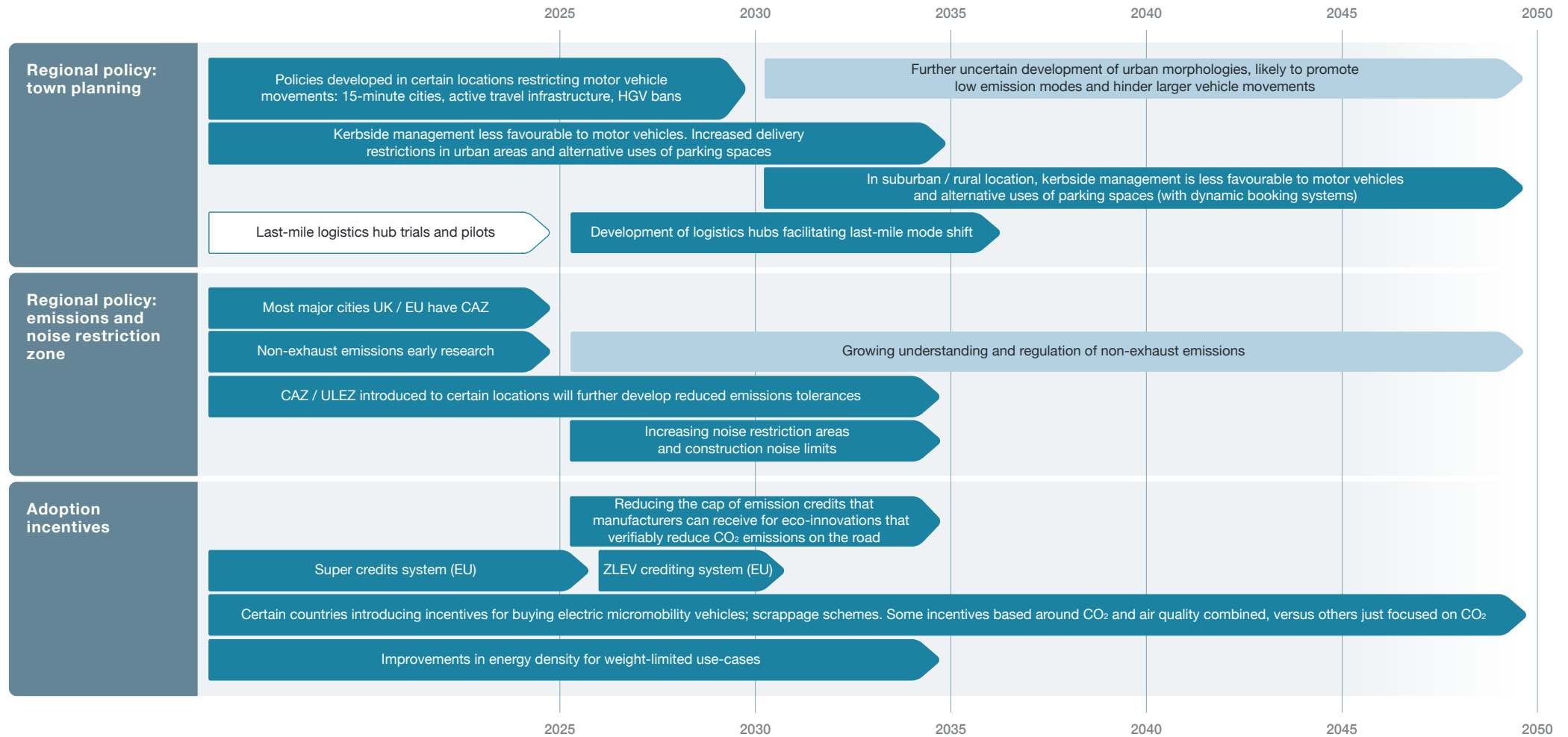
▶ High level of certainty
▶ Lower level of certainty
▶ Pilot / trials / PoCs

EC European commission
 GSR2 General Safety Regulations 2
 LCA Life cycle assessment

NEDC New European Driving Cycle
 RTFO Renewable Transport Fuel Obligation
 RUC Road User Charging

ULGV Ultra Light Goods Vehicle
 VOC Volatile organic compounds
 WLTP Worldwide harmonized light vehicles test procedure

Drivers and regulations

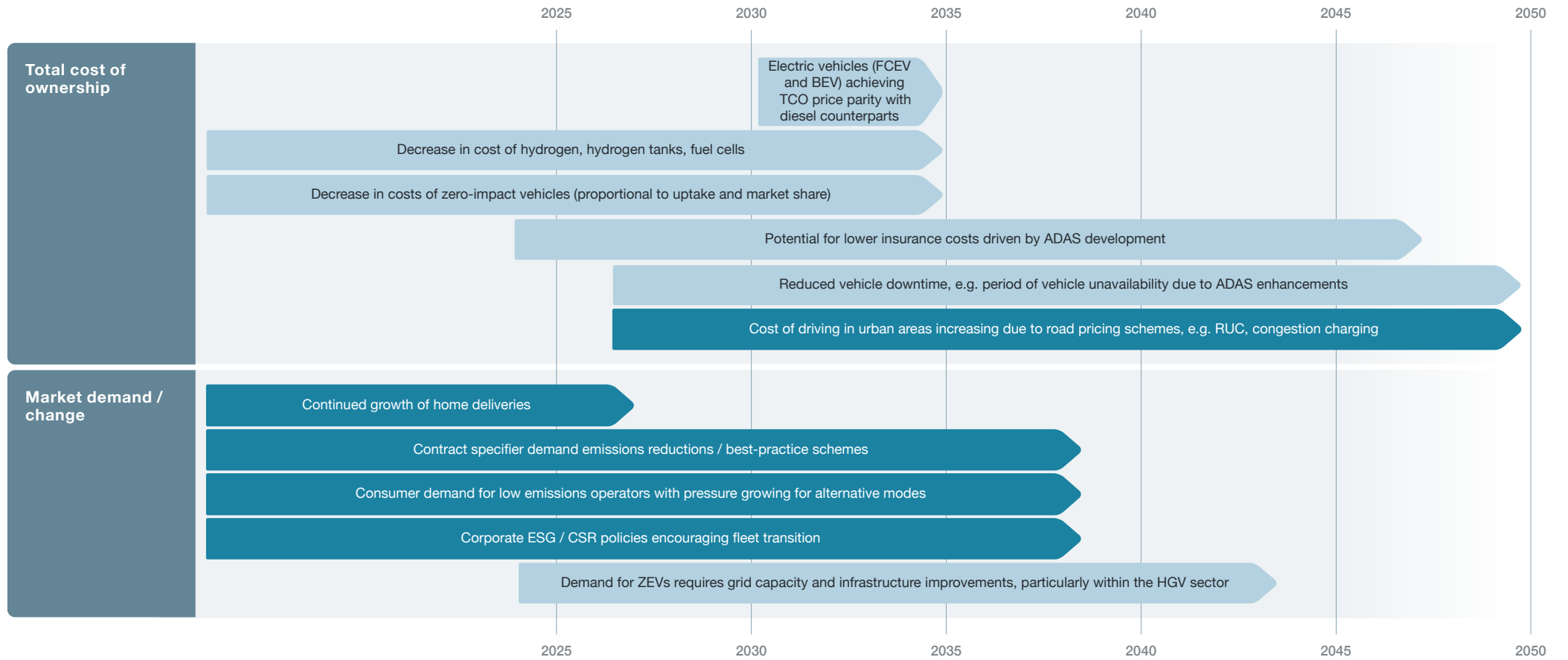


▶ High level of certainty
▶ Lower level of certainty
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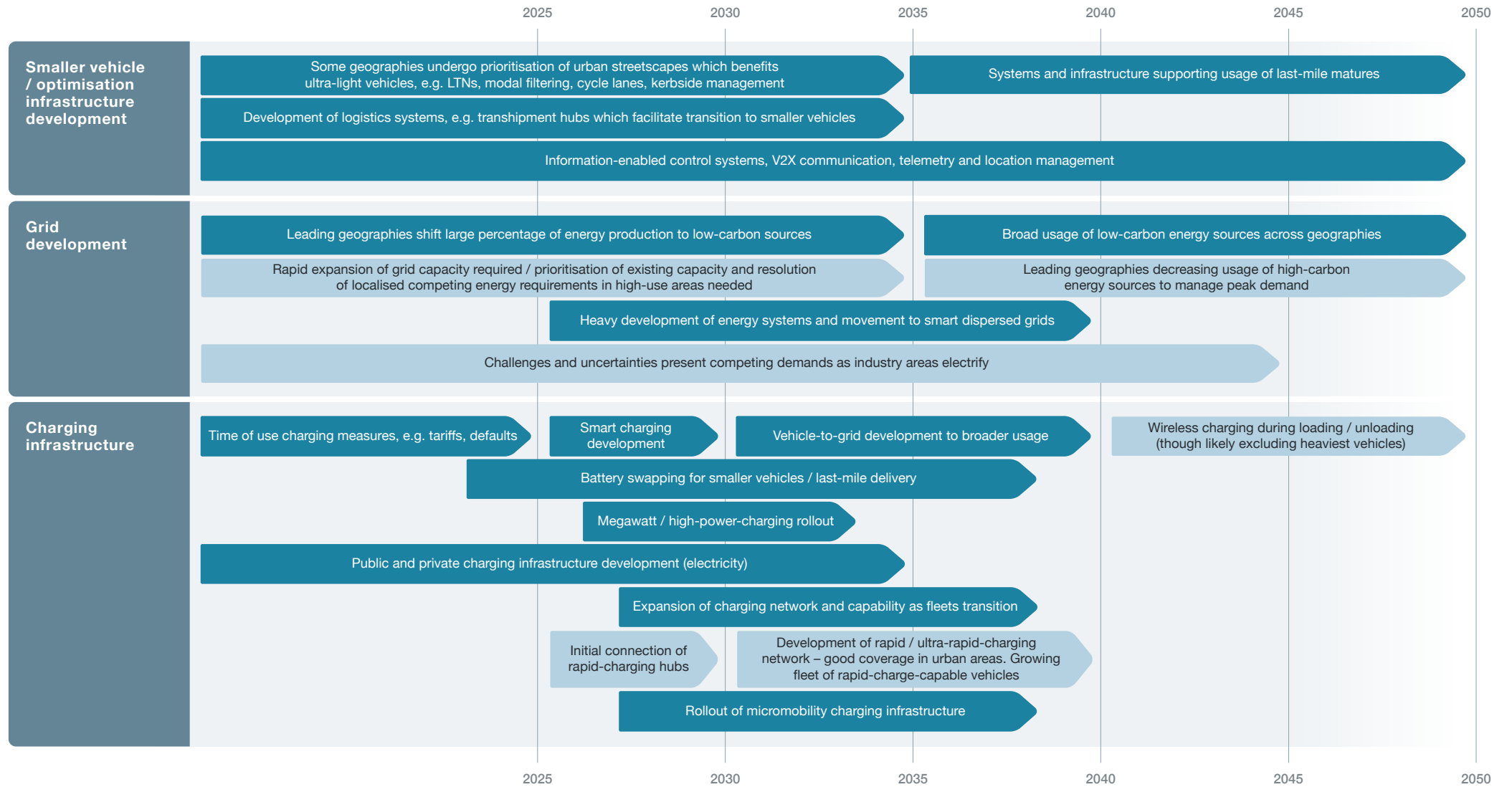
CAZ Clean air zone
 RTFO Renewable Transport Fuel Obligation
 RUC Road User Charging

ULEZ Ultra Low Emission Zone
 ZLEV Zero Low Emission Vehicle

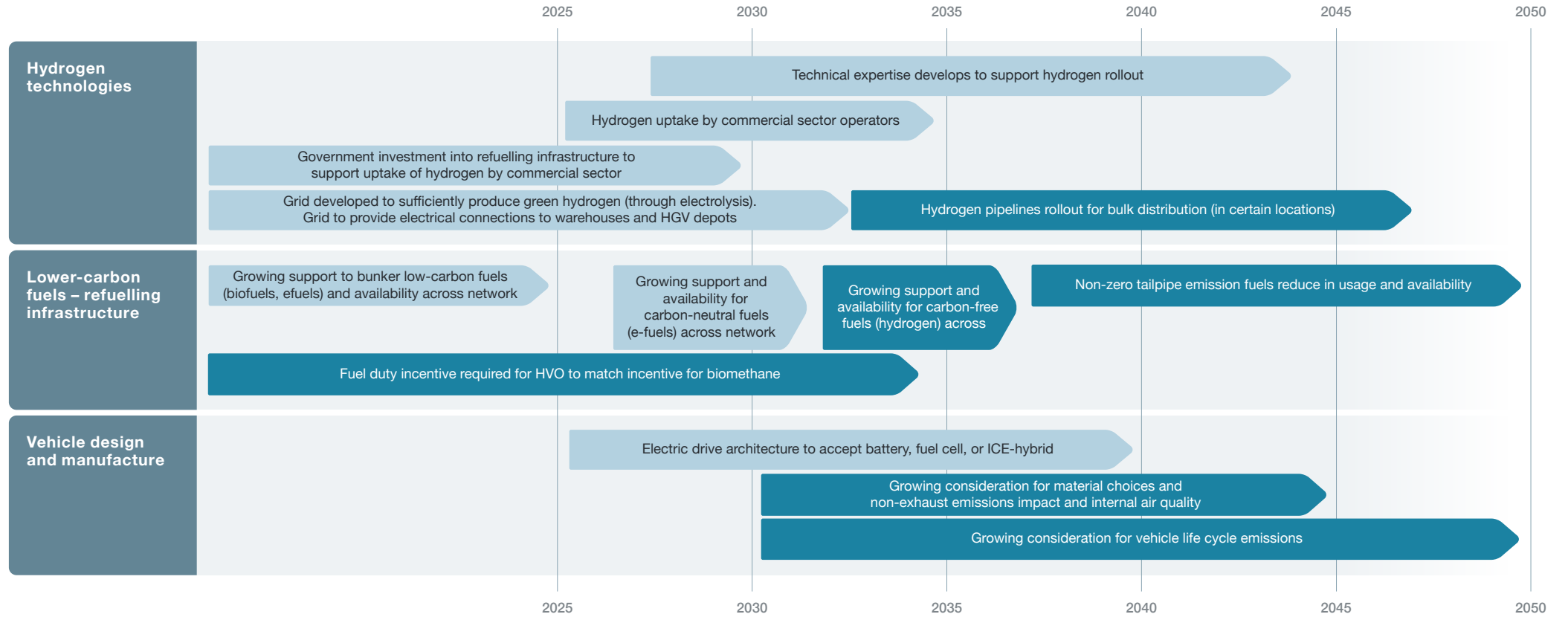
Drivers and regulations



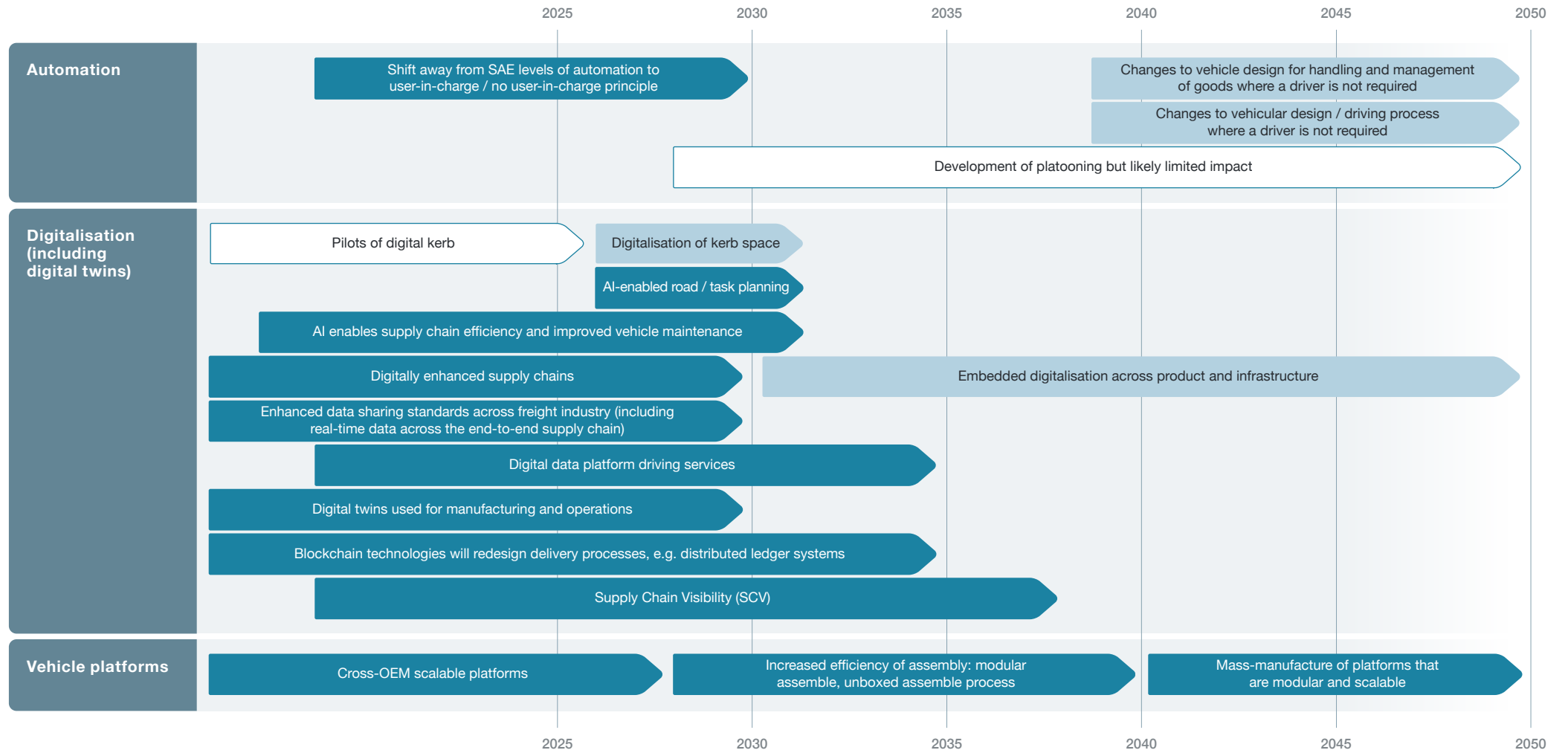
Infrastructure and technology enablers



Infrastructure and technology enablers



Infrastructure and technology enablers

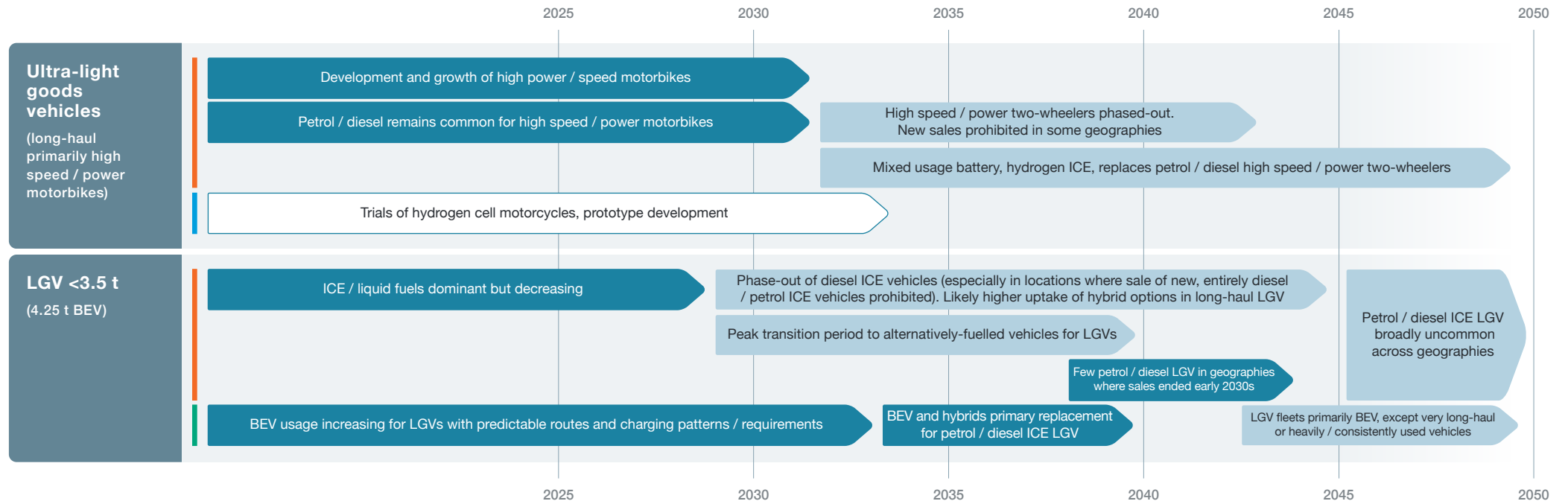




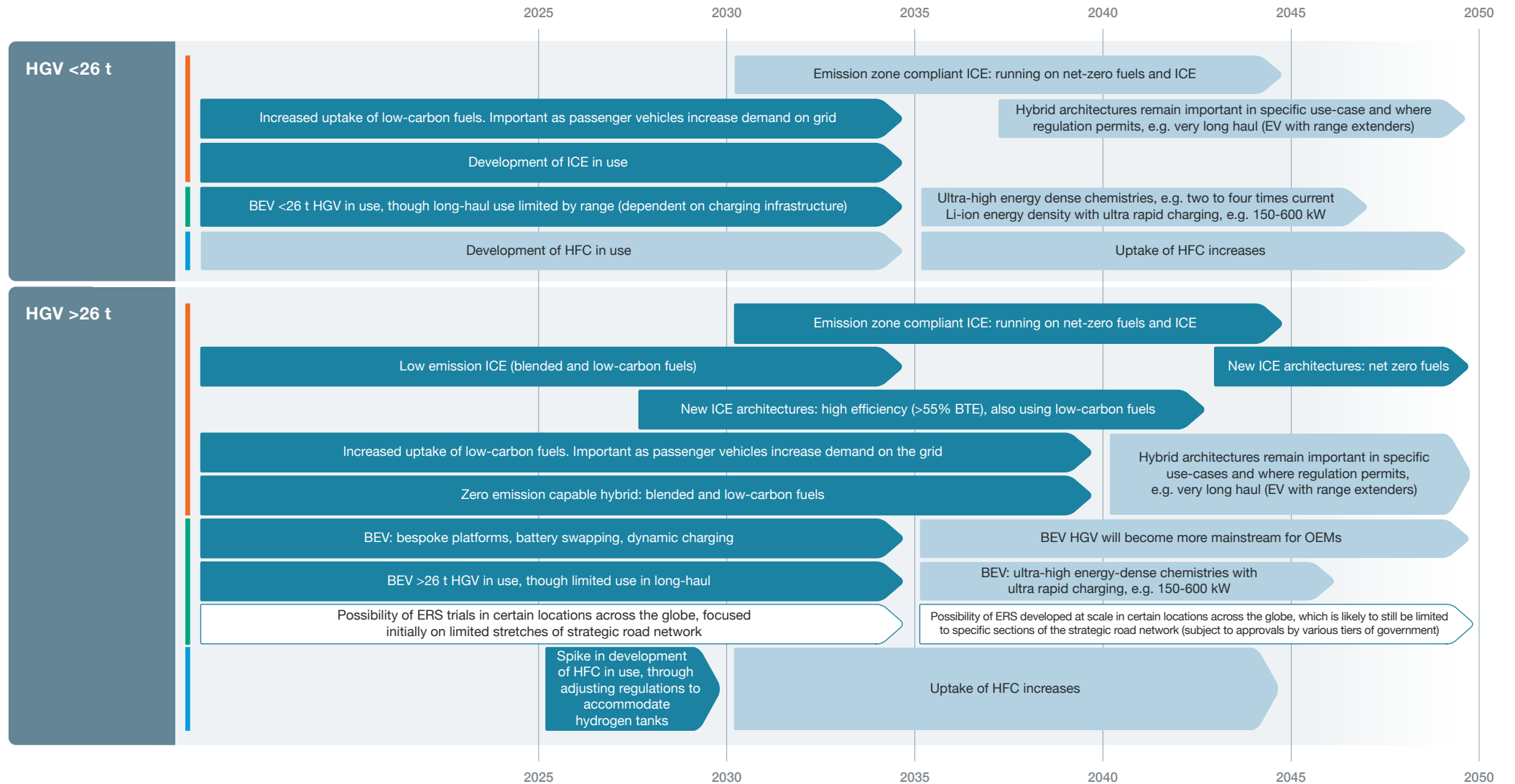
Long-haul goods movements

Typically commercial trip of more than 150 miles operating on the national road network to connect producers and consumers, both national and international.

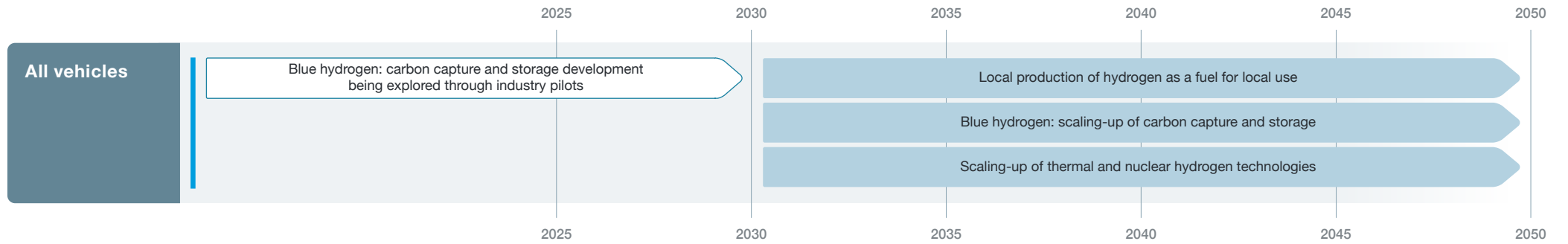
Energy vectors and vehicle propulsion type



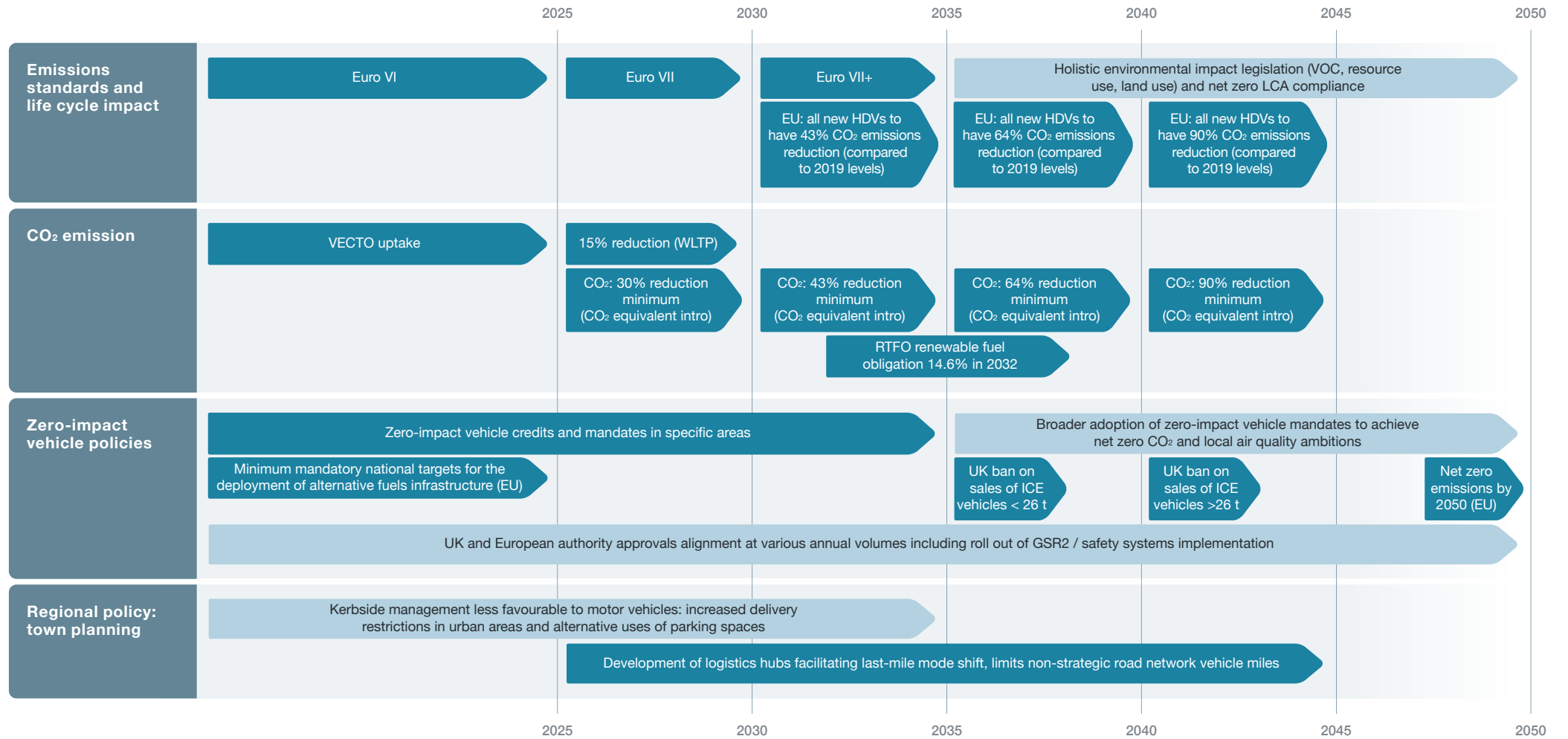
Energy vectors and vehicle propulsion type



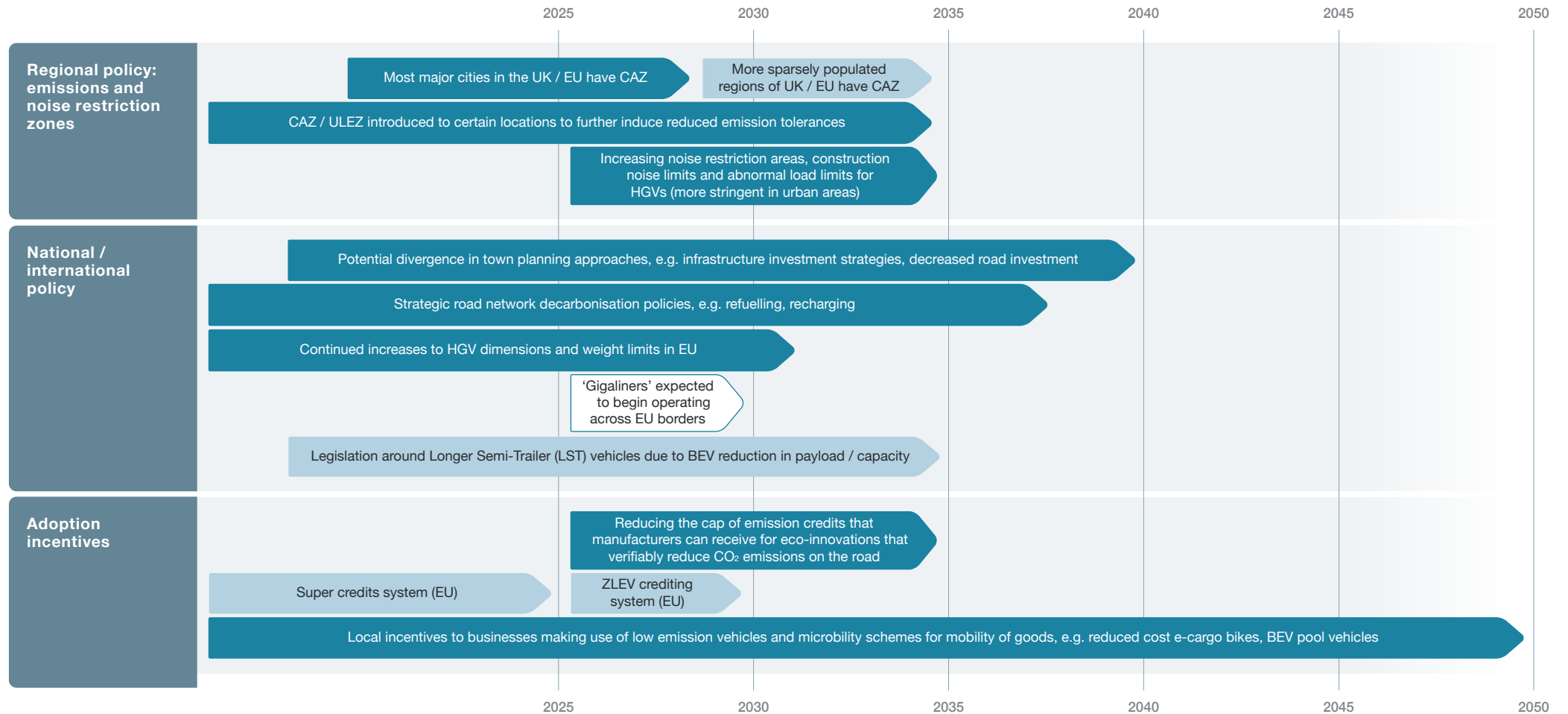
Energy vectors and vehicle propulsion type



Drivers and regulations



Drivers and regulations

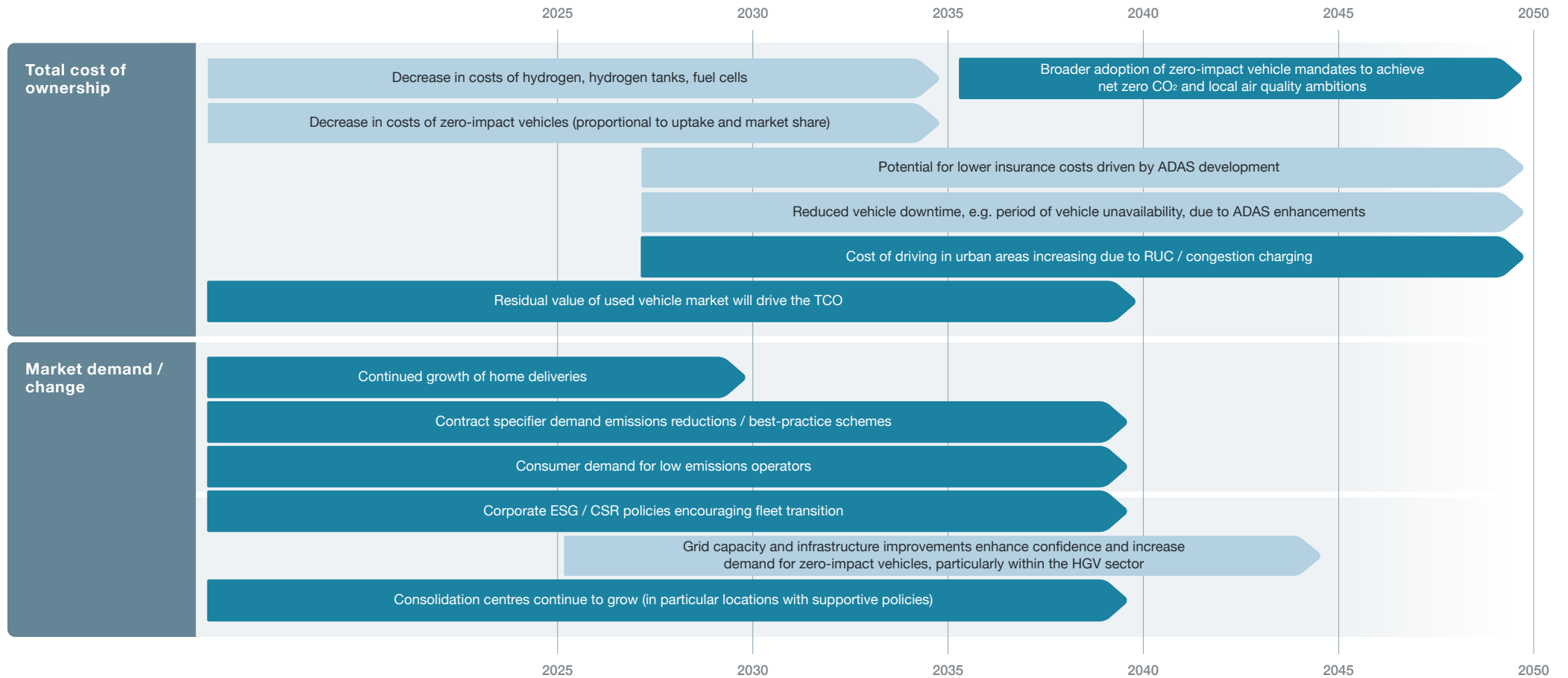


▶ High level of certainty
▶ Lower level of certainty
 Pilot / trials / PoCs

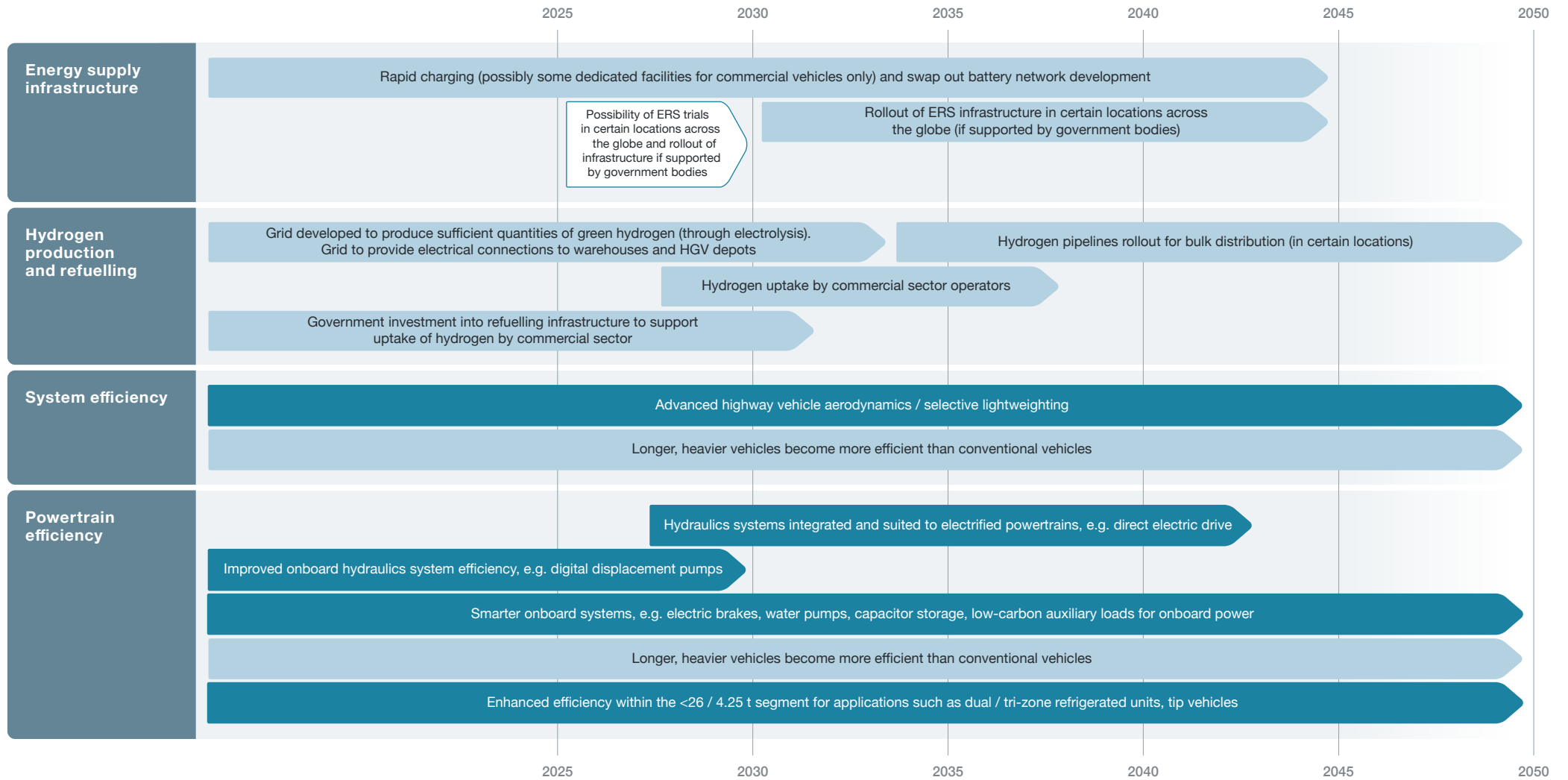
BEV Battery electric vehicle
 CAZ Clean air zone
 HGV Heavy goods vehicle

LST Longer semi trailers
 ULEZ Ultra Low Emission Zone
 ZLEV Zero Low Emission Vehicle

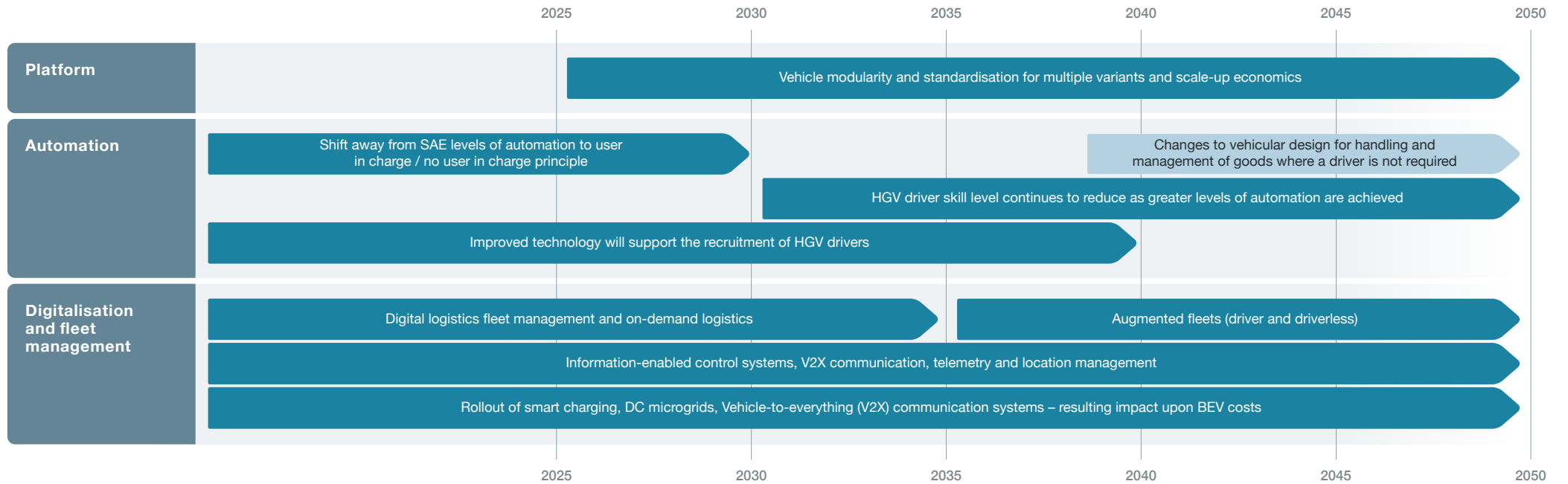
Drivers and regulations



Infrastructure and technology enablers



Infrastructure and technology enablers

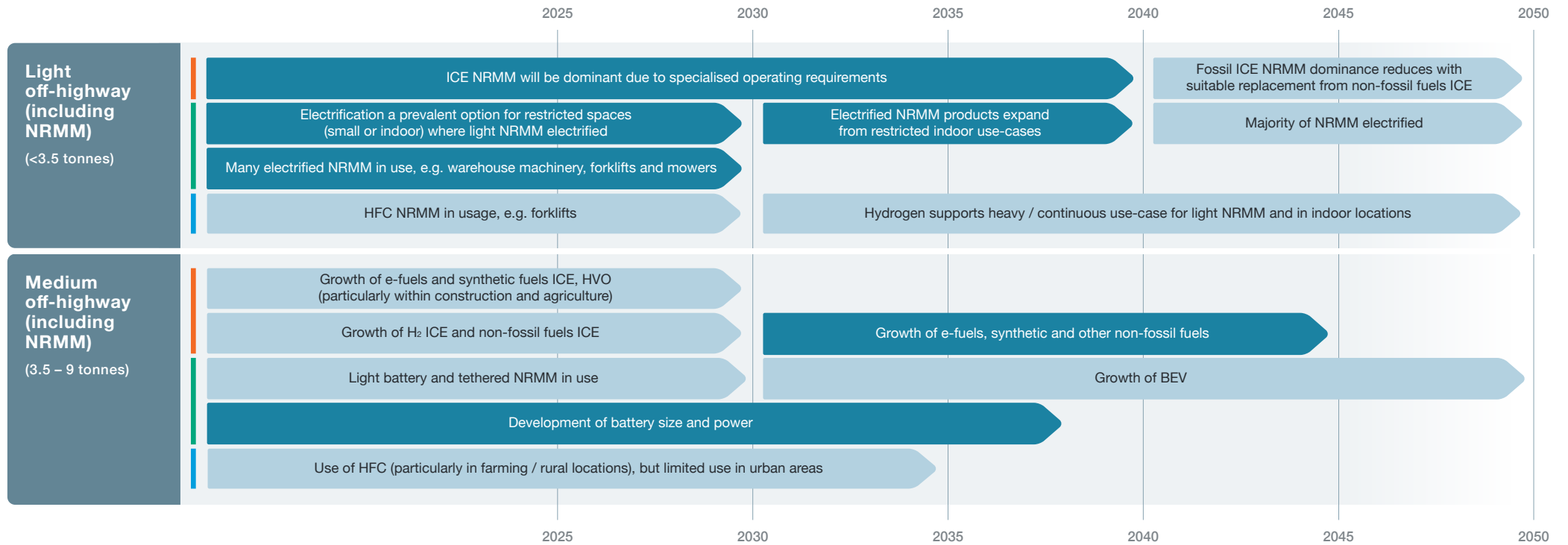




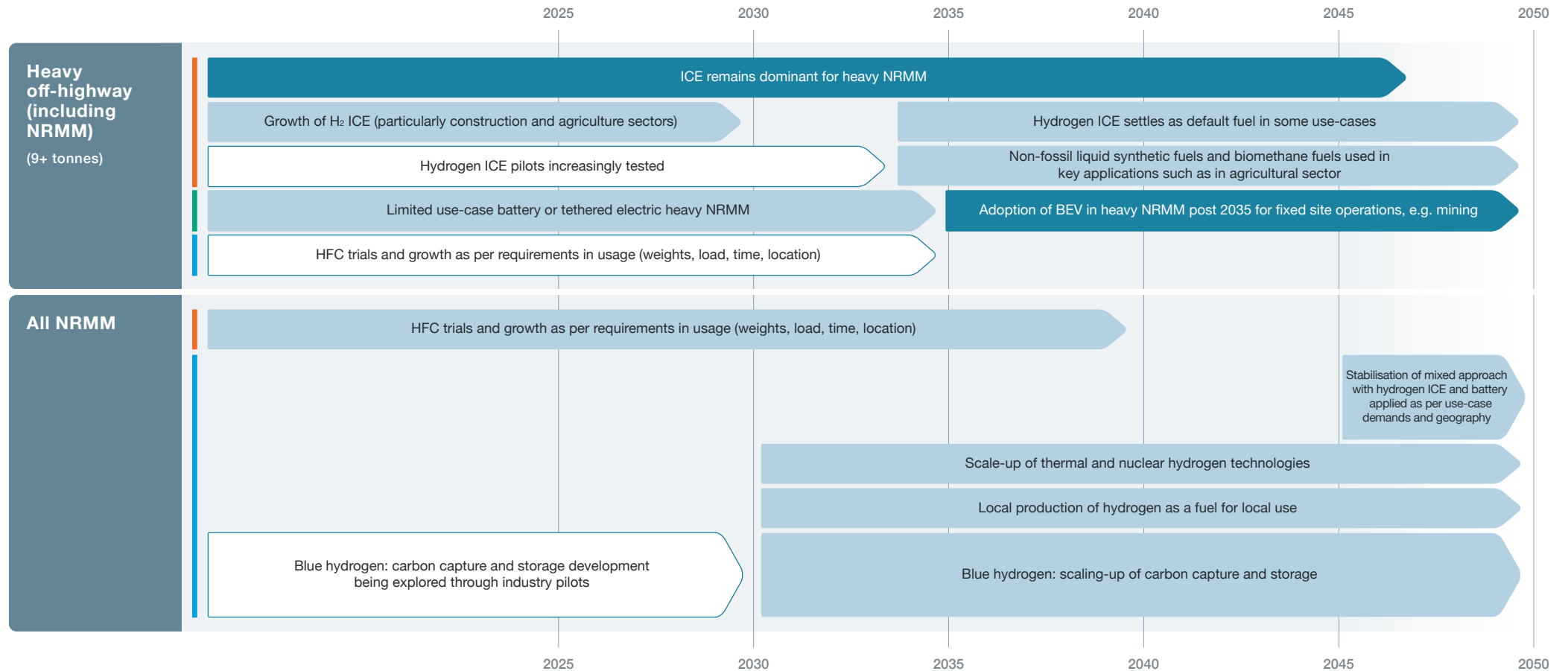
Off-highway (Including NRMM)

This includes the use of non-public roadways used for commercial purposes, e.g. construction or agriculture.

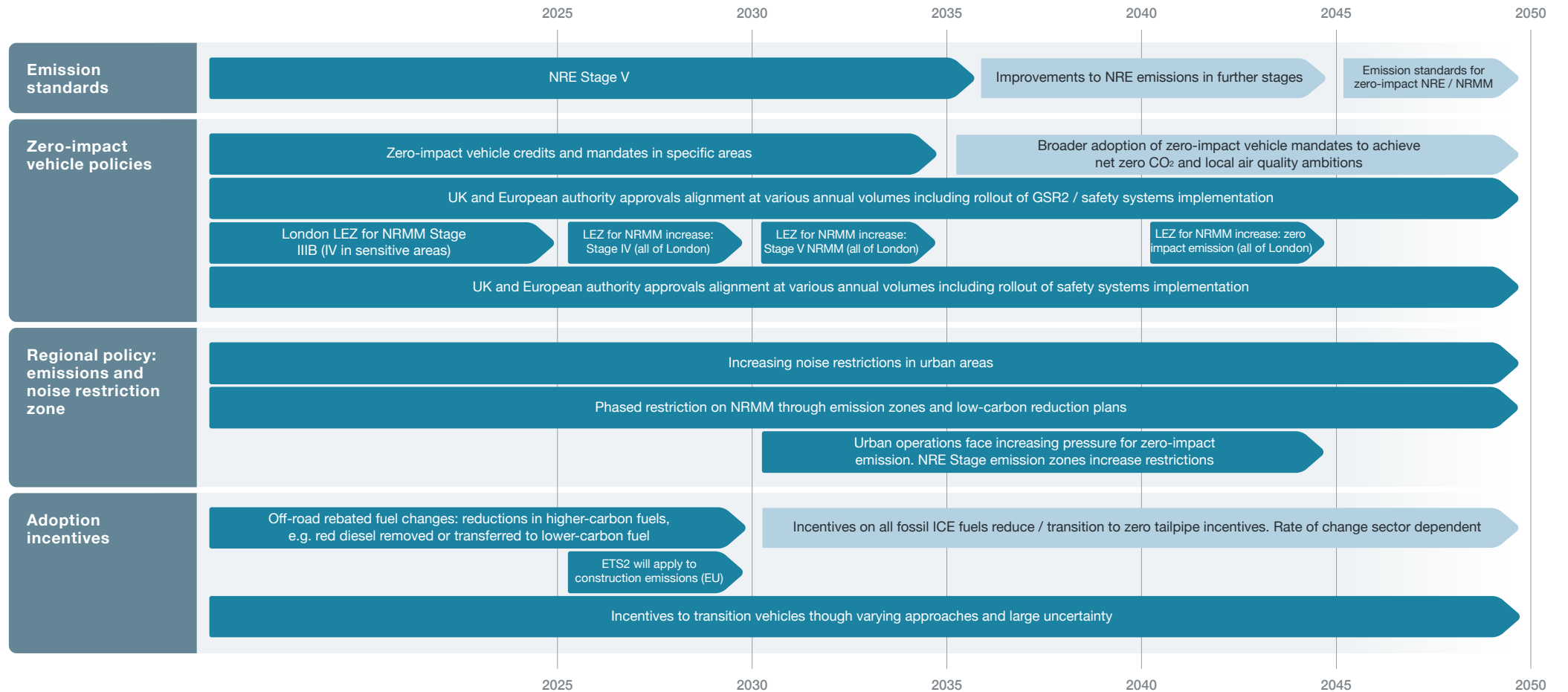
Energy vectors and vehicle propulsion type



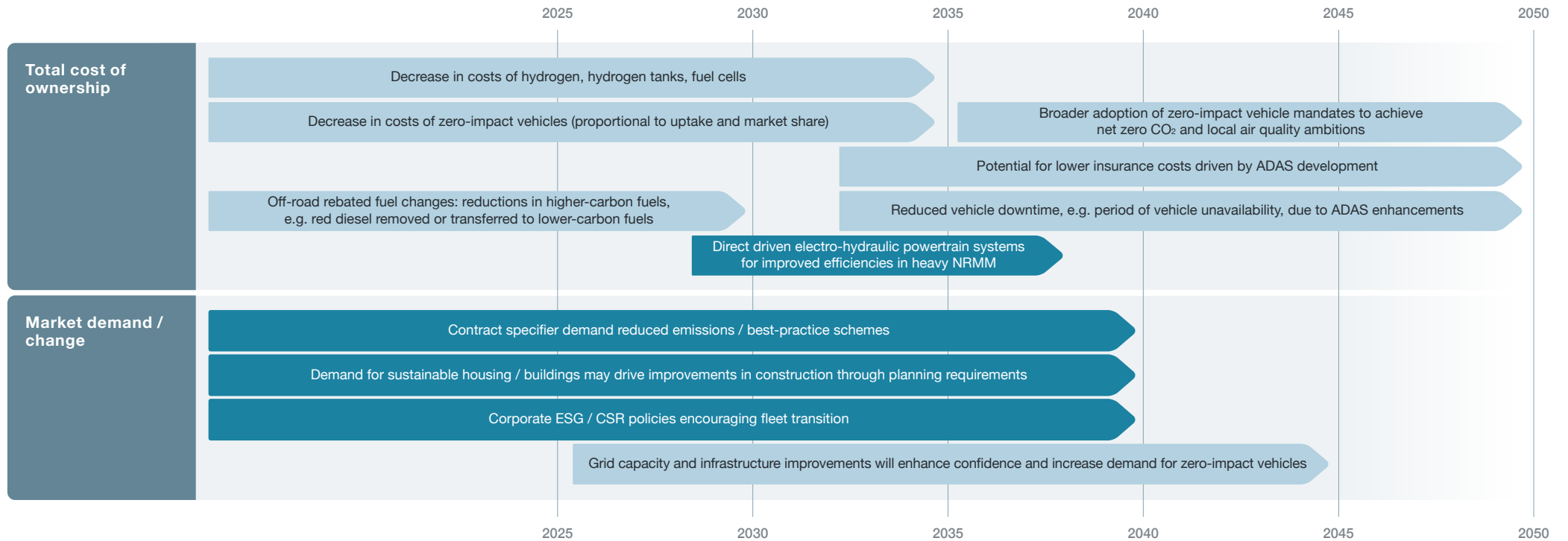
Energy vectors and vehicle propulsion type



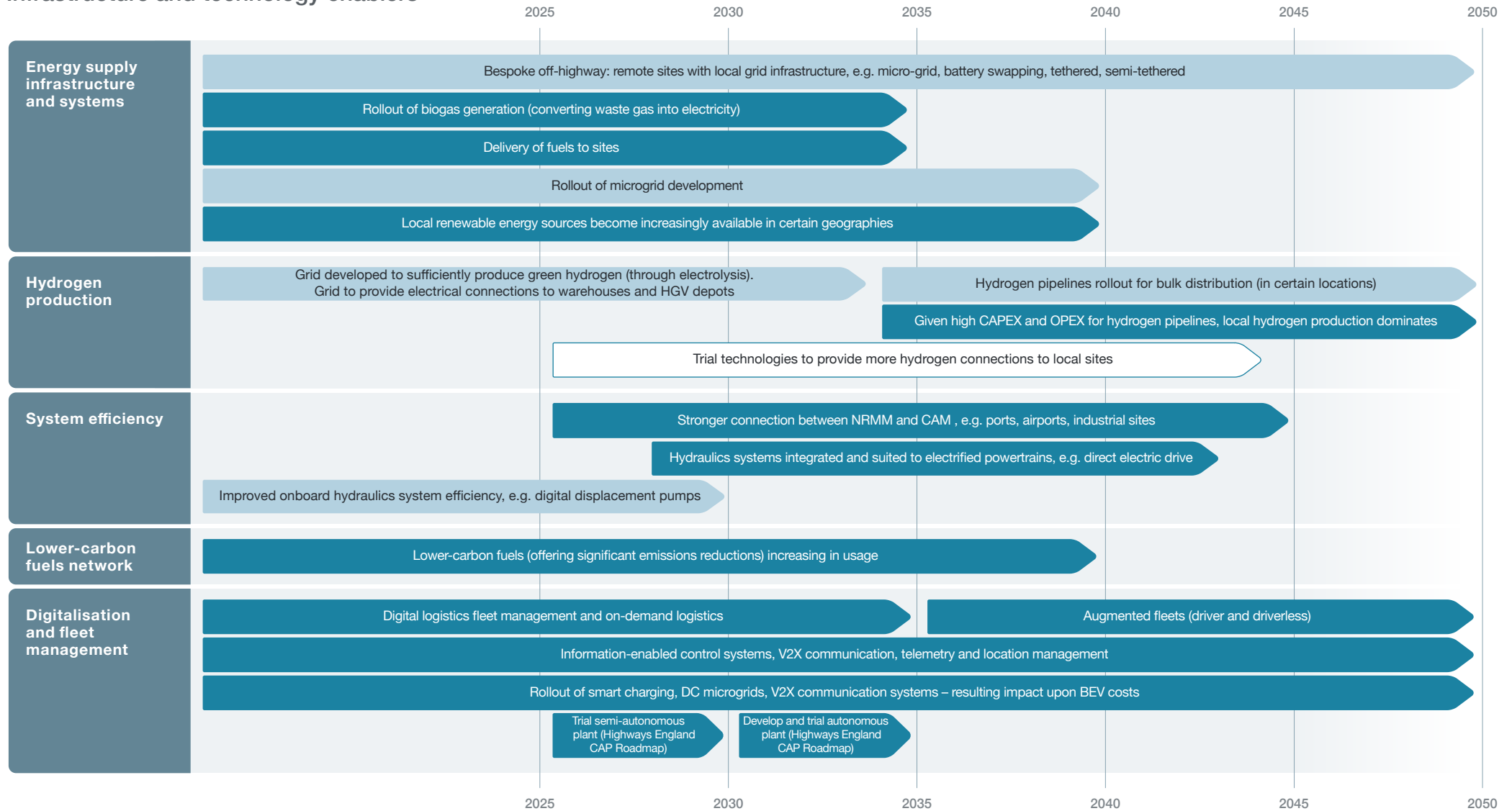
Drivers and regulations



Drivers and regulations



Infrastructure and technology enablers



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

BEV Battery electric vehicle
CAM Connected and automated mobility
CAP Connected and Autonomous Plant

ICE Internal Combustion Engine
NRMM Non-Road Mobile Machinery
V2X Vehicle to everything



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

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



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 CO₂.

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