Roadmap 2020



Heavy Goods >3.5t and Off-highway Vehicle

Product Classification



Urban Services and Off-highway Zero tailpipe emissions led





Goods and Service Vehicles







Off-highway Vehicles

Long Range and Off-Highway Net-zero* emissions led

Typically Medium / High Power



Regional Delivery and Services



Long Range Delivery and Services





Off-highway Vehicles

External Energy Source Net-zero* emissions led





Closed loop Fueled Vehicles



Future Catenary Vehicles



Tethered Off-highway Vehicles



High Utilisation, Remote-site Vehicles

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*Net-zero: The activities within the value chain of a company result in no net impact on the climate from greenhouse gas emissions. This can be achieved by balancing the impact of any remaining greenhouse gas emissions with an appropriate amount of carbon removals.

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Propulsion Technologies Roadmap



This roadmap represents a snapshot-in-time view of the global automotive industry propulsion technology forecast for mass market adoption. Specific application-tailored technologies will vary from region to region.



Dotted line bar: Technology exists in international markets, but less prevalent in Europe

Urban Services and Off-highway Zero tailpipe emissions led	Low Emission ICE and Hybrid: ULEZ compliance	Dedicated Hybrid: Optimised for ZEZ compliance, geo-fencing				
	BEV: Light Duty technology transfer	Tailored BEV: High adoption, cost effective chemistries, ubiquitous charge capability (fast and wireless)				
	Fuel cell: Specific high utilisation vehicl	les, fast re-charge, off-highway	Cost effective fuel cell: Cost competitive with BEVs			

Long Range and Off-Highway Net-zero* emissions led	Low emission ICE: (blended and low carbon fuels) Emission zone compliant ICE: runnin	ng on net zero fuels
	New ICE architectures: High efficiency (>55% BTE) New ICE architectu	res: Net zero fuels with emission zone compliance
	Hybrid: Augmenting ICE performance Dedicated Hybrid: Tailored for occasional urb	ban uses and high utilisation
	BEV Specific Platforms: (HGVs, OH) BEV: Power and energy dense che	emistries with ultra-rapid charge capability
	Fuel cell: High utilisation applications, specific fleets Fuel cell:	TCO competitive for small fleet operators

External Energy Source Net-zero* emissions led		Bespoke EV off-highway: Remote sites with local grid infrastructure (e.g. micro-grid, battery swapping, tethered, semi-tethered)								
					Catenary Electric	HGV: pantograph, specific h	nigh-utilisation routes			
				New ICE and Fuel Cell of	f-highway: Remote site net	-zero or zero-emission mob	bile and closed-loop fuelling			
	2020	2025	2030	2035	2040	2045	2050			

Energy Source	ICE fuels	Blended fuels moving to low carbon fuels (inclu	iding gaseous fuels)	Net-zero compliant fuels, sufficient supply at low cost			
Mature for	Electricity	Increasing renewable electricity supply	Ubiquitous renewable green electricity supply				
widespread adoption	Hydrogen	Sufficient (blue and green)	hydrogen supply to support automotive applic	ations Green hydrogen, sufficient supply at low cost			
Drivers and Regulations		Policy, enviror	Policy, environmental, social and economic drivers that exert influence on vehicle design and powertrain choices				
Technology Ena	blers	Engineering and technology enablers that exert influence on vehicle design and powertrain choices					

Hybrids = Mild, HEV, PHEV and range extender



Heavy Goods >3.5t and Off-highway Vehicle



Policy, environmental, social and economic drivers that exert influence on vehicle designs and powertrains Defined driver Predicted driver VECTO Uptake CO2: -30% (CO2e intro) Towards net-zero CO2e and LCA compliance CO₂: -15% CO2e Emission **ZEV** Policies ZLEV super credits and mandates in specific areas Broader adoption of ZEV mandates to achieve net-zero CO2e and local air quality ambitions Euro VII+ / EPA 2015 MY27 Euro VI / EPA 2015 Euro VII / EPA 2015 Pollution and **Drivers and** Holistic environmental impact legislation (VOC, resource use, land use) and LCA compliance Resource / NRE Stage V / NRE Stage V+ / NRE Stage V++ Regulations Zone Regulation Ultra-low emission zones Localised zero tailpipe emission zones and geo-fencing Increasing pedestrianisation and vehicle entry restrictions, next gen city designs New Freight Logistics and Business Models, **Total Cost** High utilisation fleets (digitally-enabled), Pay-per-mile Business Models of Ownership Productivity Improvements, Sustainability Strategy 2020 2025 2030 2035 2050 2040 2045 ...

Engineering and technology enablers that exert influence on vehicle designs and powertrains

Technology adoption for mass-market applications

Powertrain	Hydraulics	Improved on-board hydrau e.g. digital displac	ulics system efficiency ement pumps	Hydraulics systems integrated and suited to electrified powertrains, e.g. direct electric drive							
Eπiciency	Ancillaries	Smarter on-board systems e.g. electric brakes, water pumps, capacitor storage, low-carbon auxiliary loads for on-board power, etc									
Technology Enablers	Platforms		Vehicle modularity and standardisation for multiple variants and scale-up economics								
	CAV ¹	CAV – 1/2/3	Connected and autor	nomous – level 4	Connected and autonomous – level 5						
	Digitalisation ²	Digital logistics flee	t management and on-dem	nand logistics	Augmented fleets (driver and driverless)						
	Fleet Management	Information-enabled control systems, V2X communication, telemetry and location management									
	System Efficiency	Advanced highway vehicle aerodynamics / selective light weighting									
		A			A	A	A	A			
		2020 2025	2030) 2	2035	2040	2045	2050			

1. Adoption is dependent on supporting roadside infrastructure (incl. V2X, digital networks, data protocols, interconnects). See further details on https://zenzic.io/roadmap/

2. More details on digitalisation will be available on the IDE roadmap from March 2021