INTESA SANPAOLO
INNOVATION CENTER

# INDUSTRY TRENDS REPORT
# AUTOMOTIVE, TRANSPORTATION AND LOGISTICS

*CARMAKERS MOVE TOWARDS A GREENER AND SMARTER FUTURE*

FROST & SULLIVAN

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# EXECUTIVE SUMMARY

Over the last few years, the pace of change in the automotive space has accelerated with the share of **diesel** engines in Europe and the US declining rapidly as the popularity of **electric**, hybrid and emerging propulsion systems such as hydrogen **fuel cell** continues to rise. In addition to step changes in powertrains, the industry is also being fundamentally reshaped by the emergence of, in the short term, increasingly **connected** and, in the long term, **autonomous** commercial and personal vehicles.

In 2019, the last full year for which figures are currently available, **30%** of vehicles sold in Europe were diesel, **down from 45%** in 2017. OEMs are exploring new ways in which to improve the efficiency of combustion engines but the overall direction of travel is clear with government intervention requiring the vendors to reduce emissions whilst, at the same time, rewarding the buyers for acquiring vehicles which pollute less or not at all.

**Electric** Vehicles, including Battery and Plug-in Hybrid, have been the chief beneficiary of this. 1.9m EVs are currently on the roads of Europe and, although the pandemic has taken its toll, generous tax benefits and changing consumer needs are combining to drive growth with countries aiming to replicate Norway's success.

The development of Zero Emission Vehicles is supported by new demand but also intense supply-side activity with **charging** and **battery** technologies reaching, for the former, the critical mass and, for the latter, performance levels needed to support growth.

Frost & Sullivan estimates that there will be a fivefold increase in the number of points available in Europe between 2019 and 2027 while the growing need for faster charging capabilities is one of the factors behind the search for safer and denser solutions. Currently, solid-state batteries are emerging as a promising alternative to the go-to lithium-ion solutions which market participants across the value chain are looking to safely recycle.



Source: Frost & Sullivan

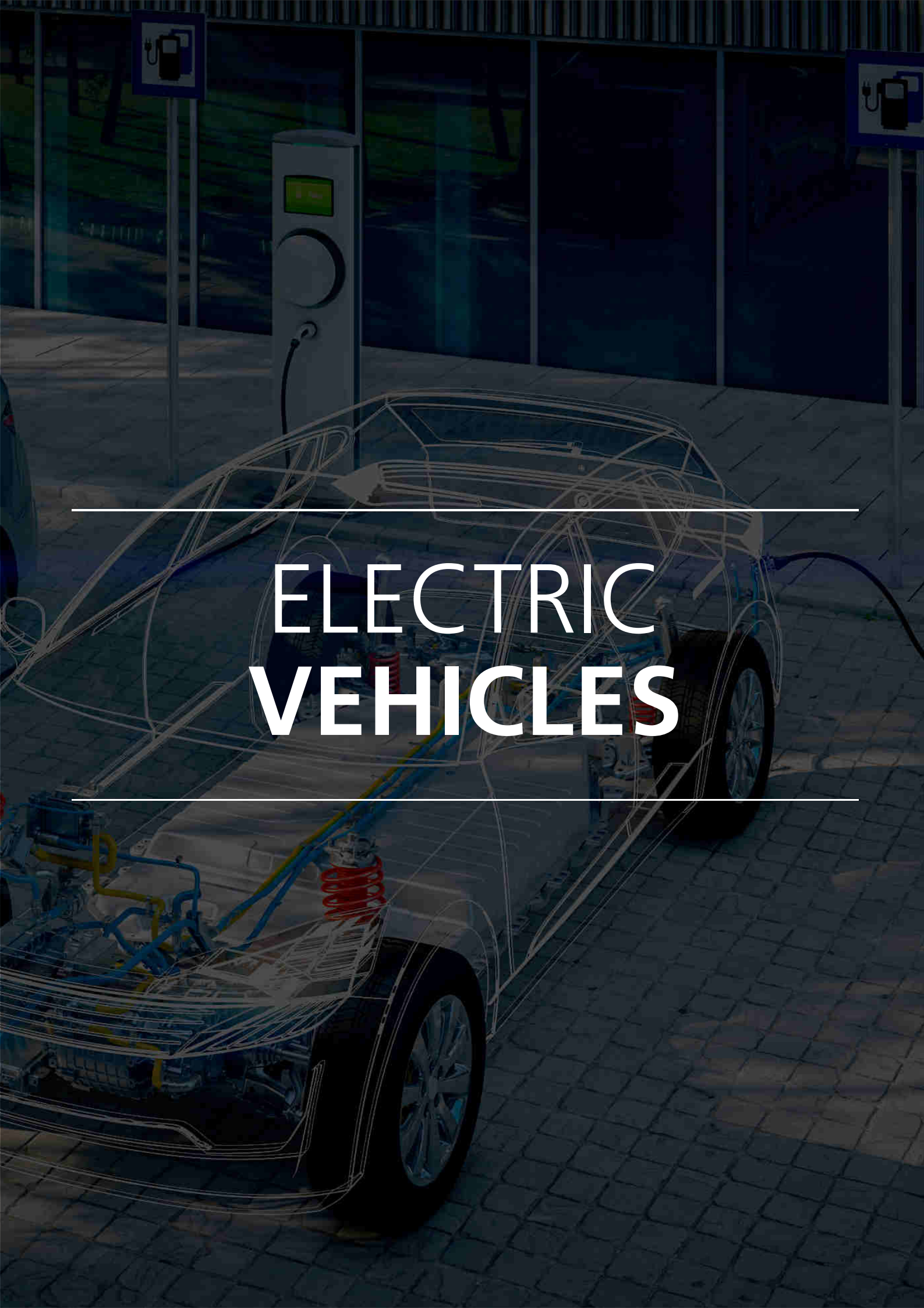
In the longer term, **Fuel Cell** EVs have the potential to offer motorists improved driving performance, longer range and faster recharging times than BEVs, PHEVs and many ICEs. Growth here is also being aided by government intervention and the expansion of the related charging infrastructure as well as material falls in costs.

Frost & Sullivan estimates that, by 2022, 75% of cars globally will be highly **connected**, mainly due to penetration of embedded systems. At the moment, OEMs' and Tier I suppliers' focus is on building out their offering in established areas such as navigation and audio. They are also working on reshaping the way in motorists interact with their vehicles with a view to providing value-added services like in-vehicle market places. In the longer term, monetising the data that connected cars generate will unlock huge opportunities.

In the mid-term, Frost & Sullivan expects that vehicles will not only be connected but also **autonomous**. All cars will offer at least some features by 2029 but the overall shift toward a driverless car is taking longer than the industry envisaged with OEMs looking to "L2+" technologies to bridge the gap and provide a platform for more sophisticated solutions in the future. Autonomous trucking is an area of great activity and part of a wider move towards autonomous Commercial Vehicles including shuttles, tractors and even vessels.

This paper examines each of these areas in turn with a focus on the ways in which personal and commercial transportation is becoming greener and smarter. More broadly, it provides a guide as to how innovation in vehicles themselves, together with the technology within them and the infrastructure surrounding them, is impacting the **Automotive** market.

Source: Frost & Sullivan



# ELECTRIC VEHICLES

Over the last two years, the pace of change in the powertrain space has accelerated with the share of **diesel** engines in Europe and the US declining rapidly as the popularity of **electric**, hybrid and emerging propulsion systems continues to increase.

The development of this second group of vehicles is driven by increasing demand but also intense supply-side activity with **charging** and **battery** technologies starting to reach the critical mass and level of performance required to support growth.

### In 2019, the last full year for which figures are currently available, 30% of vehicles sold in Europe were diesel, down from 45% in 2017

15.7 million new passenger vehicles were registered in total in the region, a decrease of 1.1% from 2018. Germany, the UK, and France remained the top three countries, together accounting for nearly 52% of overall unit shipments.

In 2019, diesel vehicle sales in Western Europe decreased by 13.4% year-on-year to reach 4.2 million, from about 5.0 million in 2018.

The extent of the decline in diesel varies from country to country and has been offset by the increase in gasoline engine vehicles in many markets;

- The **United Kingdom** (UK) recorded 2.3 million vehicle sales, a 2.4% decrease from 2018 and a 22% fall in the demand for diesel
- In **Germany**, new vehicle sales grew by 5.0% with demand for diesel increasing by 3.7%. Here, diesel vehicles and notably VW's models completed Worldwide Harmonised Light Vehicles Test (WLTP) certification towards the end of 2019 whereas gasoline models remained uncertified. Germany was the only country to witness positive growth in diesel sales although its share declined by 0.3%
- In both **Italy** and **France**, diesel vehicles have become increasingly expensive due to ever stricter emission and fuel efficiency norms

Many key European automakers will cease to develop new diesel engines from 2025 onwards whilst existing diesel powertrain platforms will be upgraded with Selective Catalytic Reduction (SCR) or other after-treatment technologies.

In addition to legislation, which is explored further below, a decrease in resale values, a reduction in subsidies and an increase in urban-area driving bans are all factors which are conspiring to ensure that diesel powertrains are set to continue to lose popularity. On the supply side, a general confusion over OEM strategies to comply with Real Driving Emissions (RDE) norms and the increased penetration of turbo gasoline engines and alternative powertrain technologies are also accelerating this shift.

### OEMs are exploring ways in which to improve the efficiency of combustion engines such as Infiniti's variable compression technology …

The 2019 **Infiniti** QX50 was the first commercialised model with variable compression ration technology which enhances fuel efficiency by 30% to 35% and reduces engine friction by 44%. The solution is characterised by its dual lower compression ratio of 8:1, which is needed for higher output driving, and its higher compression ratio of 14:1, which is needed for fuel-efficient driving on lighter loads.

Infiniti's variable compression technology comprises;

- Multilink system controls which alter the vertical position of the connecting rod and hence the piston height
- Actuator arms (a harmonic drive reduction gear) which drives a lower link that, in turn, controls the orientation of the multilink
- Electric motor actuators which, controlled by the Engine Control Unit (ECU) and guided by the data on load conditions, have actuator arms

Source: Frost & Sullivan

### … and Hyundai's Gasoline Direct Injection solution

**Hyundai** has invested around US$100 million to develop its GDi technology and launched the Sonata 2.4L Theta GDi in 2019.

From a **performance** perspective, it delivers 201 PS (*Pferdestärke*, horsepower) of power at 6,300 rpm (revolutions per minute) and a rotating force of 250 Nm (Newton metres) at 4,250 rpm. Its mileage is 15.88 kmpl (kilometres per litre) or 44.5 mpg (miles per gallon). The fuel injection pressure is increased to 100 bar once the engine is cranked which further enhances performance.

In terms of **design**, the offloading of piston and cylinder cooling jets increases durability and its balance shaft provides lower Noise, Vibration and Harshness (NVH). It uses a roller-type chain system and a split injection which enables better combustion and 50% faster catalyst light off and emission reductions.

From a **manufacturing** point of view, high pressure die casting coupled with T5 heat treatment of the cylinder block eliminates residual stress. It also prevents cylinder distortion by improving cylinder dimensional stability.

The Sonata 2.4L Theta GDi offers **Dual Variable Valve Timing** to achieve greater efficiency, shorten the valve duration at lower rpms (or when the engine requires less power) and increase the valve timing for more fuel injection and higher power output.

### But the direction of travel is clear with legislation mandating lower emissions …

Emissions and CO2 regulations remain the number one driver of changes in the demand for and supply of diesel powertrains.

In the European Union (EU), local legislation requires an ambitious 15% reduction from 2020 levels by 2025 and 38% by 2030.

Similar programmes are also in place globally and notably in the key geographies of North America (the United States [US] and Canada), China and Japan, with maximum allowances of carbon dioxide emissions measured in terms of grams per kilometres (g/km).

**MAXIMUM ALLOWANCE OF CO2 EMISSIONS MEASURED IN G/KM, SELECTED COUNTRIES, 2015-2030**

| Region | Legislation | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **EU** | WLTP<br>RDE<br>CAFE | 120 | 95 | 80 | ~60 |
| **North America** | EPA Tier 3<br>CARB LEVIII | 160 | 128 | 100-128 | 80-85 |
| **China** | NEV Quota<br>China 6b | 160 | 115 | 80-90 | 60-80 |
| **Japan** | RDE Diesel<br>2022 | 125 | 105 | 90 | 80 |

In the future, **Euro 7** regulations are expected to place even tougher limits on the emission of harmful nitrogen oxides (NOx) and particulate matter (PM).



Source: Frost & Sullivan

### … and environmental credits driving a steady move to Zero Emission Vehicles

In contrast to diesel vehicles, where legislation is intended to act as a disincentive to market growth, national and international government intervention is increasingly designed to offer a reward to suppliers of "greener" alternatives.

In Europe, **super credits** are offered as incentive multipliers for ZEVs, encouraging OEMs to lower their average fleet emissions.

Super credits are currently awarded for vehicles with CO2 emissions of less than 50 g/km. They weaken the impact that regulations have over conventional cars with excess emissions with diesel or petrol vehicles compensated for by strongly electrified cars.

Following the proposed phase-out of super credits in 2022, OEMs will receive credits for the introduction of low emission vehicles using the so called Zero Level Emission Vehicle (ZLEV) factor which may increase manufacturers' CO2 targets by up to 5%.

In the shorter term, there will be a cap on the contribution of super credits' to CO2 reductions of 7.5 g CO2/km per manufacturer.

**Eco-innovation** similarly encourages OEMs to reduce CO2 emission from ICEs. In 2018, the use of eco-innovation credits was nominal (3.6% of registrations), lowering average emissions by 1.5 g/km, significantly less than the capped limit of 7.5 g/km.

Only novel technologies are accepted as eco-innovations. For the 2015 and 2021 standards, a technology would be considered novel if it had not exceeded a market penetration of 3% in 2009. There is, however, no mechanism in place to ensure that technologies are innovative. Once a certain technology is installed in a significant share of new vehicles, the technology is not novel anymore and CO2 savings from these accepted eco-innovations would no longer count toward OEMs' CO2 targets.

In 2021, the use of eco-innovations is expected to double in comparison to the 2018 standard, reducing overall CO2 emissions by around 3 g/km.

Finally, **manufacturer pooling** allows the consolidation of emissions across OEMs so that manufacturers with low emissions can compensate for OEMs with high emissions and therefore reduce the fines for the latter.

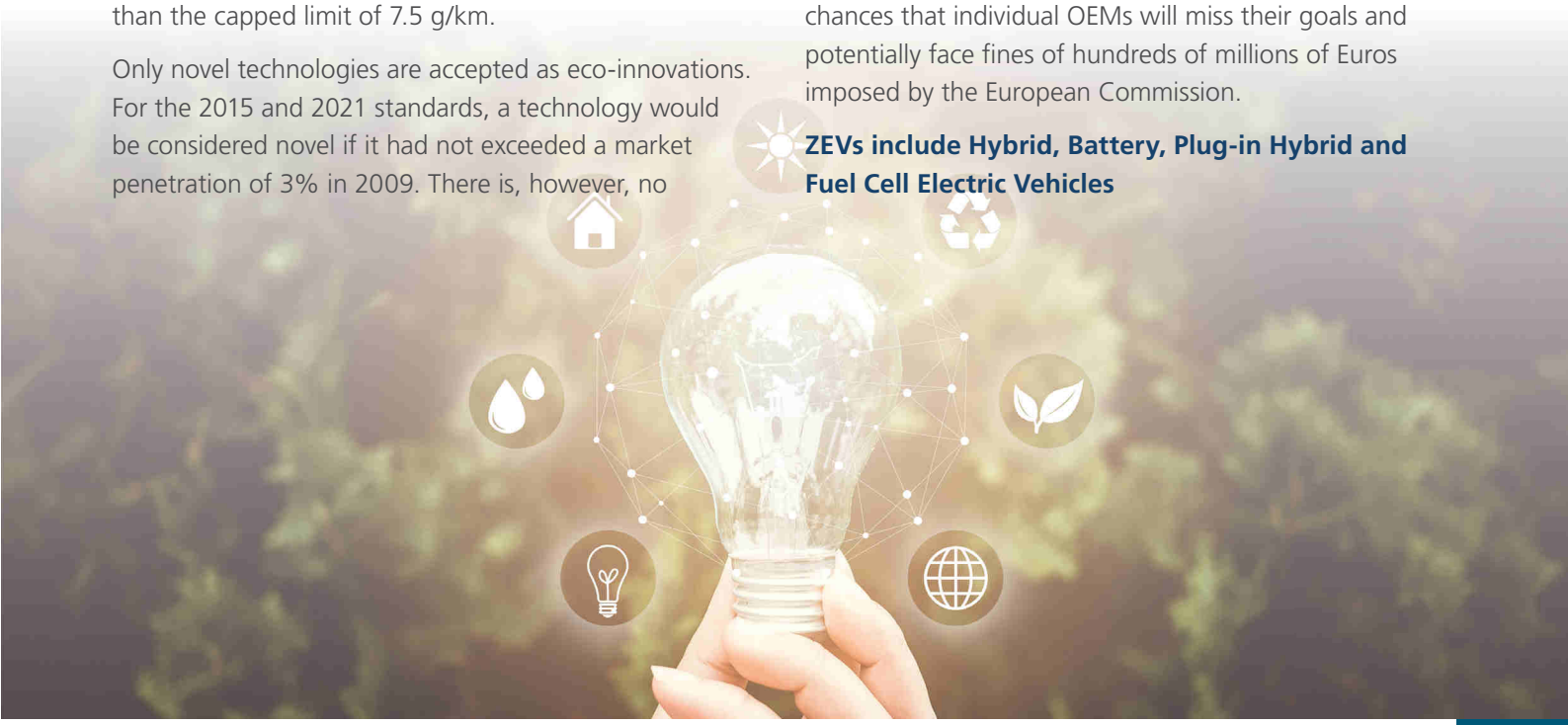
The emissions target of a pool is calculated based on the average mass of all new vehicles of the pool's members registered in the EU in a calendar year

Pooling agreements can only be shared between manufacturers of vehicles in the same segment e.g. between OEMs of passenger cars or between manufacturers of LCVs. A pool is considered to be a single manufacturer with a specific CO2 emissions target.

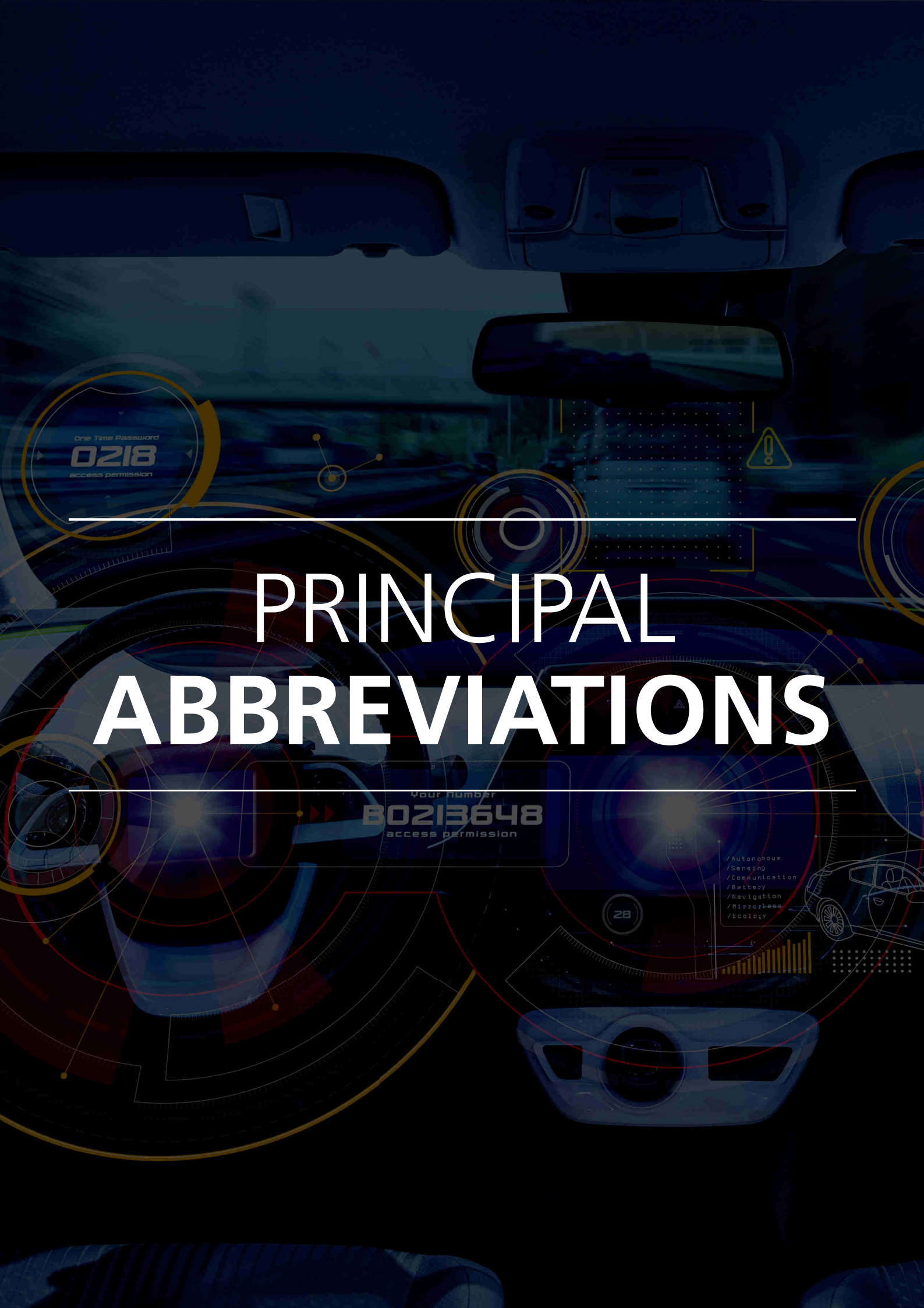
Super credits are applicable for vehicles in a pool. Pooling also allows manufacturers to manage emissions compliance with the lowest-cost approach.

Tough targets in the EU force OEMs to invest in expensive electrification technologies but there remain nonetheless chances that individual OEMs will miss their goals and potentially face fines of hundreds of millions of Euros imposed by the European Commission.

**ZEVs include Hybrid, Battery, Plug-in Hybrid and Fuel Cell Electric Vehicles**



Source: Frost & Sullivan




# PRINCIPAL ABBREVIATIONS

| | |
|---|---|
| **AC** | *Alternating Current* |
| **ADAS** | *Advanced Driver Assistance System* |
| **AI** | *Artificial Intelligence* |
| **APAC** | *Asia Pacific* |
| **AR** | *Augmented Reality* |
| **B** | *Billion* |
| **BEV** | *Battery Electric Vehicle* |
| **CaaS** | *Cars-as-a-Service* |
| **CAPEX** | *Capital Expenditure* |
| **CASE** | *Connected, Autonomous, Shared, Electric* |
| **CLaaS** | *Connected Living-as-a-Service* |
| **DC** | *Direct Current* |
| **ECU** | *Engine Control Unit* |
| **EOL** | *End Of Life* |
| **ETA** | *Estimated Times of Arrival* |
| **EU** | *European Union* |
| **EV** | *Electric Vehicle* |
| **FCEV** | *Fuel Cell Electric Vehicle* |
| **FNOL** | *First Notice of Loss* |
| **GWh** | *Gigawatt hour* |
| **H2** | *Hydrogen* |
| **HD** | *High Definition* |
| **HMI** | *Human Machine Interface* |
| **HP** | *Horsepower* |
| **HUD** | *Head-up Display* |
| **ICE** | *Internal Combustion Engine* |
| **IoT** | *Internet of Things* |
| **JV** | *Joint Venture* |
| **Kg** | *Kilogramme* |
| **Km** | *Kilometre* |
| **Kmpl** | *Kilometres per litre* |
| **kW** | *Kilowatt* |
| **LCV** | *Light Commercial Vehicle* |
| **LIB** | *Lithium-ion Battery* |
| **Li-ion** | *Lithium-ion* |

| | |
|---|---|
| **M** | *Million* |
| **MaaS** | *Mobility-as-a-Service* |
| **MAAS** | *Maritime Autonomous Surface Ship* |
| **MEA** | *Membrane Electrode Assembly* |
| **MNO** | *Mobile Network Operator* |
| **Mpg** | *Miles per gallon* |
| **MR** | *Mixed Reality* |
| **Nm** | *Newton metre* |
| **NVH** | *Noise, Vibration and Harshness* |
| **O&G** | *Oil and Gas* |
| **OBC** | *On-board Charger* |
| **OEM** | *Original Equipment Manufacturer* |
| **OPEX** | *Operating Expenditure* |
| **OS** | *Operating System* |
| **OTA** | *Over-The-Air* |
| **PHEV** | *Plug-in Hybrid Electric Vehicle* |
| **PM** | *Particulate Matter* |
| **PS** | *Pferdestärke (Horsepower)* |
| **RDE** | *Real Driving Emission* |
| **SCR** | *Selective Catalytic Reduction* |
| **SIEM** | *Security Information and Event Management* |
| **SSB** | *Solid-state Battery* |
| **TSP** | *Telematics Service Provider* |
| **UAV** | *Unmanned Aerial Vehicle* |
| **UBI** | *Usage Based Insurance* |
| **UGV** | *Unmanned Ground Vehicle* |
| **UK** | *United Kingdom* |
| **US** | *United States* |
| **UX** | *User Experience* |
| **V2X** | *Vehicle To Everything* |
| **VR** | *Virtual Reality* |
| **VSOC** | *Vehicle Security Operations Centre* |
| **WLTP** | *Worldwide Harmonised Light Vehicles Test* |
| **ZEV** | *Zero Emission Vehicles* |
| **ZLEV** | *Zero Level Emission Vehicle* |

Source: Frost & Sullivan

## ABOUT INTESA SANPAOLO INNOVATION CENTER:

Intesa Sanpaolo Innovation Center is the company of Intesa Sanpaolo Group dedicated to innovation: it explores and learns new business and research models and acts as a stimulus and engine for the new economy in Italy. The company invests in applied research projects and high potential start-ups, to foster the competitiveness of the Group and its customers and accelerate the development of the circular economy in Italy.

Based in the Turin skyscraper designed by Renzo Piano, with its national and international network of hubs and laboratories, the Innovation Center is an enabler of relations with other stakeholders of the innovation ecosystem - such as tech companies, start-ups, incubators, research centres and universities - and a promoter of new forms of entrepreneurship in accessing venture capital. Intesa Sanpaolo Innovation Center focuses mainly on circular economy, development of the most promising start-ups, venture capital investments of the management company Neva SGR and applied research

For further detail on Intesa Sanpaolo Innovation Center products and services, please contact businessdevelopment@intesasanpaoloinnovationcenter.com

## ABOUT FROST & SULLIVAN:

For over five decades, Frost & Sullivan has become world-renowned for its role in helping investors, corporate leaders and governments navigate economic changes and identify disruptive technologies, Mega Trends, new business models and companies to action, resulting in a continuous flow of growth opportunities to drive future success.

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