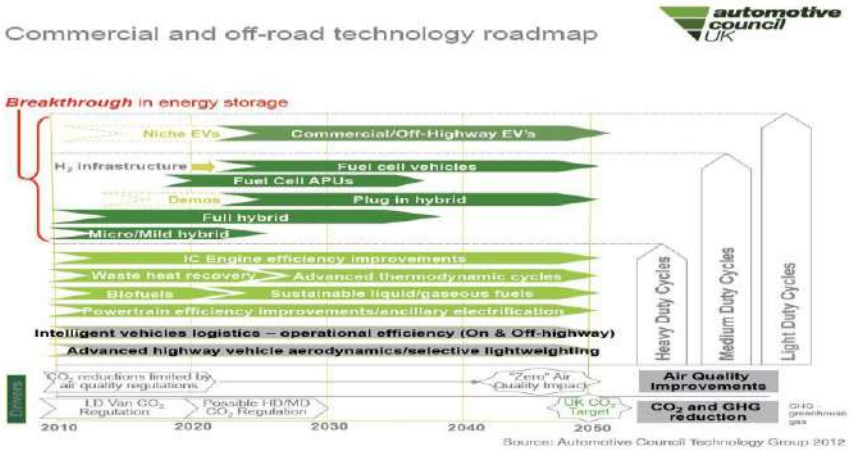
automotive council UK

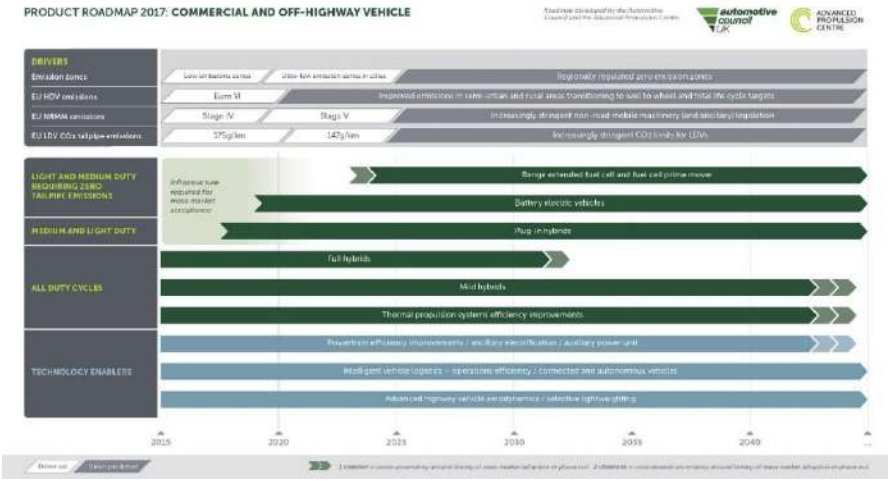
ADVANCED PROPULSION CENTRE UK

Commercial and Off-Highway Vehicle Roadmap

Updated by the Advanced Propulsion Centre in collaboration with and on behalf of the Automotive Council

Executive summary: *Commercial and off-highway vehicle roadmap*



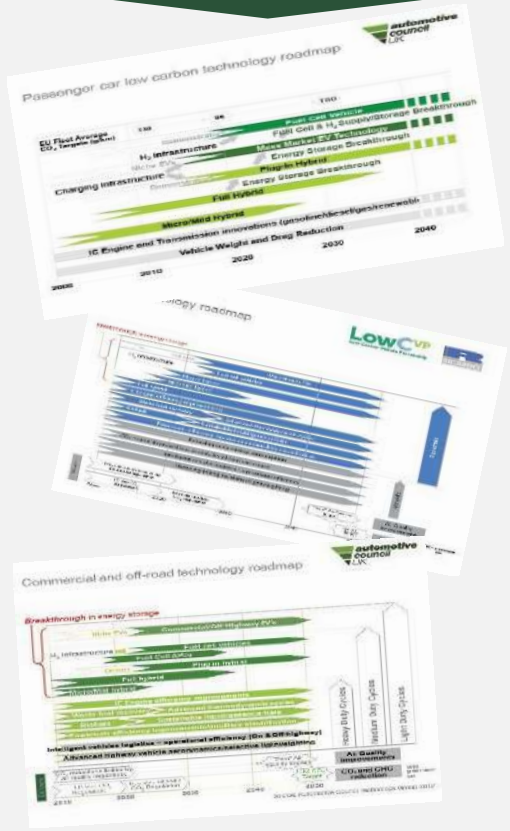


- The 2013 commercial and off-highway vehicle roadmap acknowledges both CO_2 and air quality as drivers and **identified technologies that are suitable for various drive cycles.**
- In the 2013 roadmap, efficiency improvements for heavy duty cycles could be attained through thermal propulsion system improvements whereas light and medium duty cycles can implement various levels of hybridisation/electrification
- **The 2017 roadmap reflects advances in hybrid technology** and the growing importance of air quality and zero emission operating zones on CV and off-highway manufacturers.
- **Duty cycle and operating environment will still determine powertrain choice.** Inner city and light/medium duty vehicles will likely transition into zero emission capable vehicle whereas heavy duty or rural/semi-urban vehicles will require a high efficiency thermal propulsion system with varying degrees of hybridisation.
- **The impact of vehicle connectivity and autonomy** on overall fleet efficiency and energy management is incorporated into this roadmap.
- Infra-structural requirement has replaced “technology break through” as an implementation barrier.

Update process: *The product roadmaps were developed using the following approach*

The process was co-ordinated by the **Advanced Propulsion Centre on behalf of Automotive Council.**

Review of existing product roadmaps



Research the new economic, social, technical and legislative drivers

1-1 confidential interviews

Consensus with participating OEM's

Review with Automotive council Technology working group

Developed new product roadmaps endorsed by the Automotive Council

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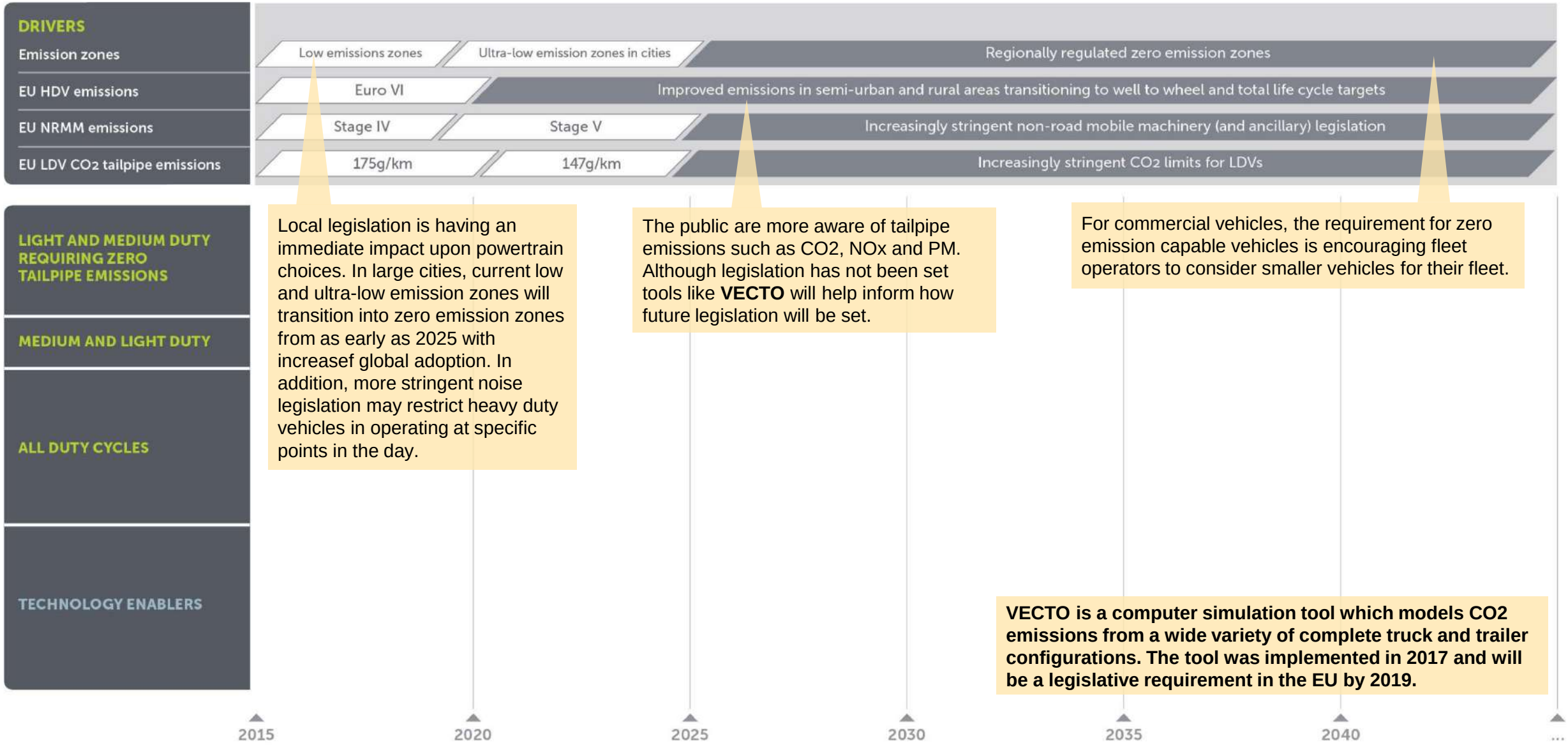
Drivers: *Drivers have been defined as both regulatory and standards but also take into consideration the environmental basis which is market driven by customer requirements*



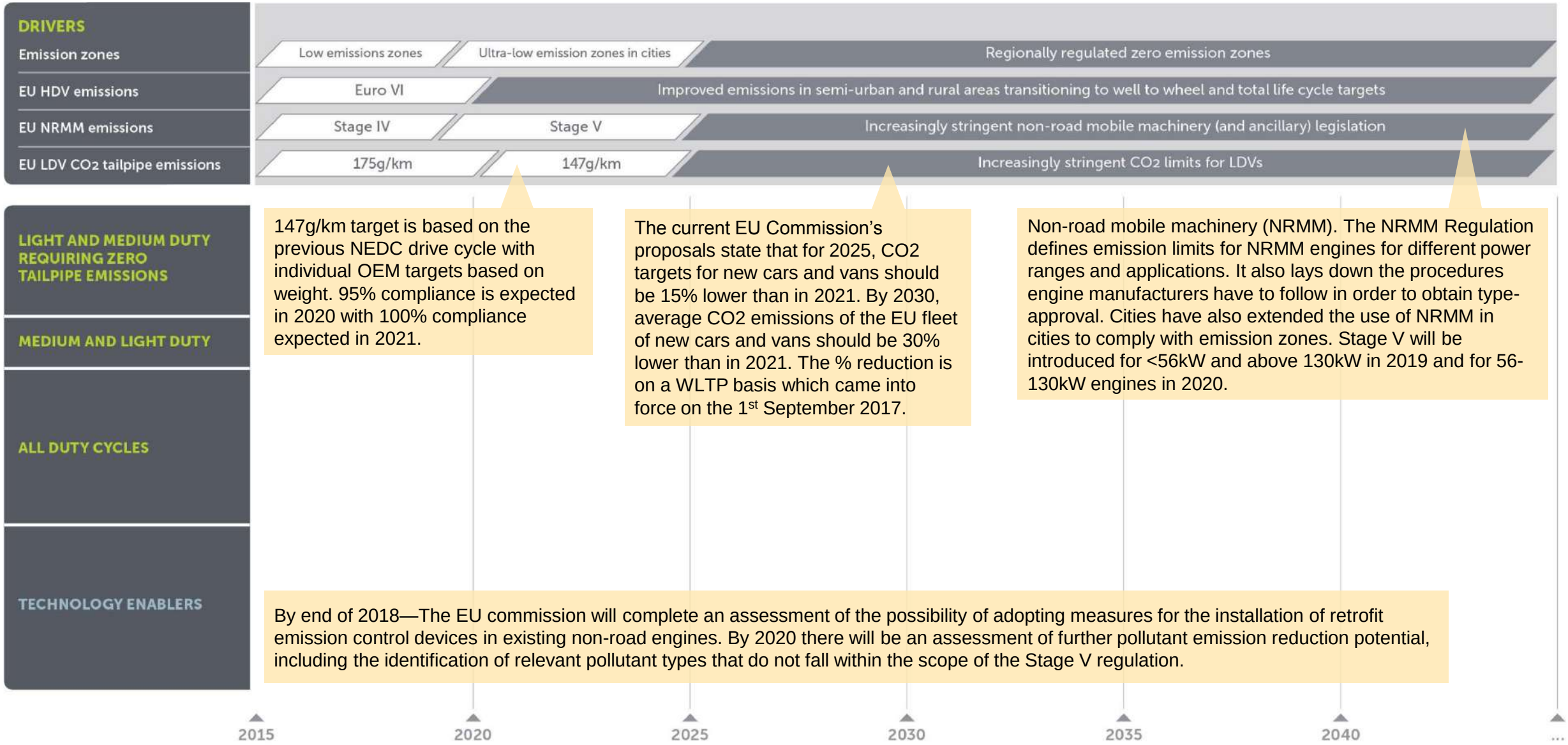
Local legislation is having an immediate impact upon powertrain choices. In large cities, current low and ultra-low emission zones will transition into zero emission zones from as early as 2025 with increasef global adoption. In addition, more stringent noise legislation may restrict heavy duty vehicles in operating at specific points in the day.

The public are more aware of tailpipe emissions such as CO2, NOx and PM. Although legislation has not been set tools like **VECTO** will help inform how future legislation will be set.

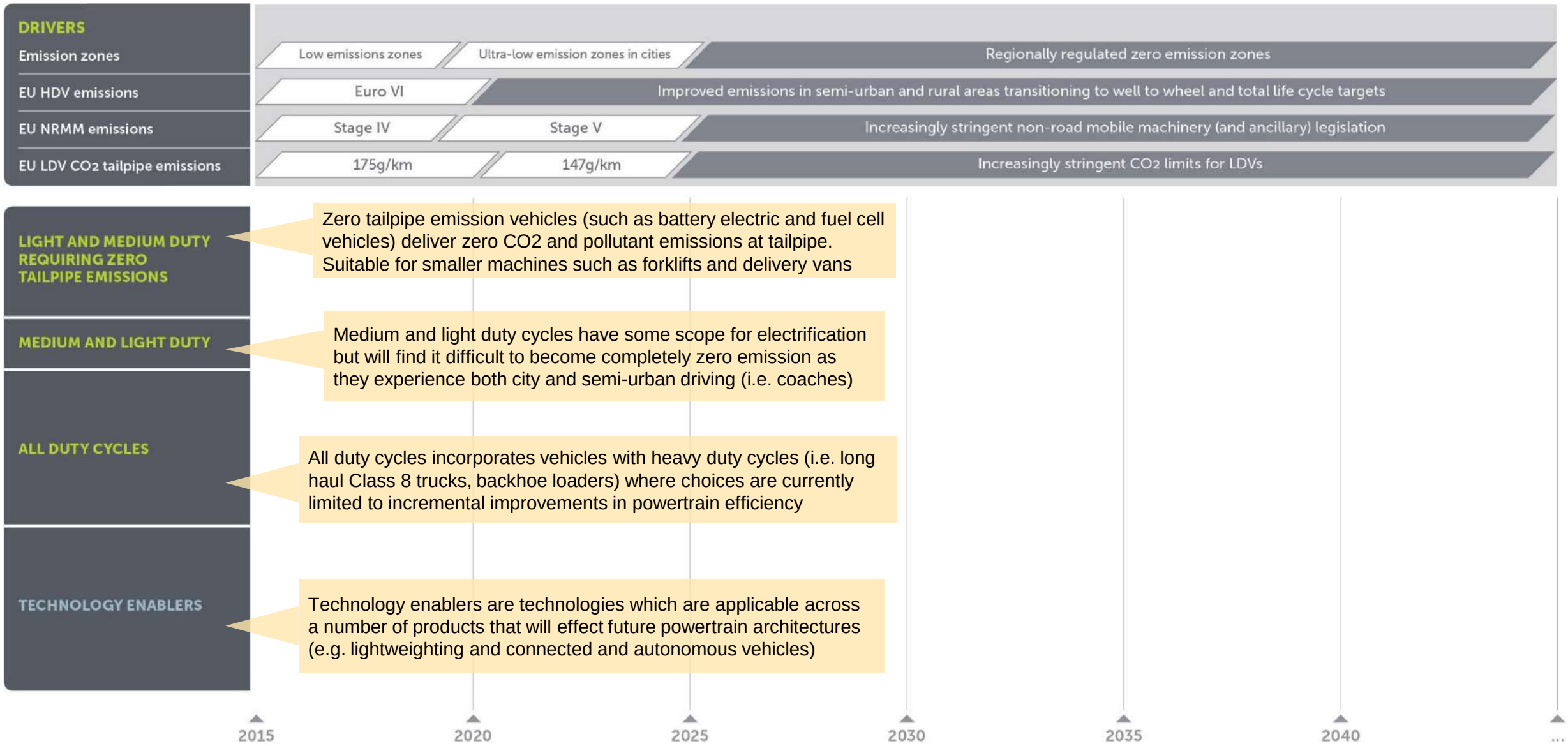
For commercial vehicles, the requirement for zero emission capable vehicles is encouraging fleet operators to consider smaller vehicles for their fleet.

VECTO is a computer simulation tool which models CO2 emissions from a wide variety of complete truck and trailer configurations. The tool was implemented in 2017 and will be a legislative requirement in the EU by 2019.

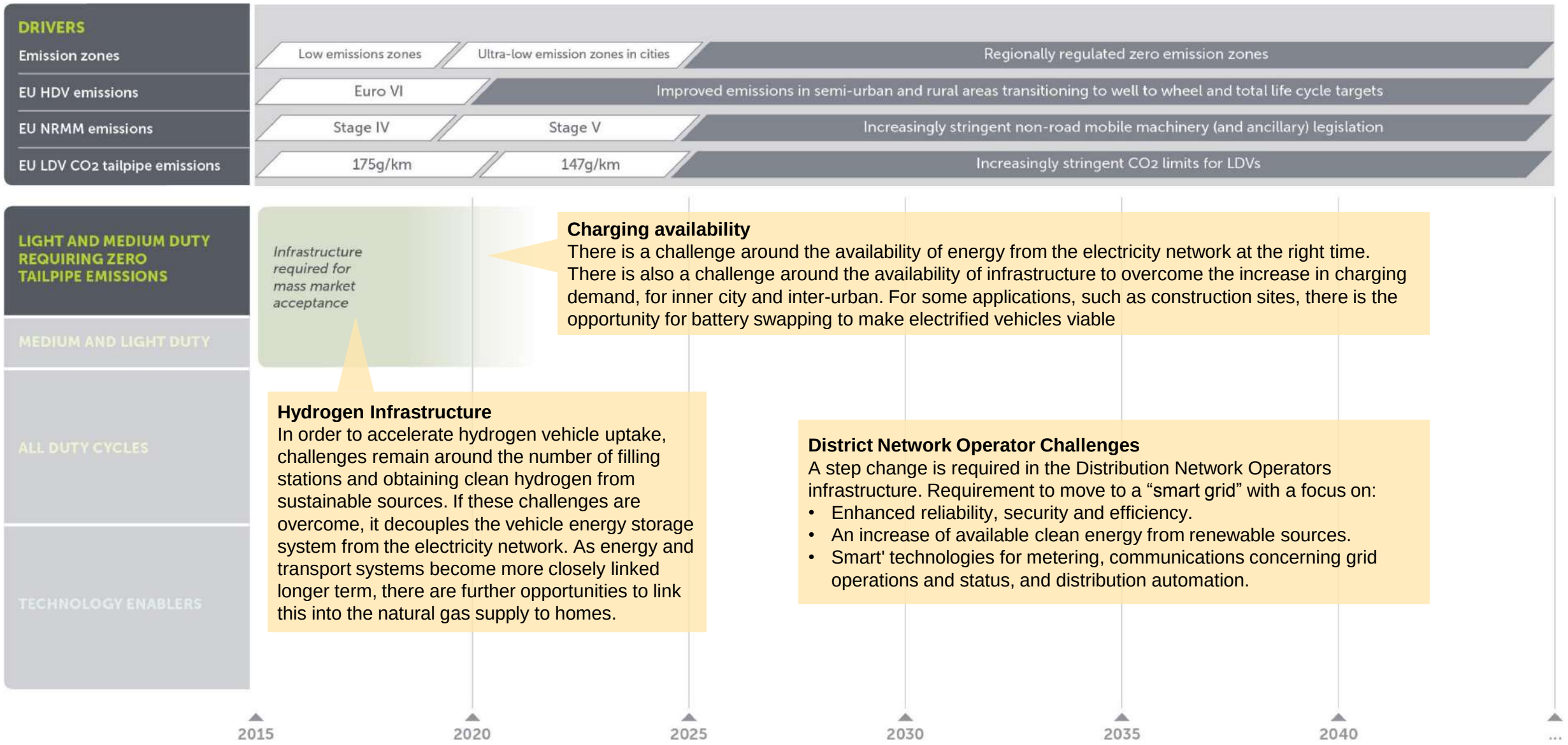
Drivers: *Drivers have been defined as both regulatory and standards but also take into consideration the environmental basis which is market driven by customer requirements*



Categories: *Commercial vehicles and off-highway vehicles experience heavy, medium and light duty cycles; the roadmap recognises powertrain choice will be determined by which duty cycle a vehicle experiences*



Infrastructure: *Mass market adoption of alternatively fuelled commercial vehicles is highly dependent on introducing a refuelling infrastructure capable of handling the increased energy demand from transport*



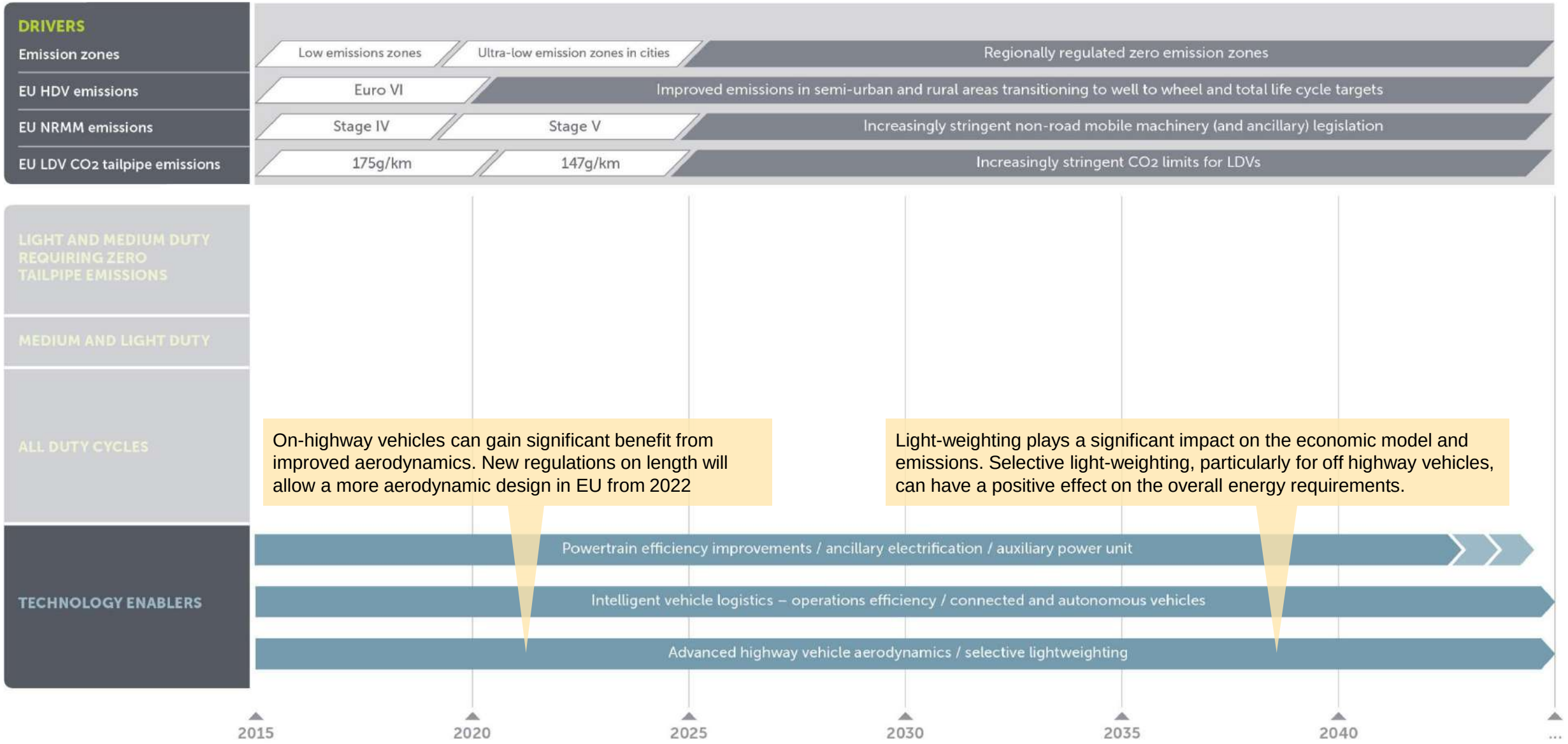
Charging availability
There is a challenge around the availability of energy from the electricity network at the right time. There is also a challenge around the availability of infrastructure to overcome the increase in charging demand, for inner city and inter-urban. For some applications, such as construction sites, there is the opportunity for battery swapping to make electrified vehicles viable

Hydrogen Infrastructure
In order to accelerate hydrogen vehicle uptake, challenges remain around the number of filling stations and obtaining clean hydrogen from sustainable sources. If these challenges are overcome, it decouples the vehicle energy storage system from the electricity network. As energy and transport systems become more closely linked longer term, there are further opportunities to link this into the natural gas supply to homes.

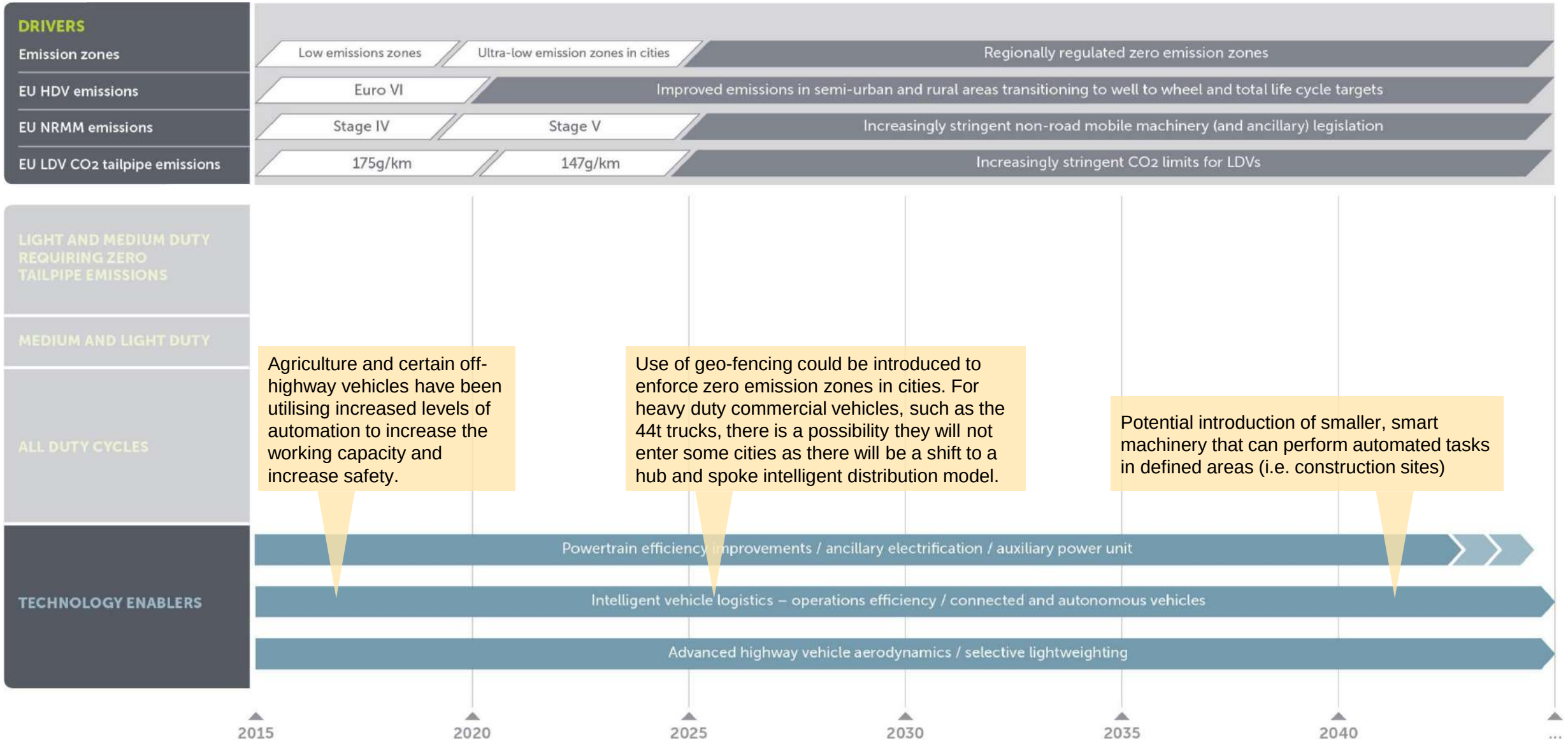
District Network Operator Challenges
A step change is required in the Distribution Network Operators infrastructure. Requirement to move to a “smart grid” with a focus on:

- Enhanced reliability, security and efficiency.
- An increase of available clean energy from renewable sources.
- Smart' technologies for metering, communications concerning grid operations and status, and distribution automation.

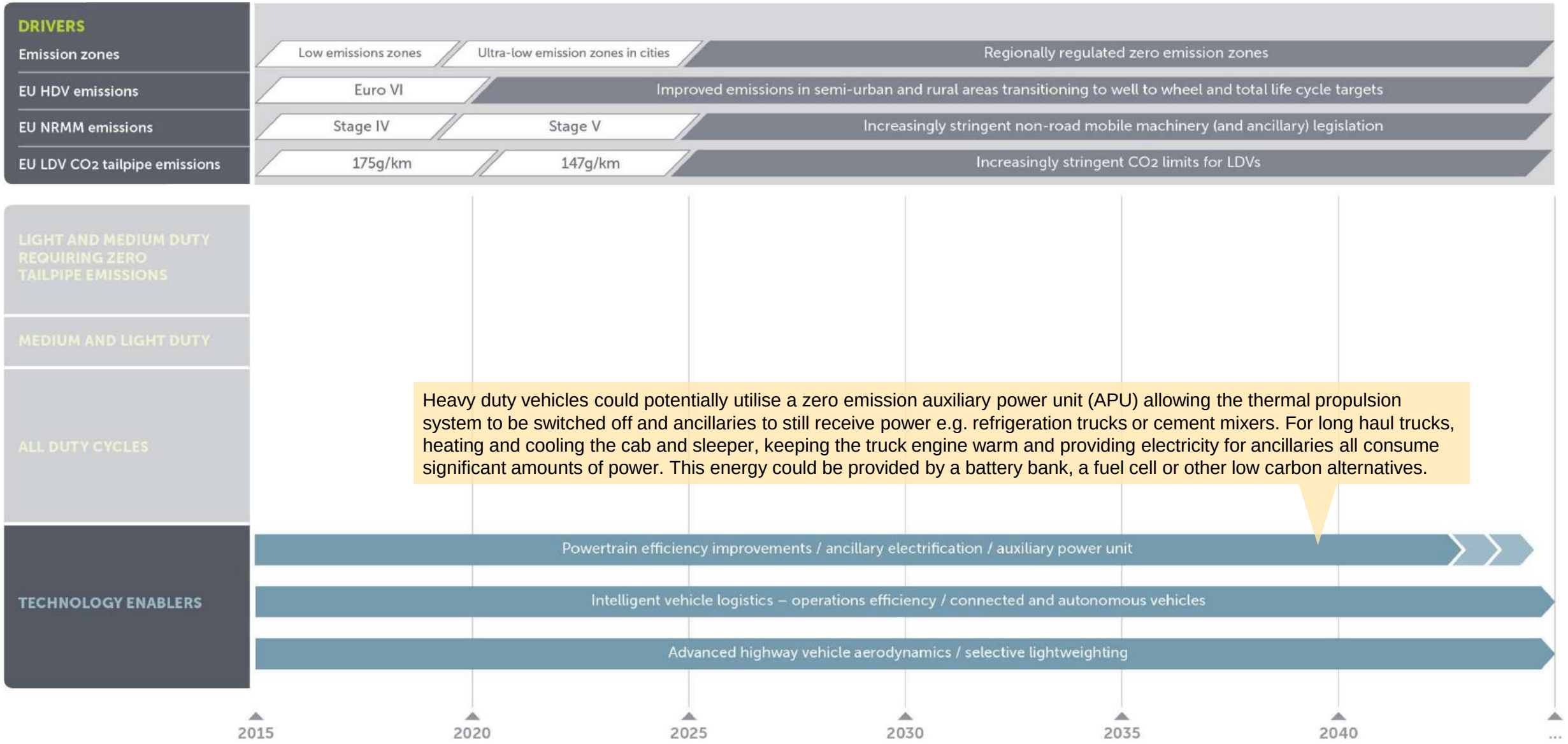
Technology enablers: *Vehicle lightweighting and improved aerodynamics can have a significant impact on the fuel economy and emissions from certain vehicle types*



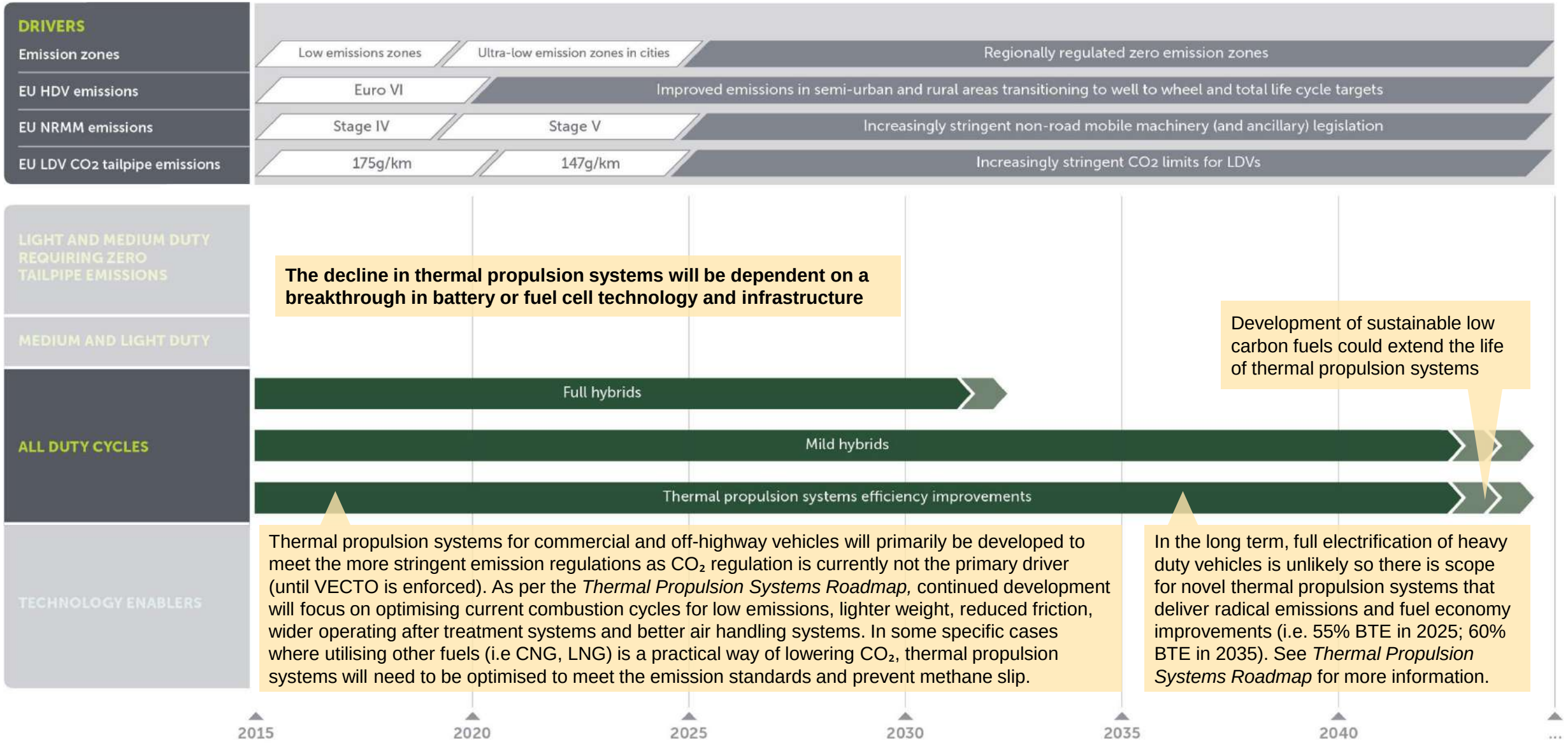
Technology enablers: *Improving operational efficiency can lead to significant emissions reduction; connected and autonomous vehicle technology will be a big enabler for fleet wide reductions in CO2 and emissions*



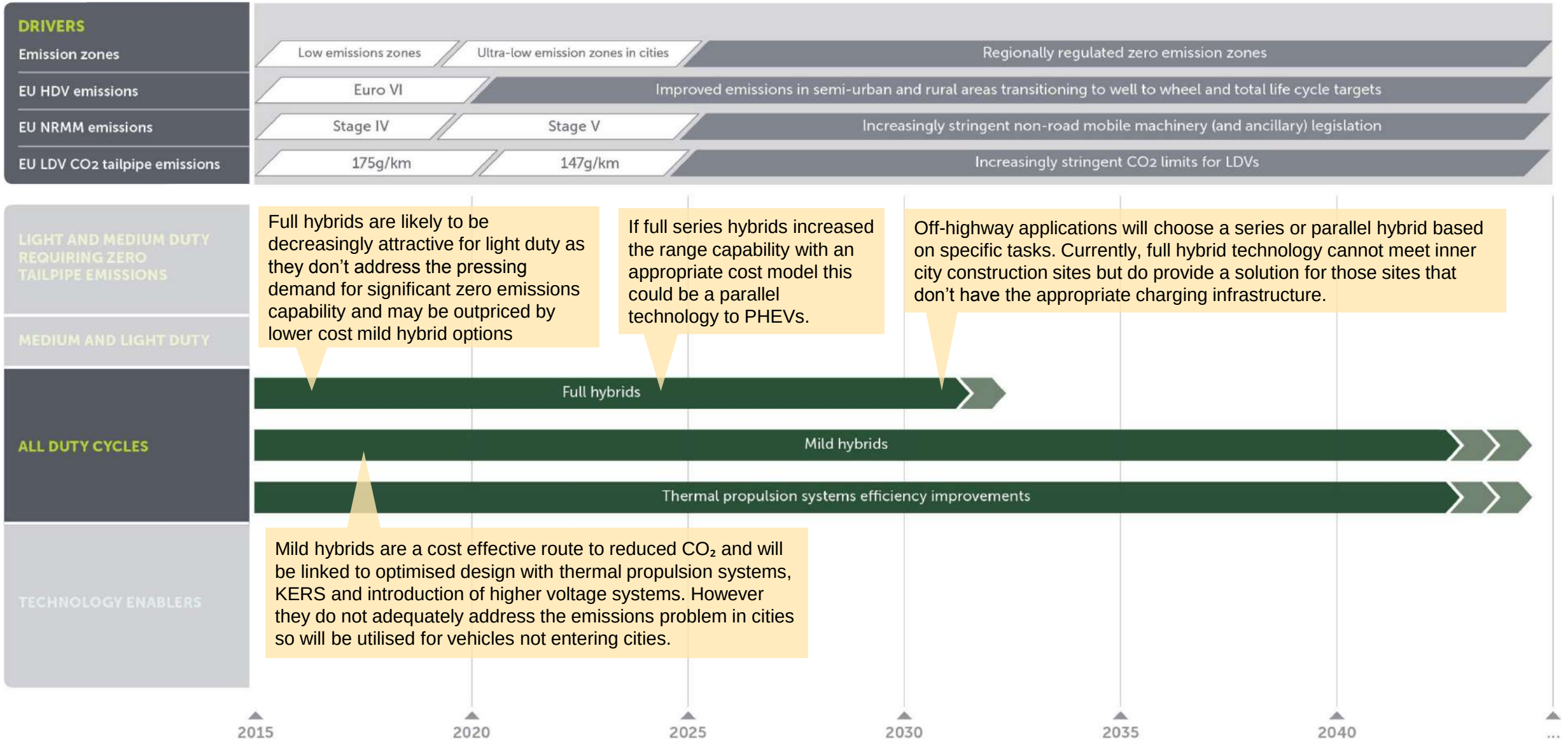
Technology enablers: *Focus on total powertrain efficiency including transmission, driveline and actuator systems to optimise the use of energy is critical for both on and off-highway vehicles*



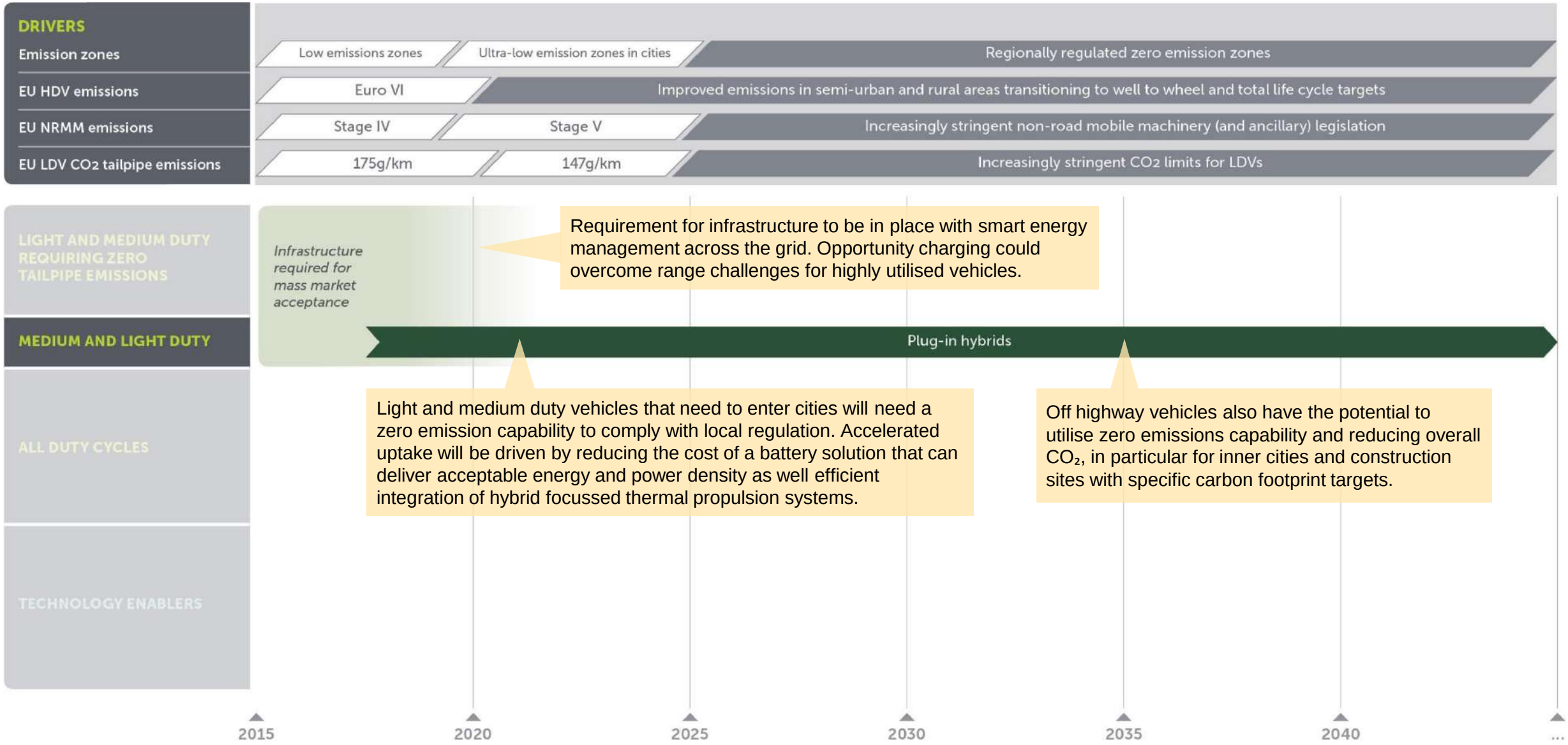
All duty cycles: *Thermal propulsion systems will remain crucial for heavy duty vehicles and remain an integral part of a hybrid systems for medium and light duty vehicles not requiring full zero emission capability*



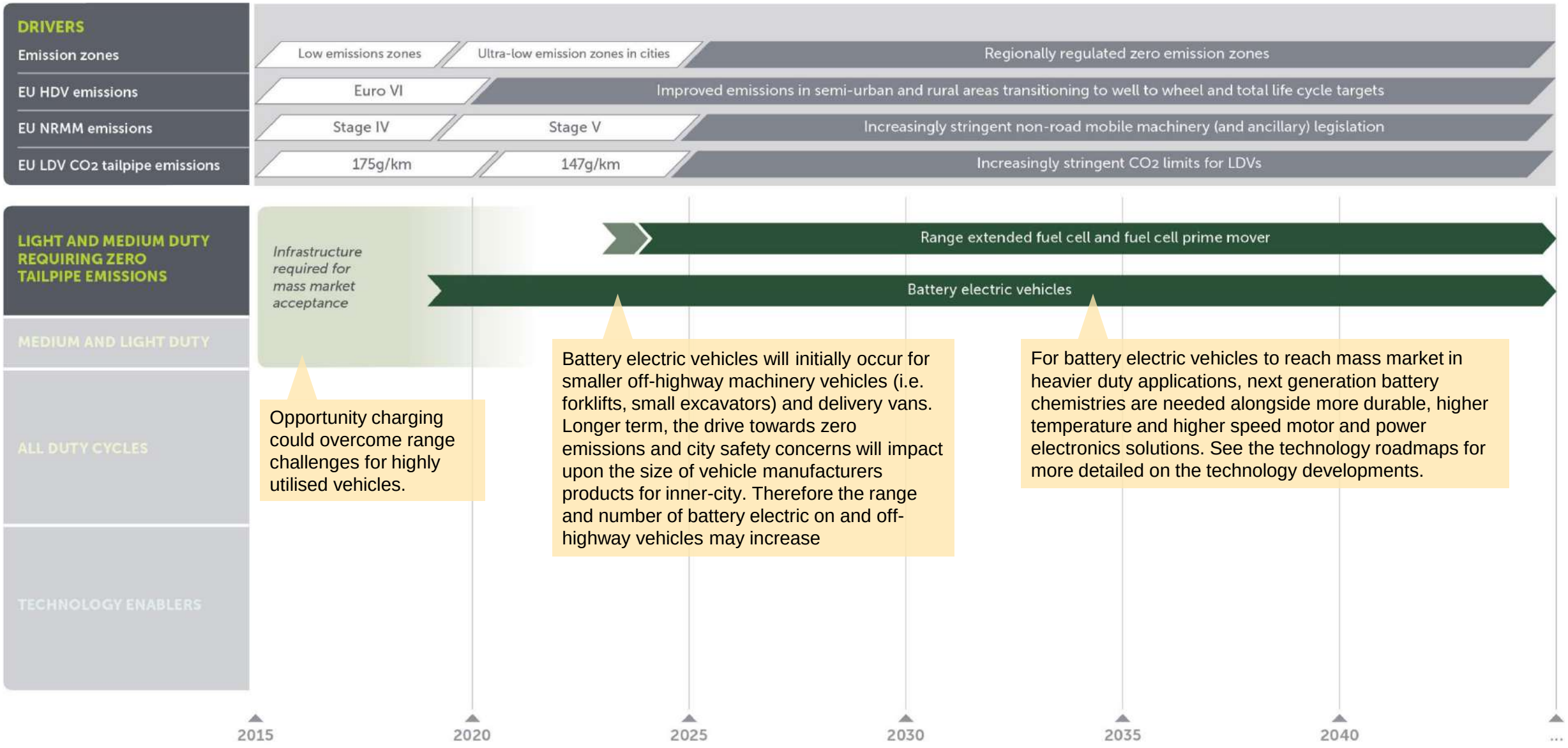
All duty cycles: *Mild and full hybrids will be prevalent in heavier duty cycles where higher levels of electrification are too costly and there is a significant infrastructure barrier to deployment*



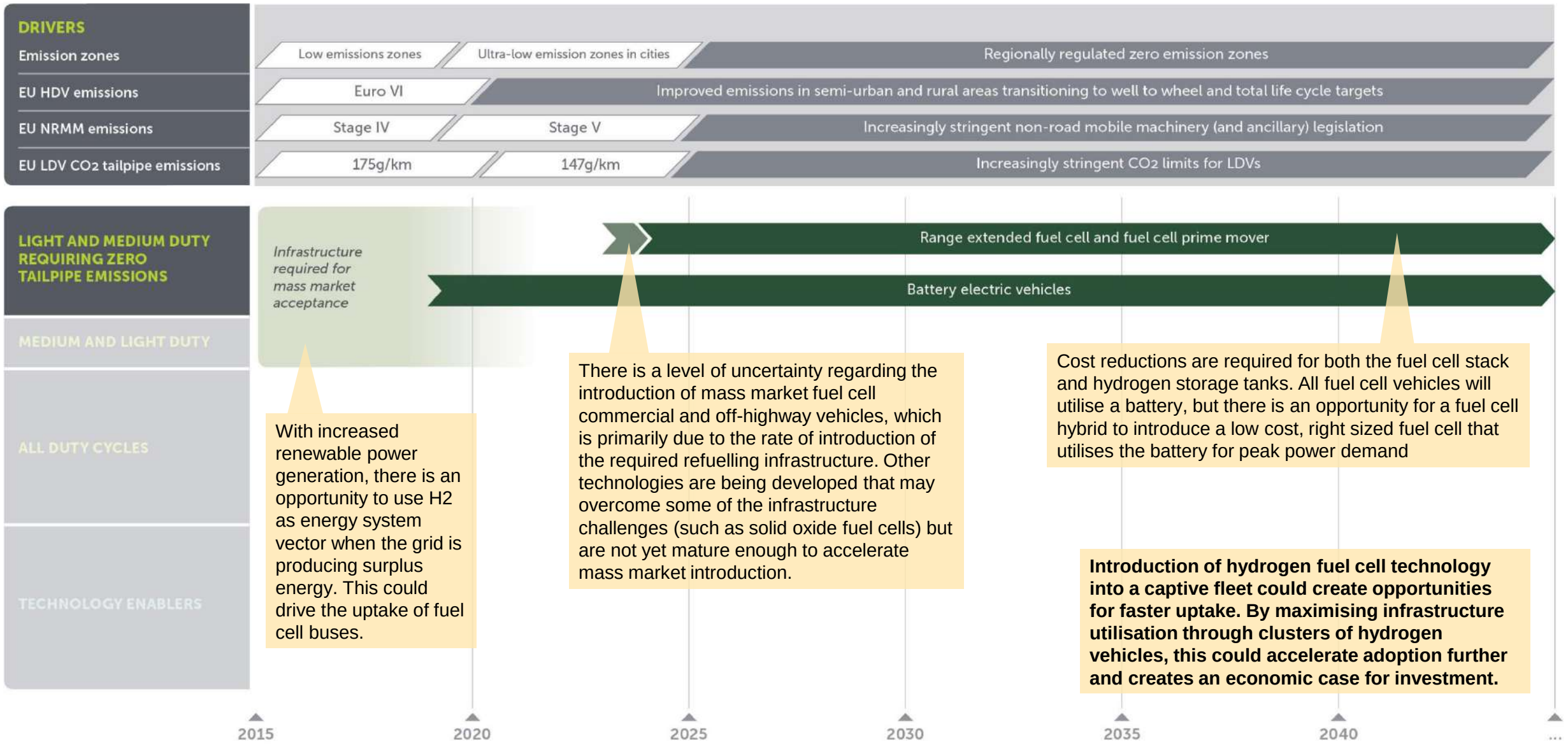
Medium and light duty: *Some medium and light duty commercial vehicles will experience both city and semi-urban drive cycles needing both range and zero emission capability, therefore facilitating the need for plug-in hybrids*



Zero tailpipe emissions: *Battery electric vehicles will be initially commercialised for smaller vehicle types and require a step change in technology to transition into heavier duty cycles*



Zero tailpipe emission: *The timing of mass market introduction of fuel cell commercial vehicles is uncertain due to lack of infrastructure, however initial uptake could be driven by captive fleets that have a central refuelling location*



PRODUCT ROADMAP 2017: **COMMERCIAL AND OFF-HIGHWAY VEHICLE**

Roadmap developed by the Automotive Council and the Advanced Propulsion Centre

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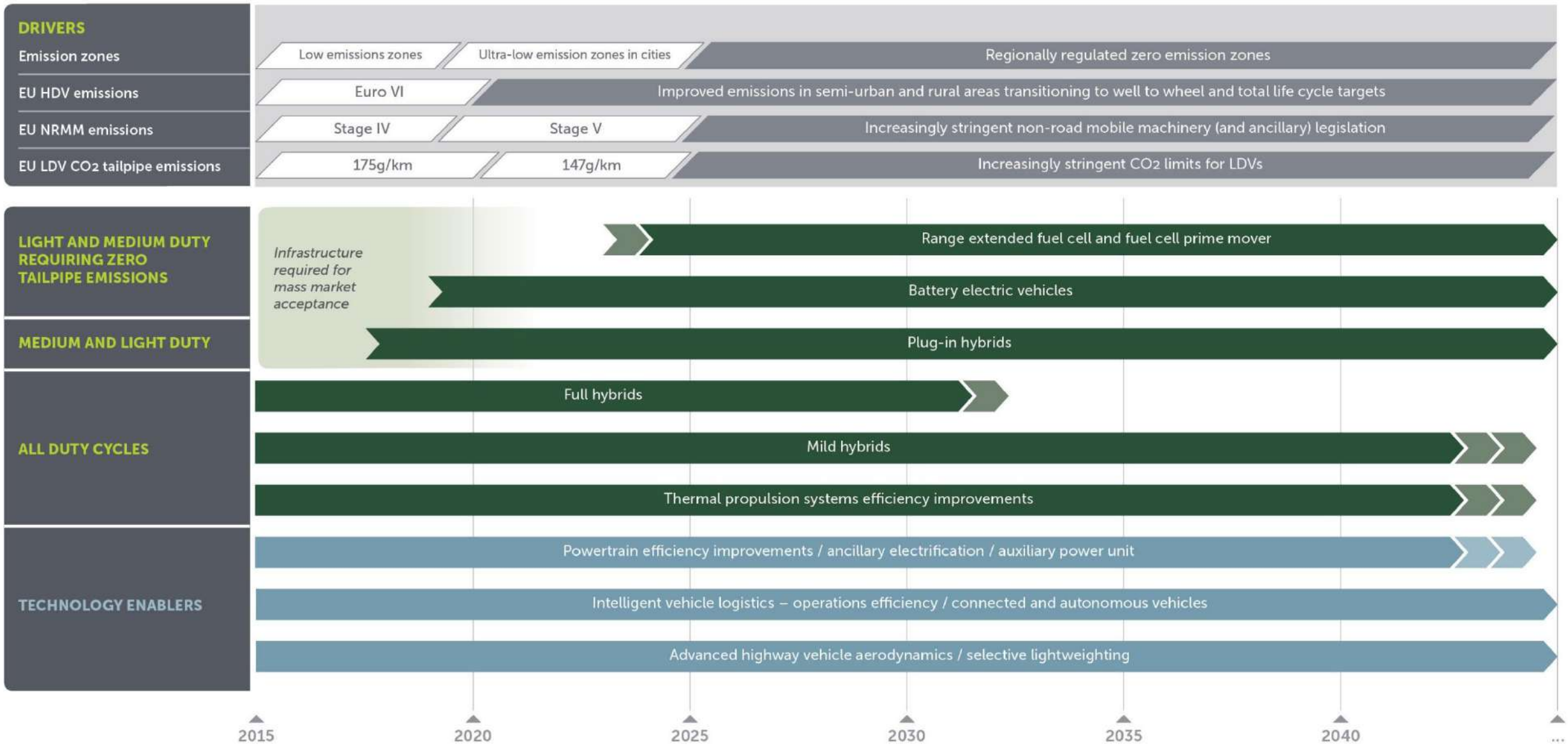

Driver set | Driver predicted

Solid bar represents >1% global marked adoption and is preceded by significant product and process R&D

1 chevron = some uncertainty around timing of mass market adoption or phase out *2 chevrons = considerable uncertainty around timing of mass market adoption or phase out*