Powertrain & Exhaust Aftertreatment Scenario

ECMA 2018

25-26 October 2018

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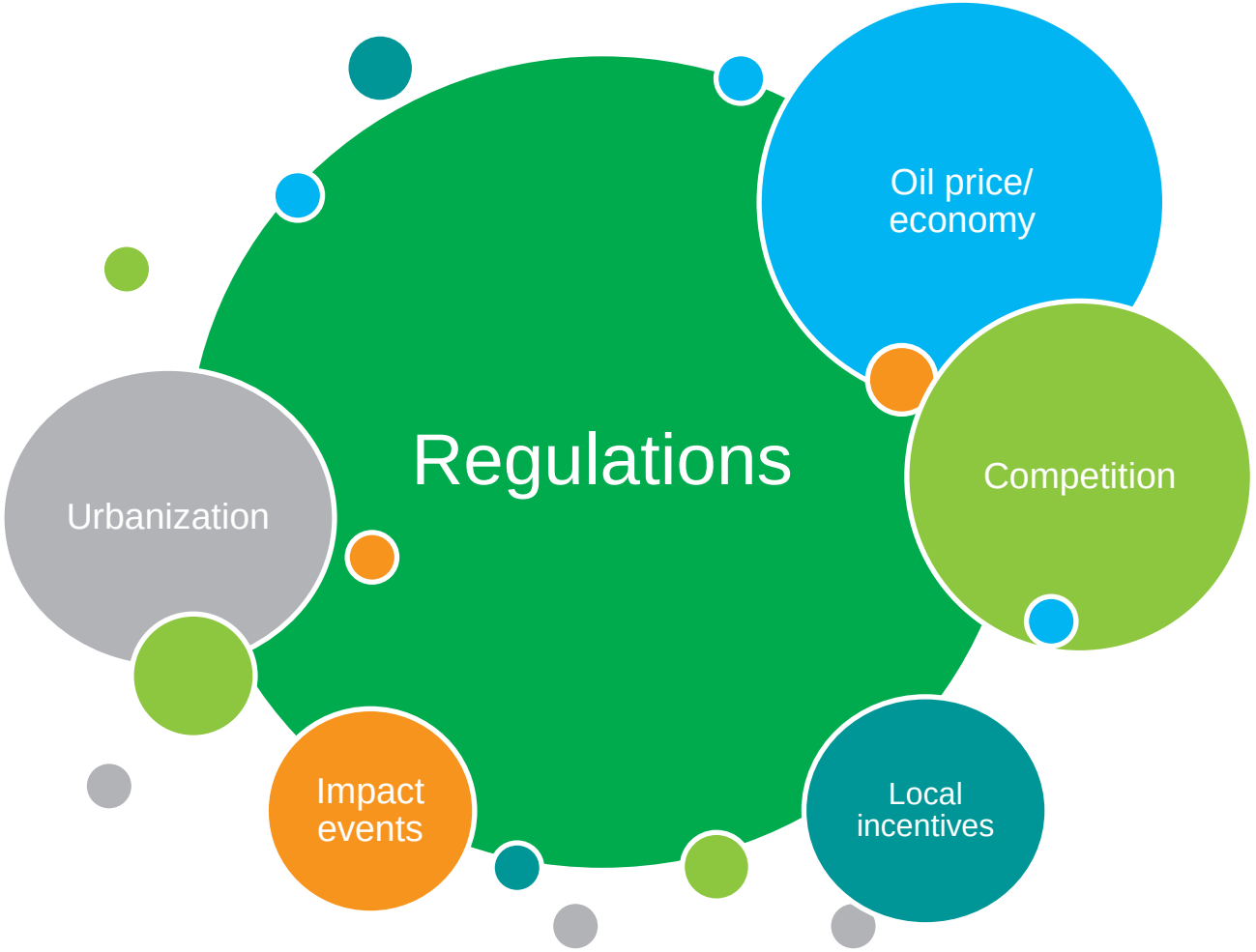
Market drivers for powertrain production



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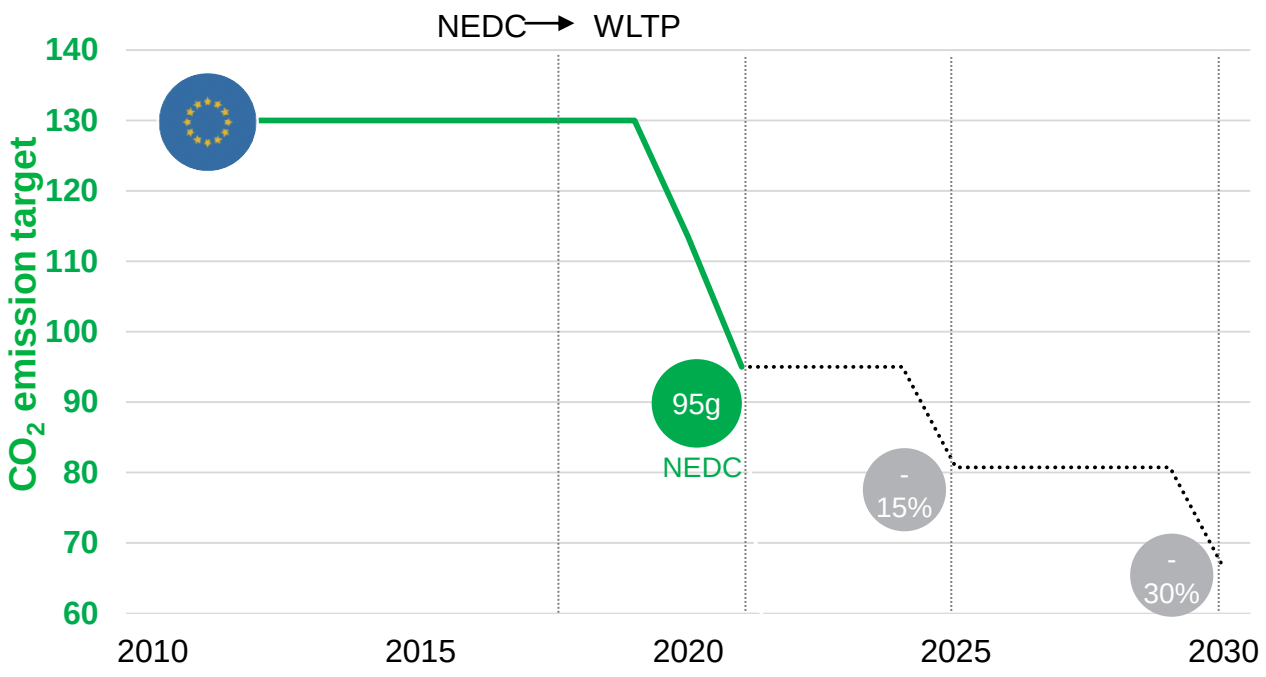
European CO_2 regulation beyond 2020

Regulations

Evolution of CO_2 emission targets for new registrations



Notes: Post-2021 CO_2 emission targets with no more absolute values given the New European Driving Cycle (NEDC) to WLTP switch

Source: IHS Markit

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The Worldwide Harmonized Light Vehicle Test Procedure (WLTP) CO_2 emissions shall be monitored for all new registered vehicles beginning on 1 January 2018

For each manufacturer, the average-specific emissions based on WLTP CO_2 values shall be determined starting on 1 January 2018

Beginning on 1 January 2021, those average-specific emissions shall be used to determine the manufacturer's compliance with its specific emission target

Target CO_2 emission reduction of 15% by 2025 and 30% by 2030 for passenger vehicles and vans

Manufacturers achieving a 15% share of zero- and low-emission vehicles (FCEV, BEV, PHEV, REEV) by 2025 will receive an easier CO_2 target for the rest of their fleet. This share will be raised to 30% by 2030. Zero-emission vehicles will count more than low-emission vehicles.

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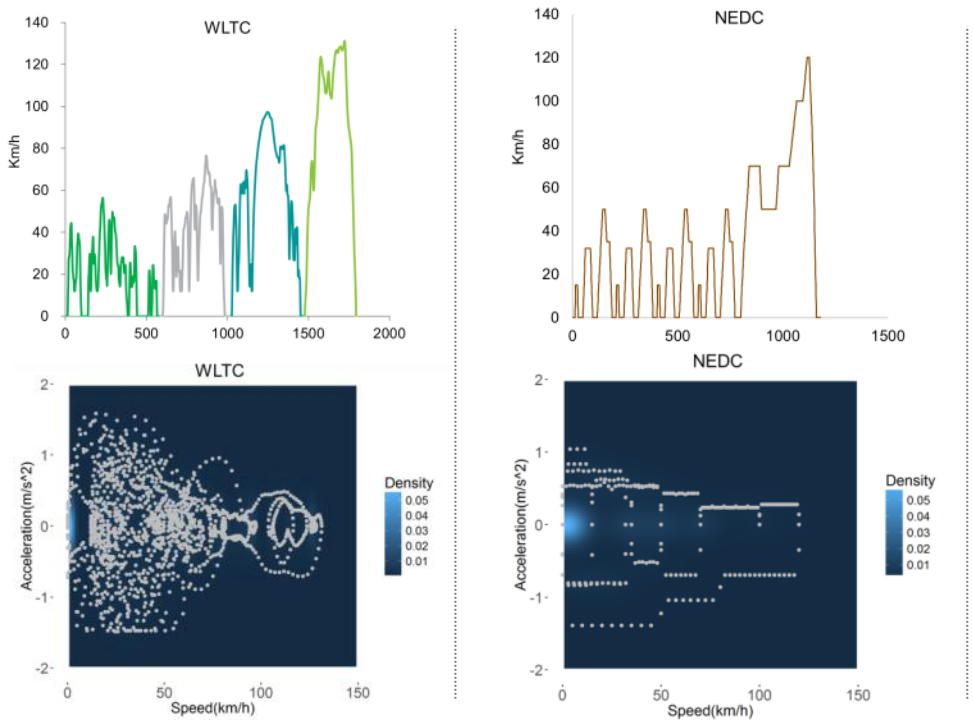
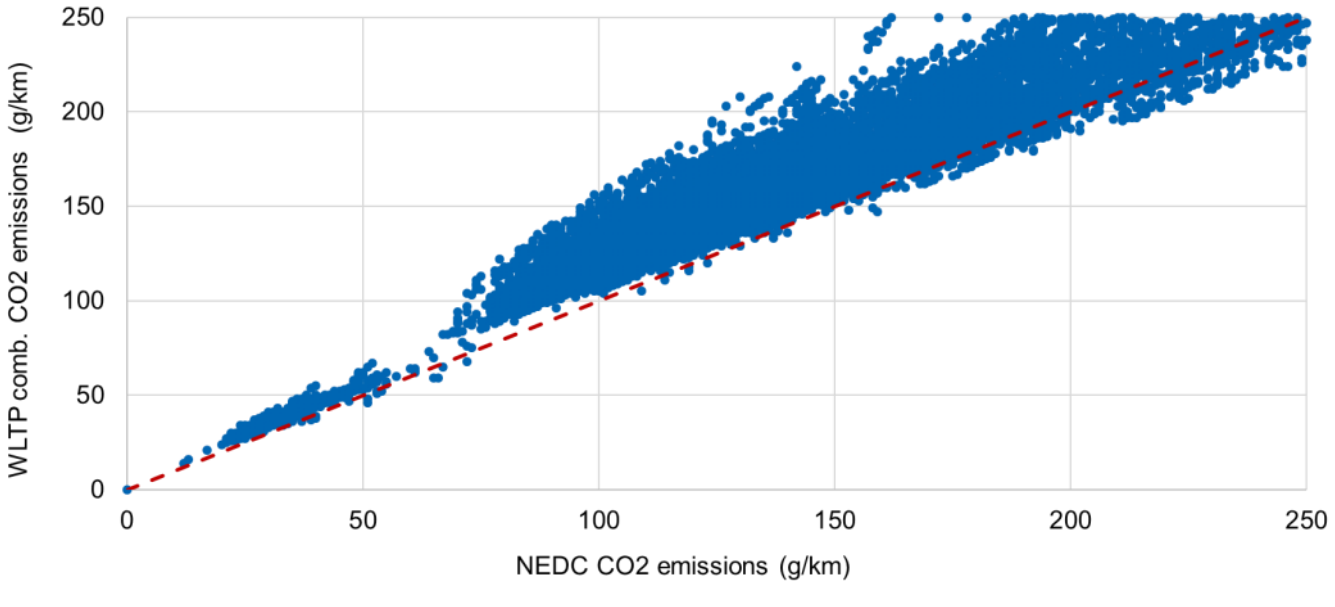
European homologation test cycle evolution

Regulations

Impacts of the transition from NEDC to WLTC on the CO_2 road to target





Notes: Road load comparison between NEDC and WLTP – Source IHS Markit

Source: IHS Markit VPaC EU

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Simulation result comparison shows an estimated 20% average gap between WLTP CO_2 and current NEDC CO_2
This will certainly make the OEMs' path to compliancy even harder

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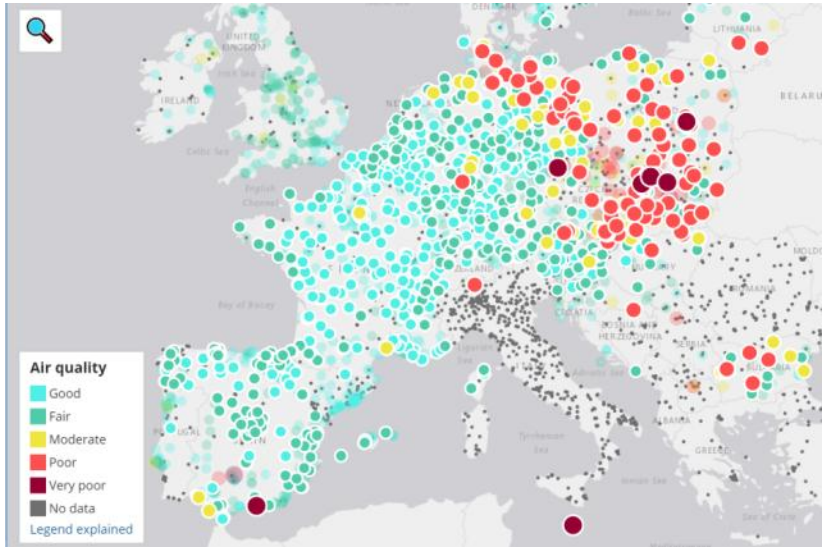
Emissions monitoring and real driving emissions (RDE) introduction

How does the wish to fill the gap between certification and reality impact OEMs?

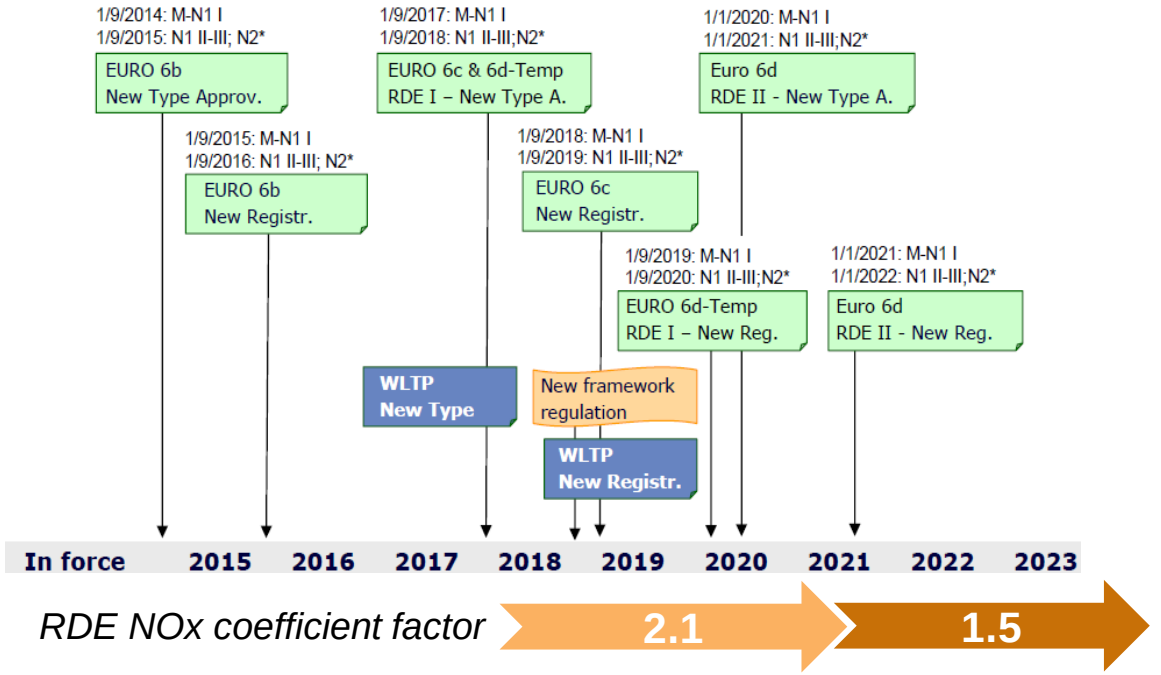
Regulations

Overview of the requirements for exhaust emissions in Europe



Air quality measurements from ***European Air Quality Index***

Source: European Environment Agency, http://airindex.eea.europa.eu/



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Growing concerns toward cities' air quality and local pollution matters have driven new European policies. This includes Particulate Numbers (PN) and Nitrogen Oxides (NOx) real-time monitoring through the RDE test cycle. Despite making exhaust emissions much cleaner, this framework will highly weaken diesel in Europe.

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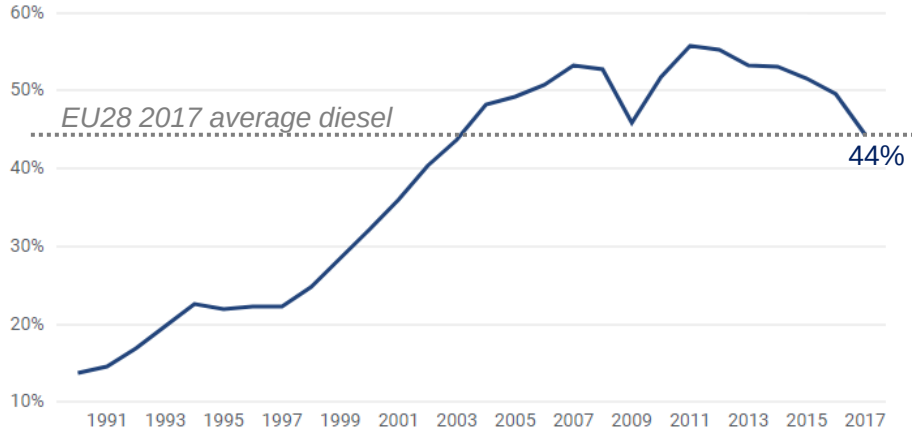
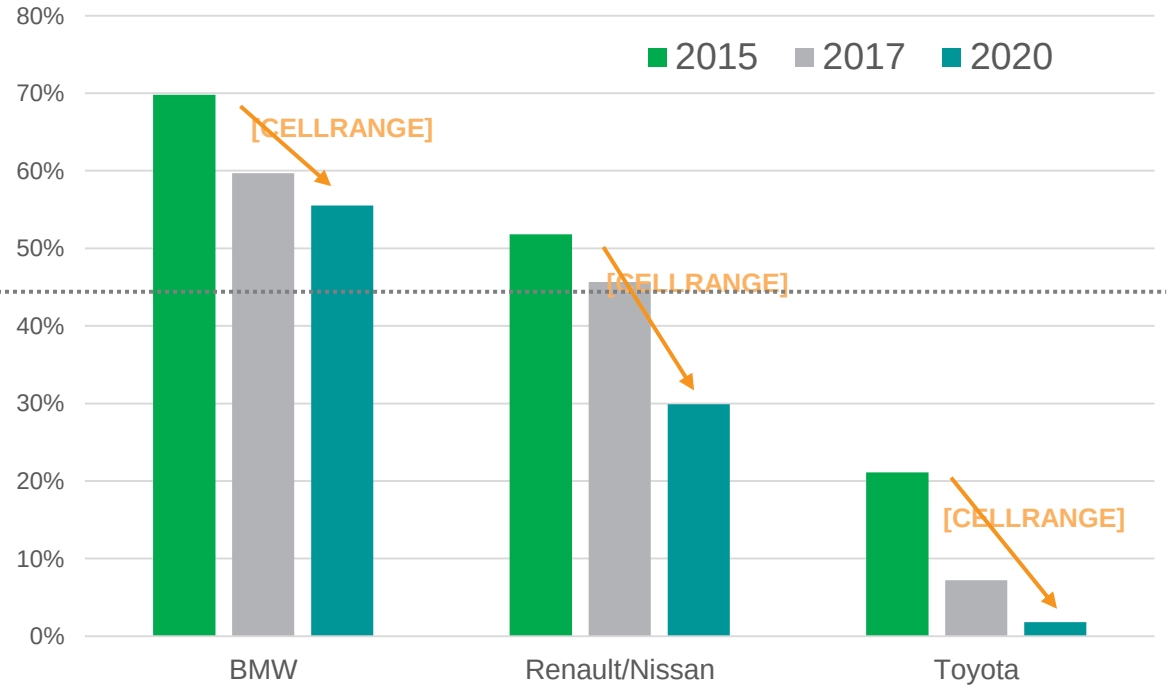
Consequence of fast-moving markets: Dramatic fall of diesel shares

Impact Events

EU28 (PV only) diesel sale shares actuals in post diesel-gate era



Source : Data ACEA 1990–2017 Diesel Sales share



Source: IHS Markit VPaC 2018H1 (preliminary)

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Quantification of the diesel demand fall by OEM shows fragmented landscapes, but an undeniable trend. The 2017 EU sales actual decrease clearly highlights the irreversible consumer perception turnaround.

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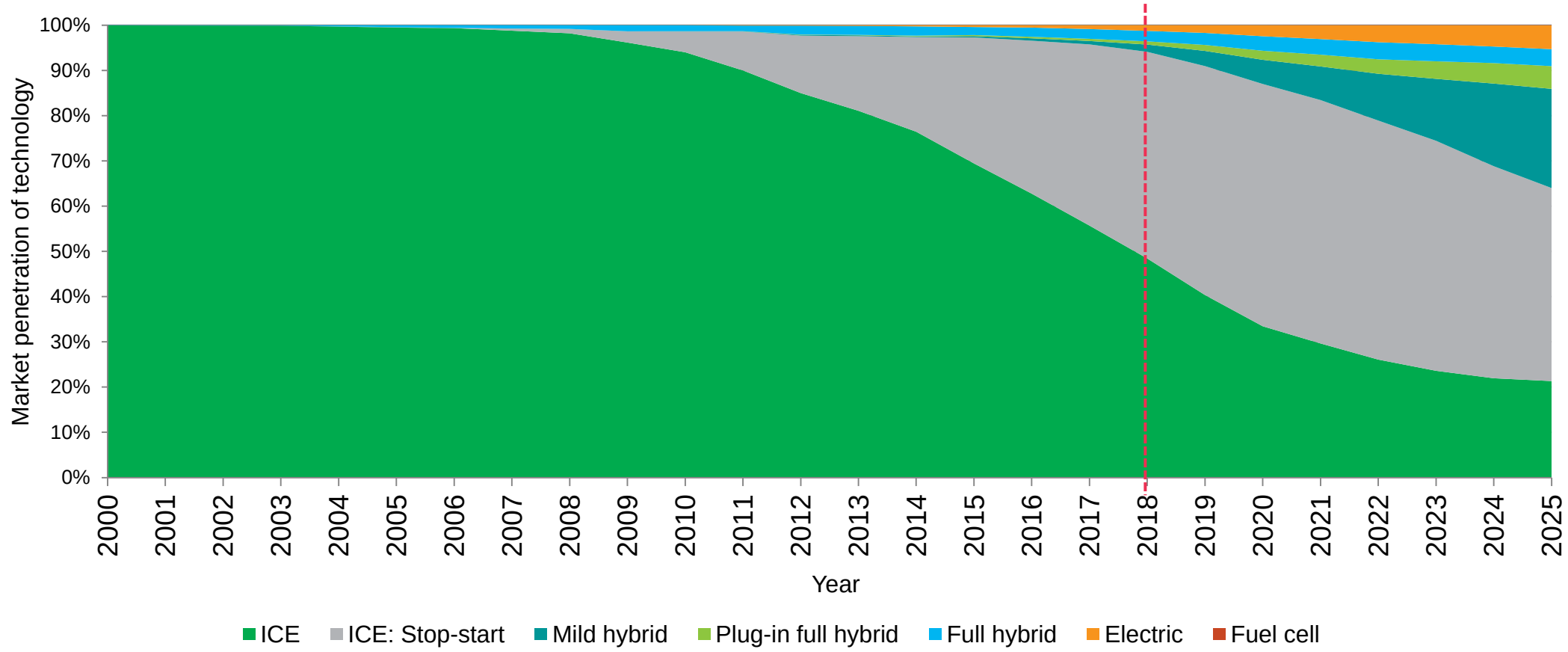
Industry landscape

Change is on the way

Global powertrain production forecast to 2025 (including LCVs)



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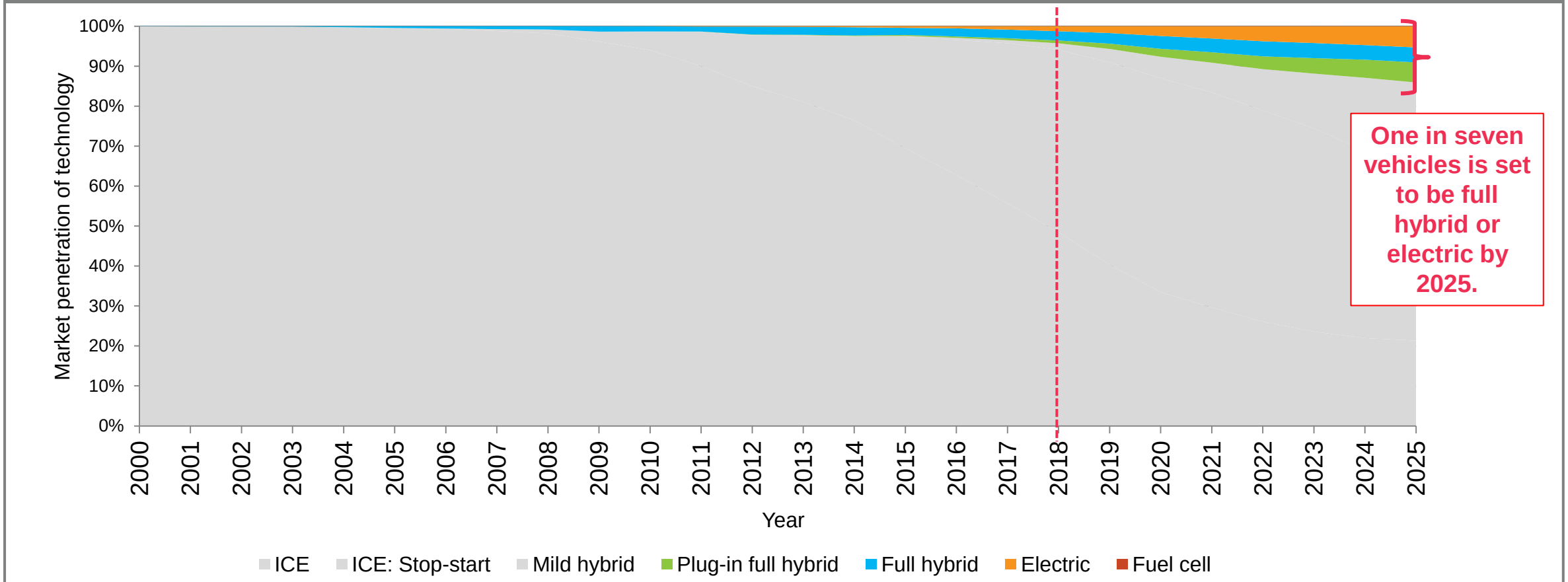
Industry landscape

Lots of interest and hype surrounding the “one in seven”

Global powertrain production forecast to 2025 (including LCVs)



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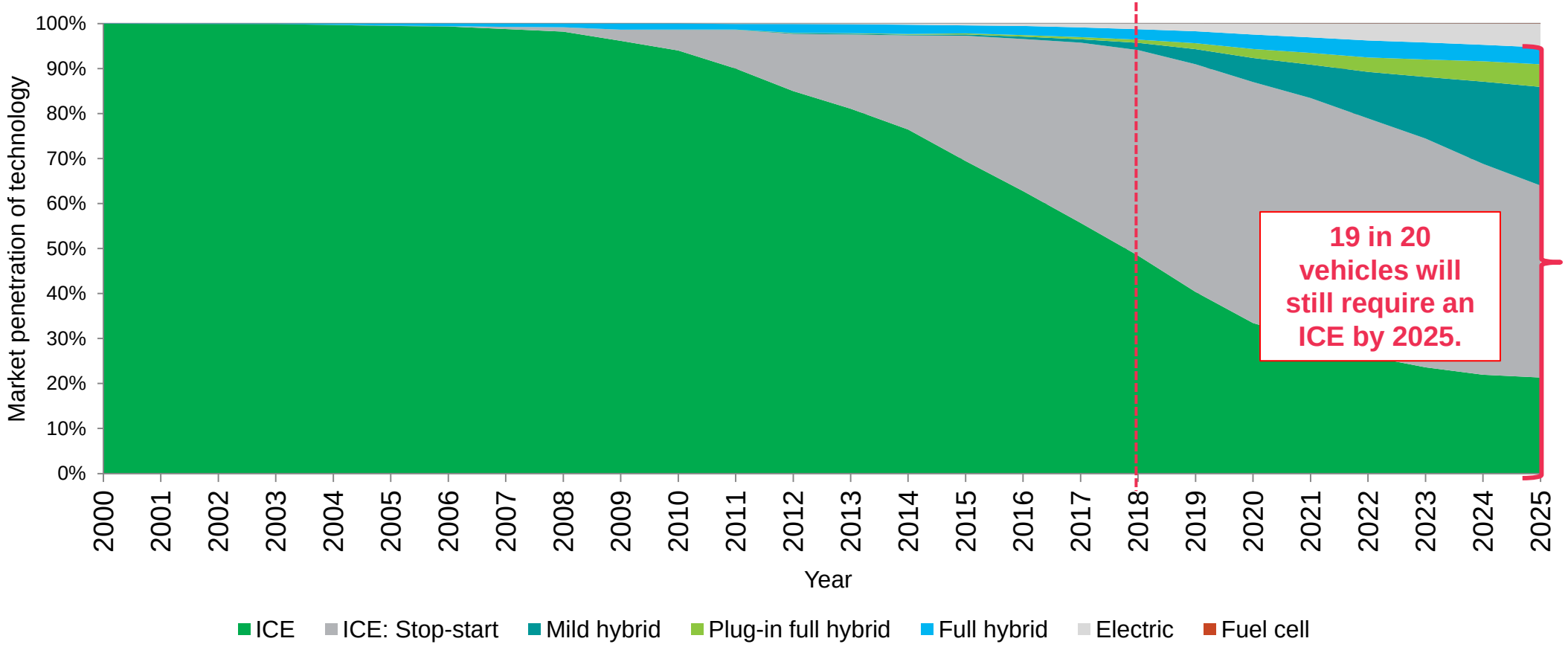
Industry landscape

In the grand scheme of things, healthy powertrain demand exists

Global powertrain production forecast to 2025 (including LCVs)



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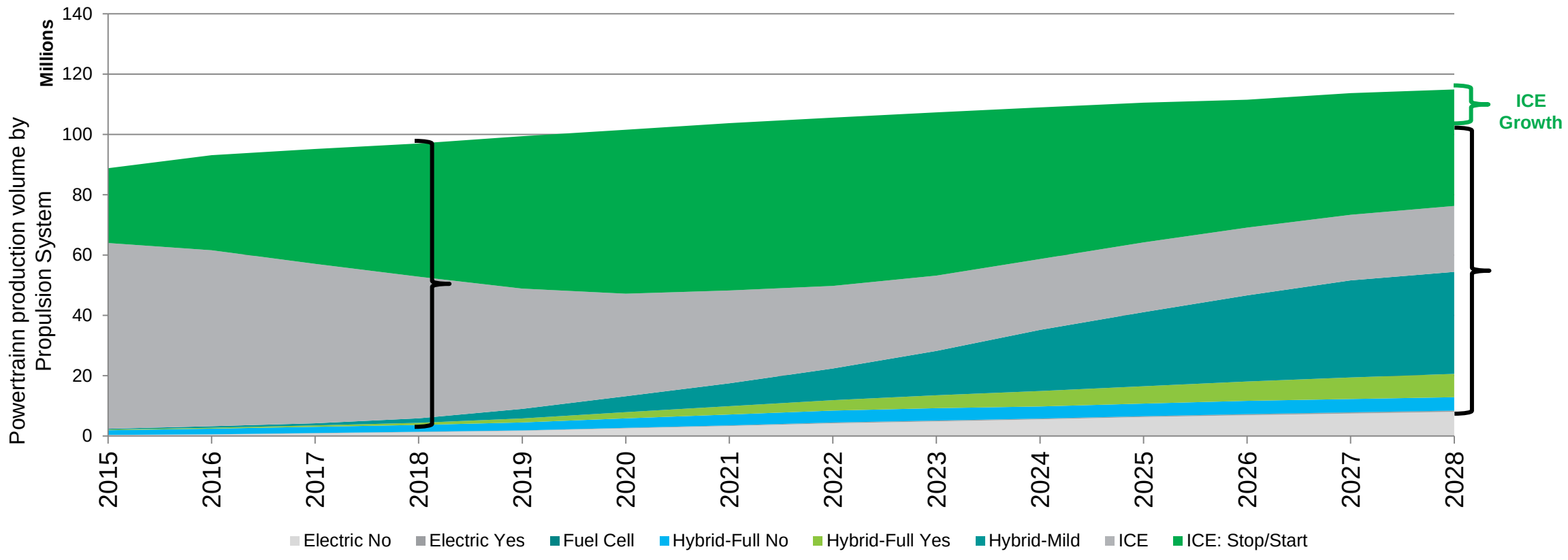
Industry landscape

Demand still growing for (some form of) internal combustion engine

Global powertrain production forecast 2015-2028 (including LCVs) – Total Volume



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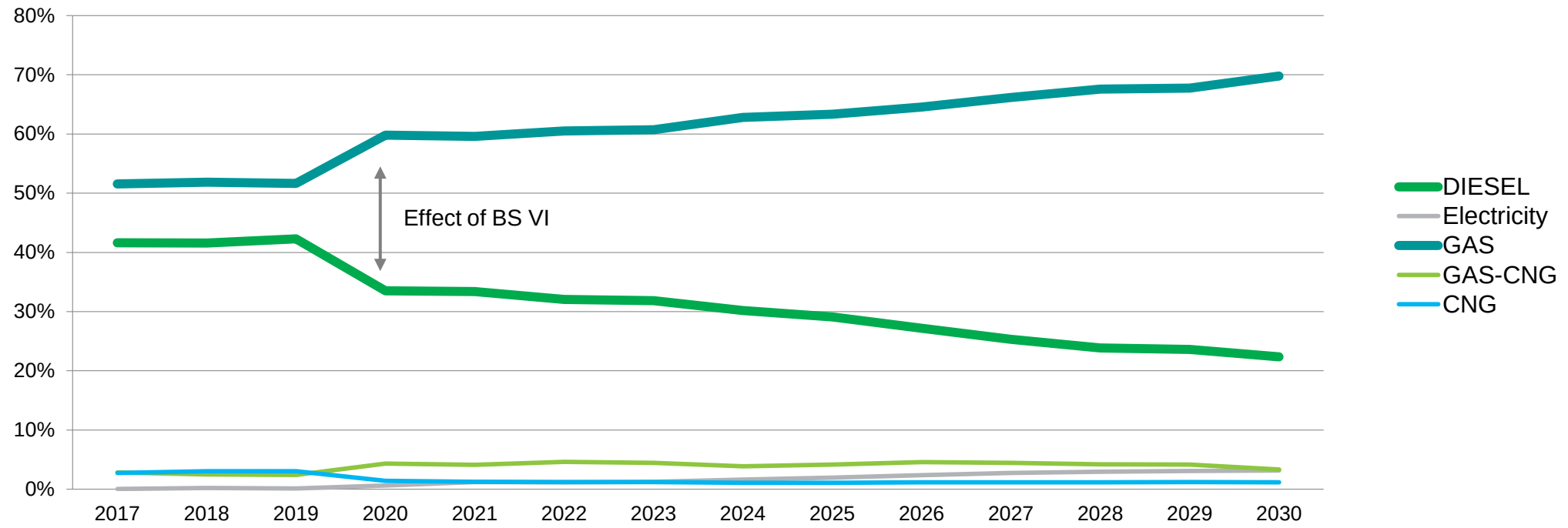
Indian powertrain production forecast

The irreversible retreat of the diesel fuel-based engines

Indian Market penetration by fuel-type, 2017-30



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BS VI regulation highlights the 10 ppm limit on sulfur content of gasoline and diesel fuels. High cost of engine aftertreatment control technologies required for BS VI diesel engines will find market preference shifting towards gasoline engines, along with rising interest in powertrains driven by CNG and Electricity.

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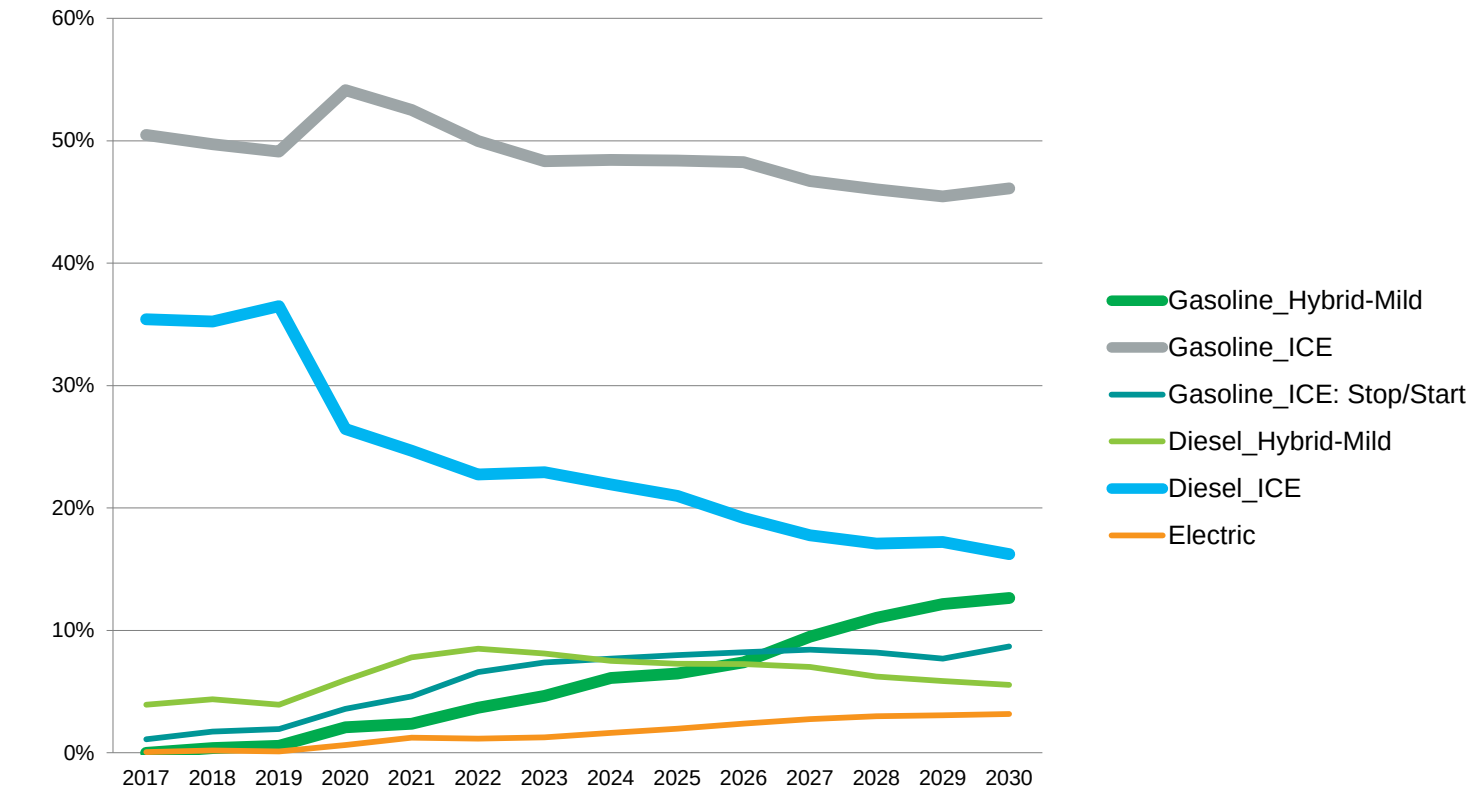
Indian powertrain production forecast

Gasoline market to dominate diesel from 2021

Indian market penetration by propulsion design, 2017-2030



Source: IHS Markit

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- Gasoline Mild-hybrid will find popularity in the Indian market from 2021, replacing ICE engine options under Diesel and Gasoline
- Diesel decline to begin from 2020, impacted by BS VI introduction
- Diesels will have 20% market share by the end of the next decade
- The EV market is expected to capture 3% of market share by 2030

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Regulatory summary

Tightening, increasingly harmonized regulation

- Until regulations potentially align around 2025, differences will exist in major markets.
- Other markets are typically deploying European regulations, but with lower standards.
- Cost synergies will dictate OEMs' strategy.

IHS Markit component forecasting horizon

Unknown, but likely to come forward

Summary of major international emissions standards, 2015–16

Country/ region	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	Euro 6b		Euro 6d-TEMP/WLTC+RDE					Euro 6d				Euro 7/ Tier 4/LEV IV/ China 7/ Proconve L8?
	Tier 2		Tier 3/LEV III									
	LEV III											
	JC08				WLTP							
	China 4/China 5					China 6						
	KLEV II		KLEV III/Euro 6b									
	Bharat IV					Bharat VI						
	Proconve L6					Proconve L7						

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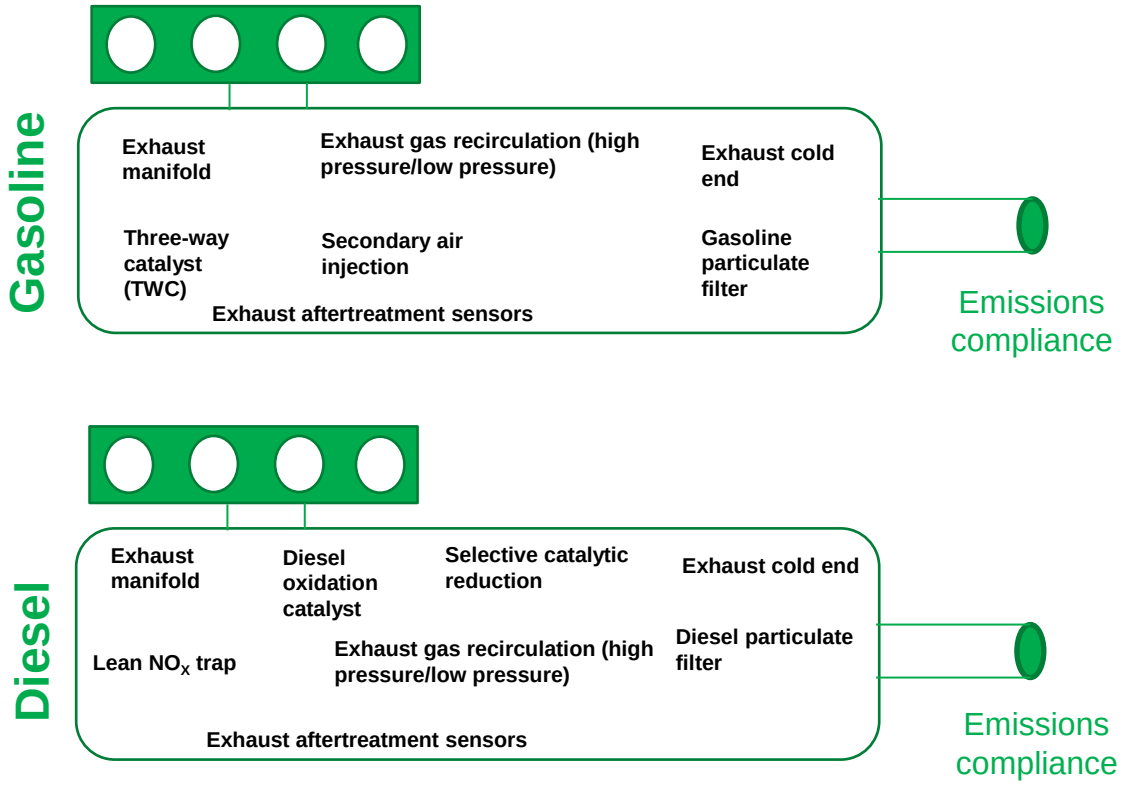
Implications for exhaust aftertreatment

OEMs will deploy a selection of the following technologies



Source: Shutterstock

The supply chain provides a variety of technical solutions for myriad engine technologies to help OEMs meet emissions standards in different markets around the world.

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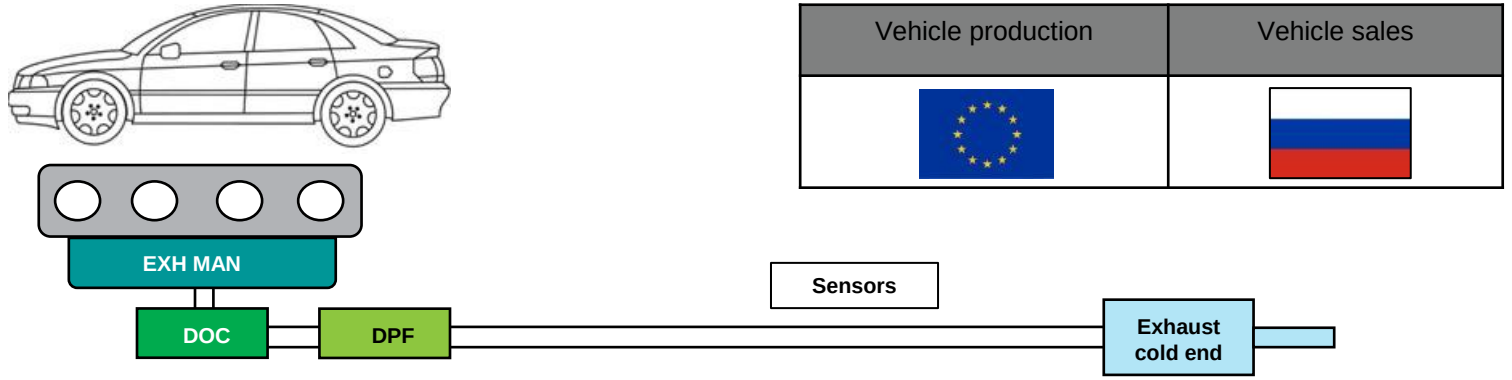
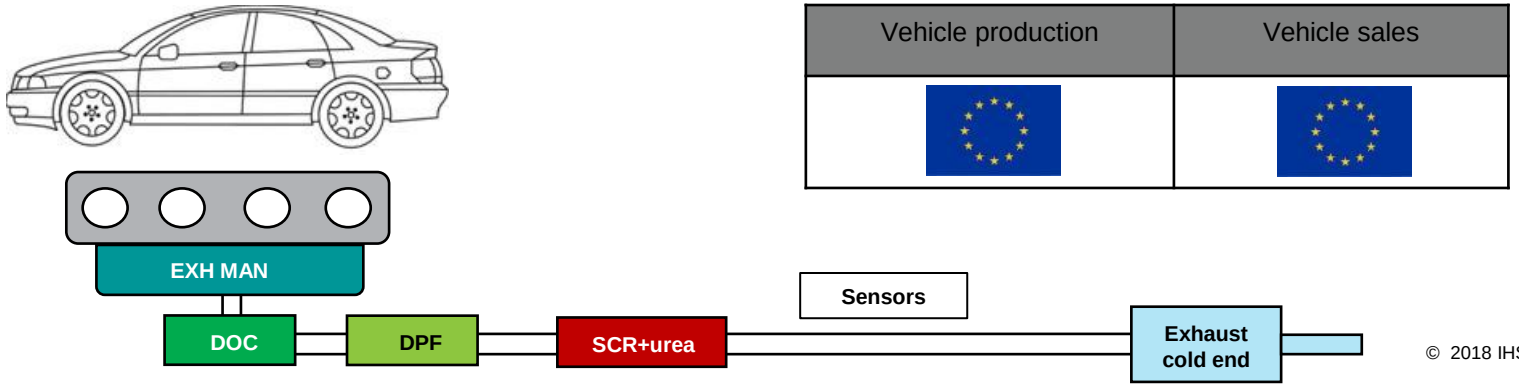
Implications for exhaust aftertreatment

Different component configurations heading to different destinations

Vehicle A, OEM A, diesel, Euro 5–compliant



Vehicle A, OEM A, diesel, Euro 6–compliant



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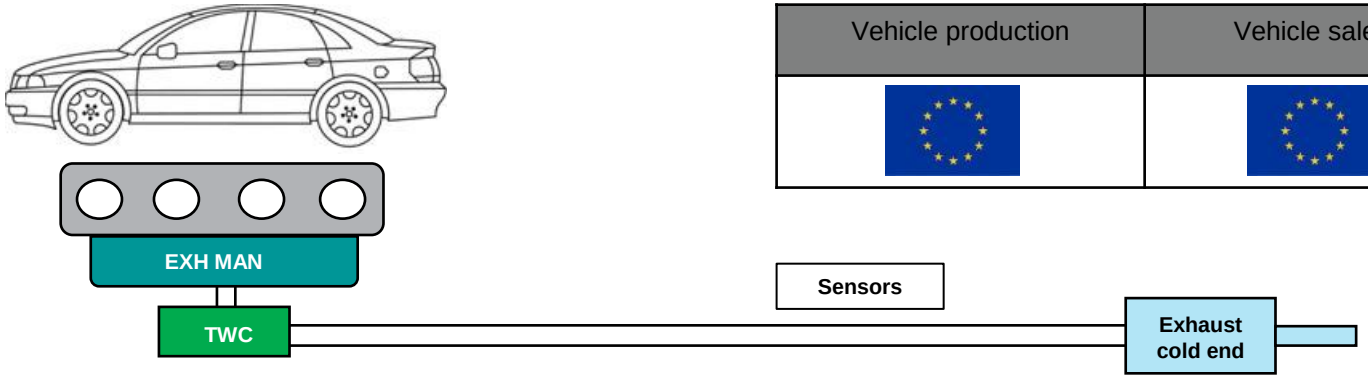
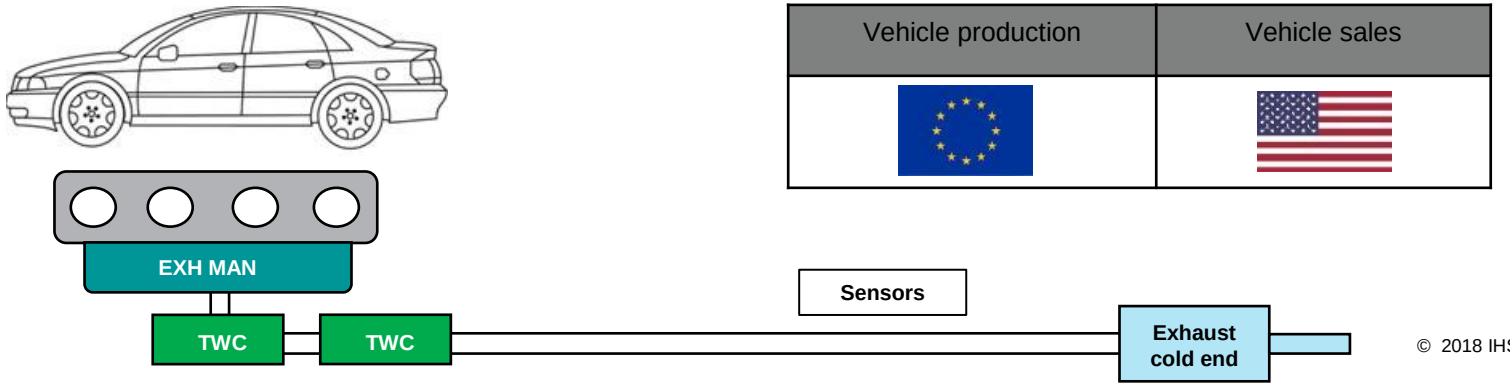
Implications for exhaust aftertreatment

Different component configurations heading to different destinations

Vehicle B, OEM B, gasoline, Euro 6–compliant



Vehicle B, OEM B, gasoline, SULEV/LEV III–compliant



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Focus: exhaust manifold

Factors influencing forecast

- Key Developments
  - Material change
  - Cylinder head integration
  - Combination with Catalytic Converter: ‘Maniverter’
- Key requirements driving development:
  - Weight Saving
  - Thermal retention properties
  - Turbocharger response time
  - Package Space

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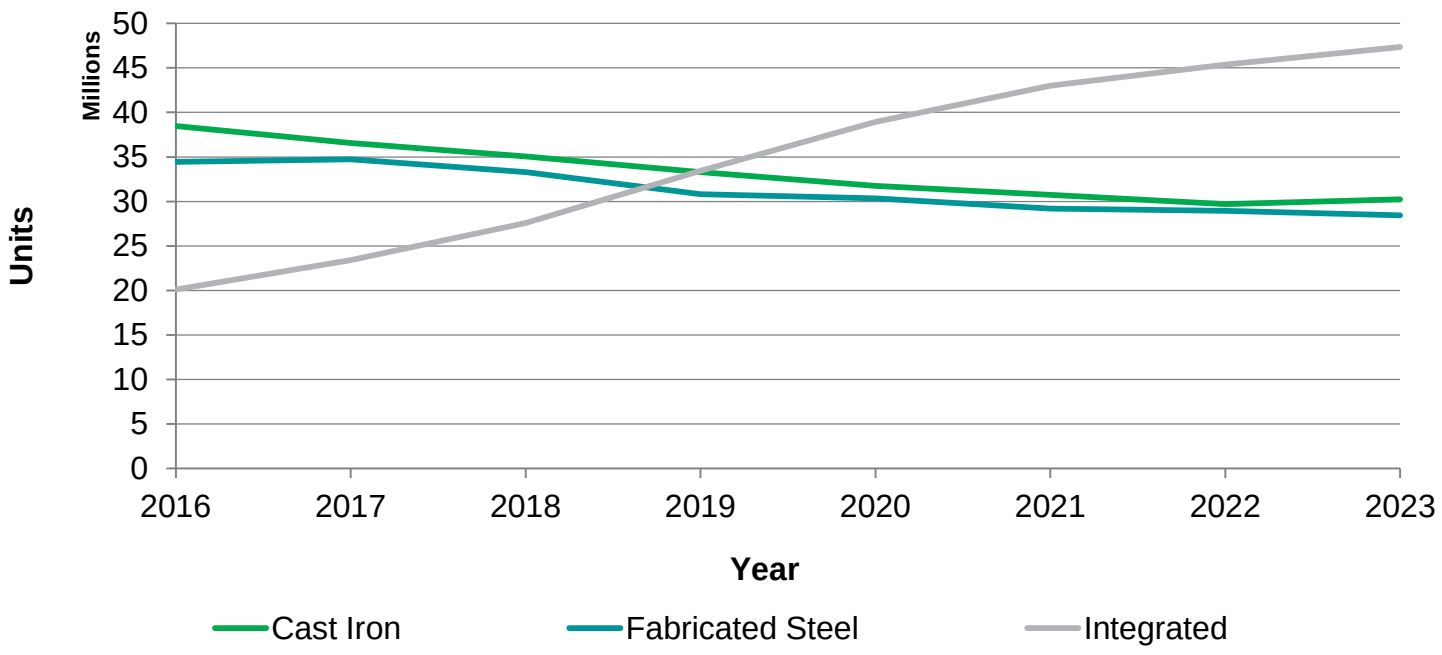
Focus: exhaust manifold

Forecast findings

Global Demand – Exhaust Manifold



Note: Integrated Exhaust Manifold volume not included in IHS Markit SupplierInsight
Source: IHS Markit

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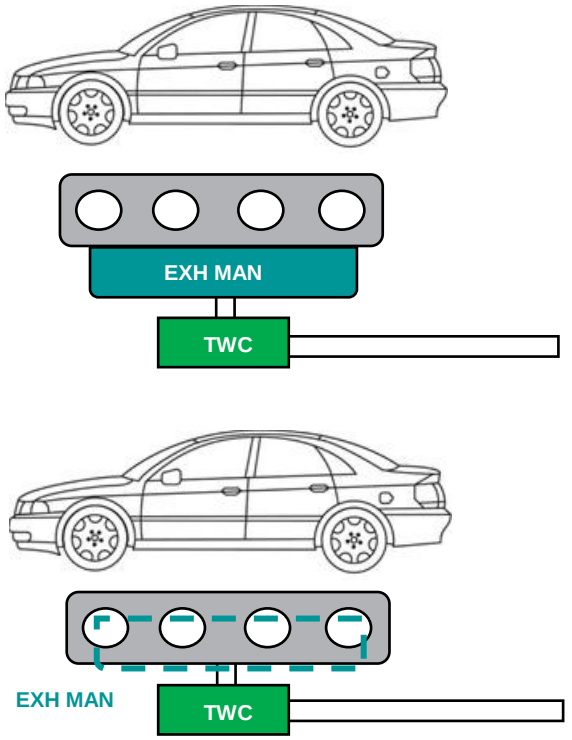

Exhaust Manifolds will increasingly be cylinder head integrated for cost, weight, thermal and packaging reasons

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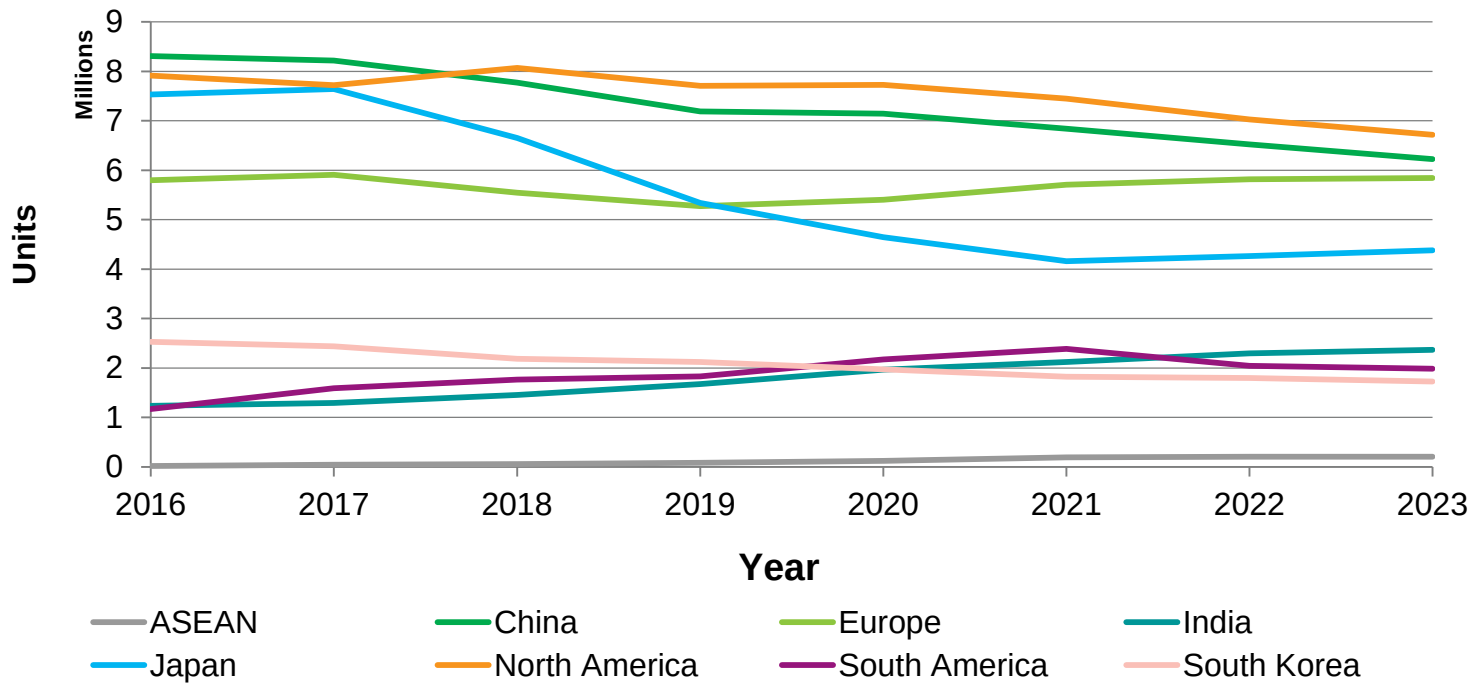
Focus: exhaust manifold

Forecast findings

Regional Demand – Fabricated Exhaust Manifold



Note: data shown relates to Engine Production Region rather than Vehicle Production Region
Source: IHS Markit

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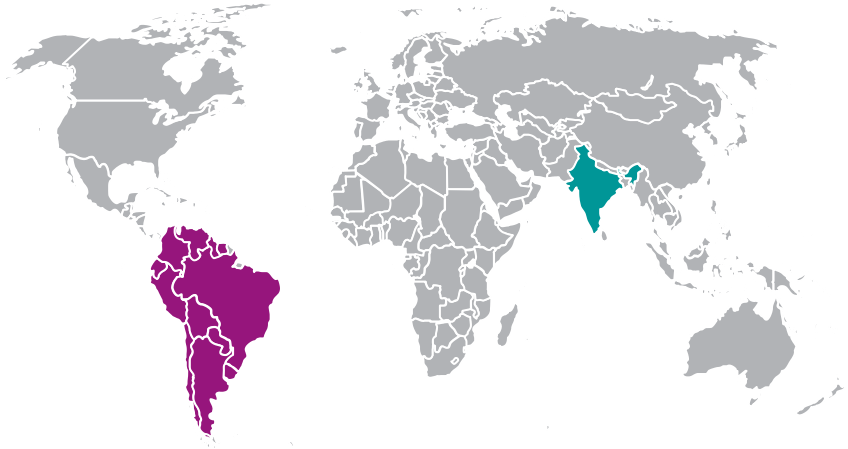
Growth regions:



Growth opportunities remain in South American and Indian powertrain markets. Progression towards manifold integration, coupled with diesel decline in (predominantly) Europe, highlights a declining market in larger, established markets

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Focus: catalytic converter

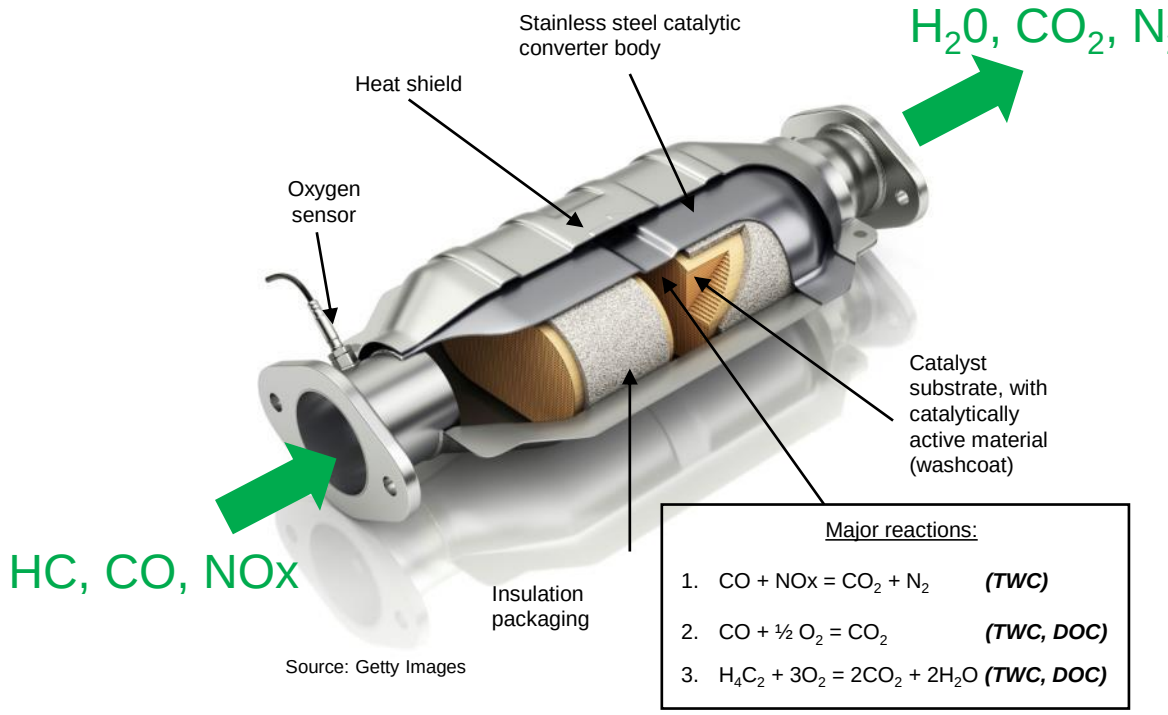
Factors influencing forecast

Key developments:

- Need for >1 per exhaust branch
- Closer coupling through move upstream (underfloor to close-coupled, close coupled to amalgamated) or manifold integration

Key requirements driving development:

- Optimised integration
- Thermal insulation and/or heating
- Particulate filter integration
- Use of >1 in series
- Vee engine designs typically more stubborn in terms of integration & approach
- Precious metal thrifting



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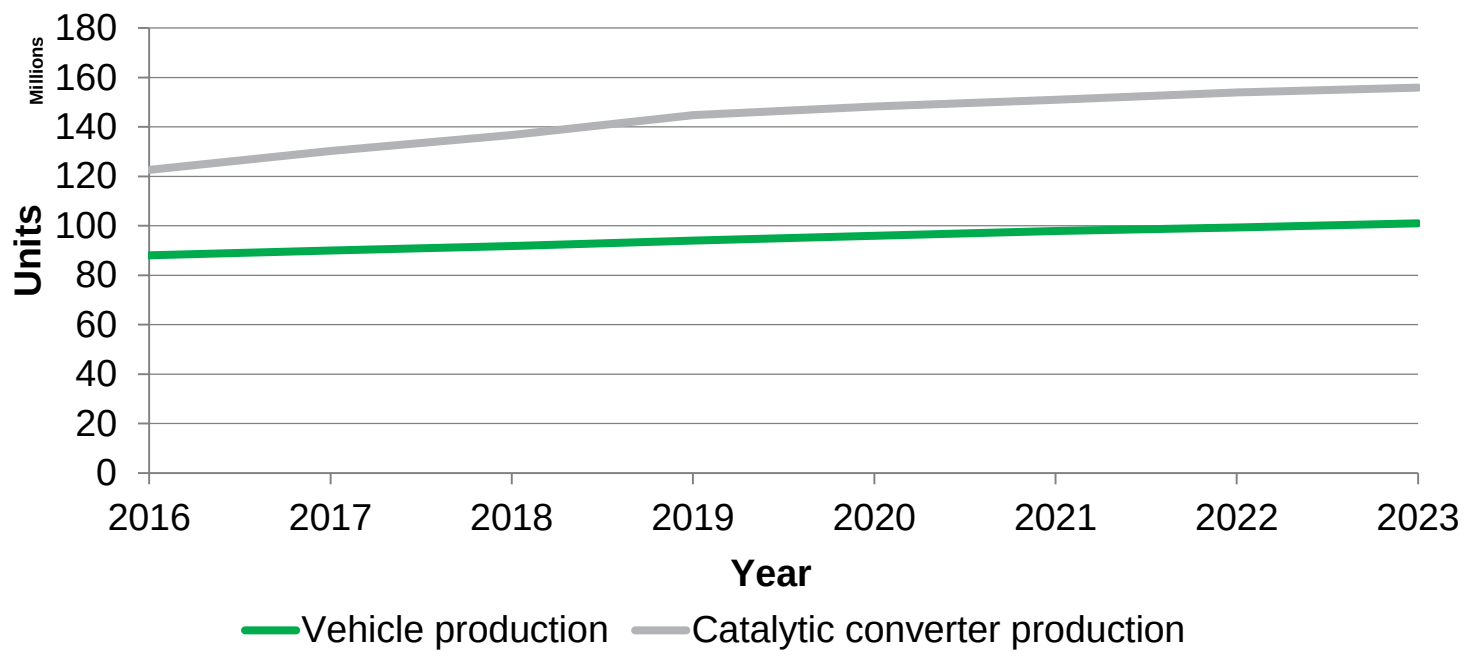
Focus: catalytic converter

Forecast findings

Catalytic converter global demand



Notes: Vehicle production volumes excludes battery electric vehicles (BEVS), Regional coverage excludes ASEAN & MENA
Source: IHS Markit
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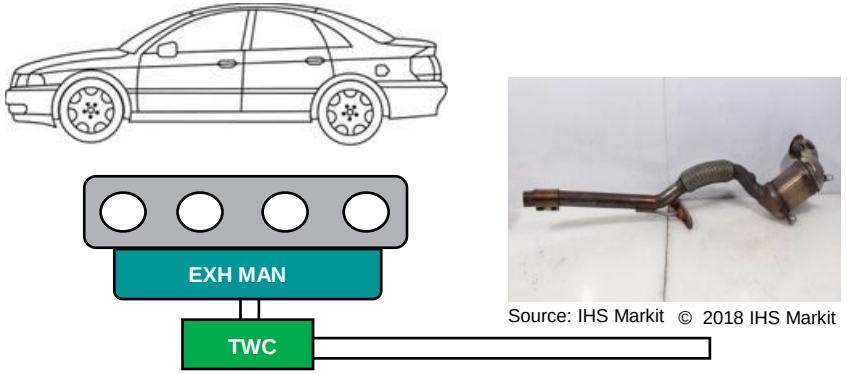

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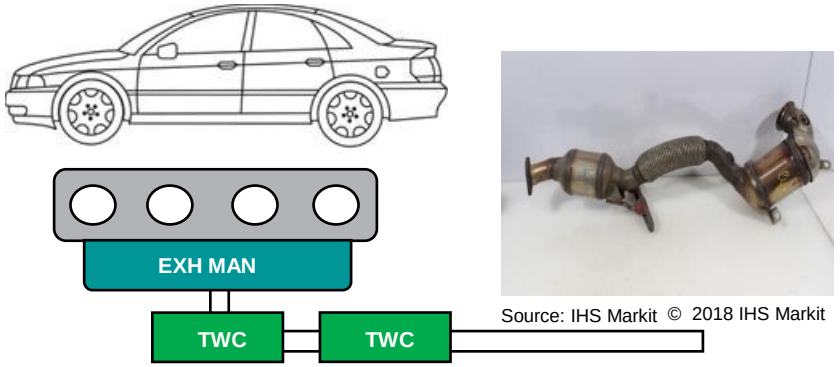

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The catalytic converter market is growing, driven by increasingly stringent legislation and in spite of downsizing.

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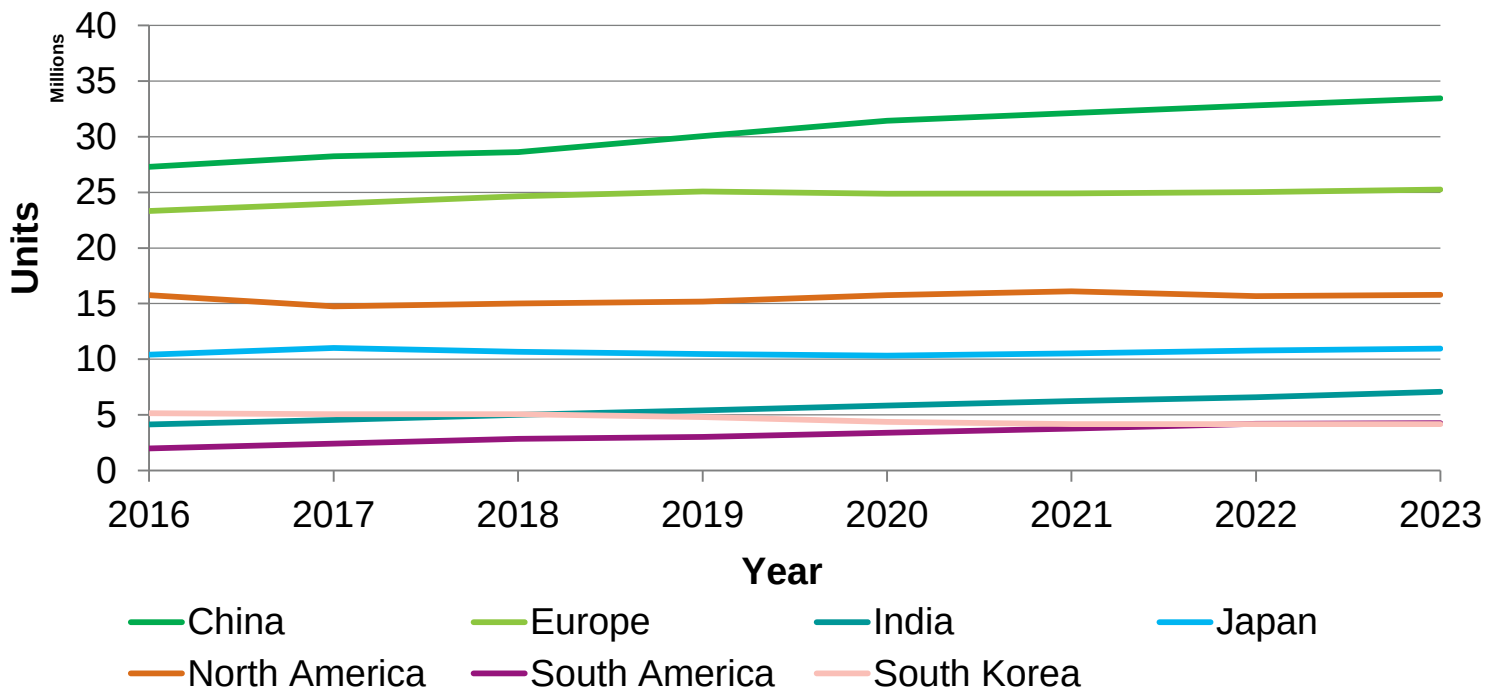
Focus: catalytic converter

Forecast findings

Catalytic converter regional demand



Note: data shown relates to Engine Production Region rather than Vehicle Production Region

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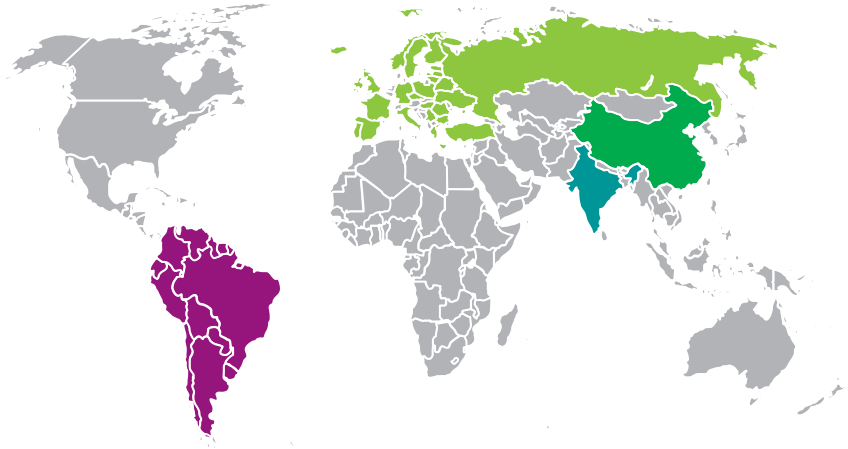
Growth regions:



Some modest growth remains in European catalytic converter volume. Notable growth regions (in order) are China, South America and India

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Focus: particulate filter

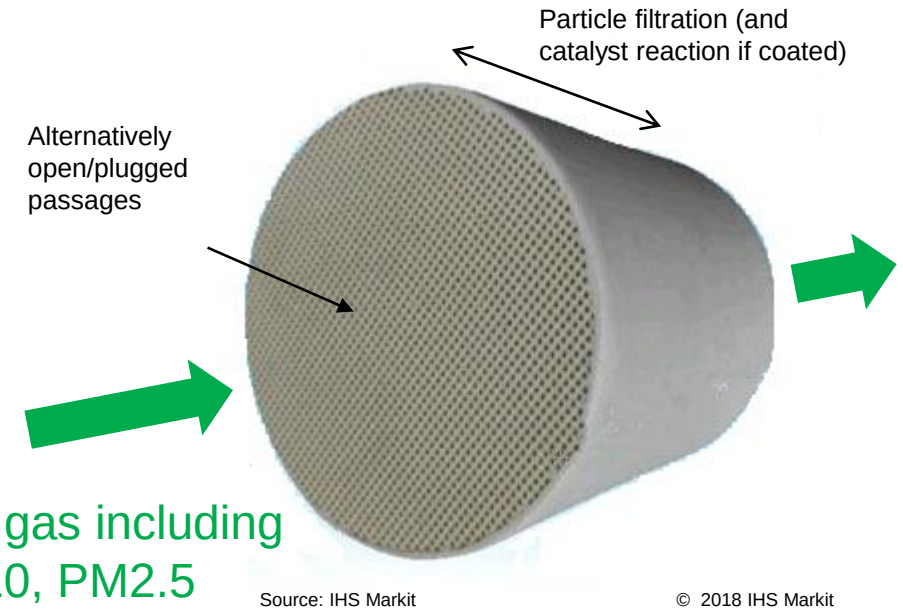
Factors influencing forecast

Key developments:

- Deployment on Gasoline DI engines
- Declining diesel demand
- Upstream positioning and improved integration
- ‘Make it fit’ for now on many gasoline applications

Key requirements driving development:

- Improvements in filtration efficiency
- Regeneration improvements (diesel applications)
- Optimization for cold start performance
- Use of catalytic washcoat
- Potential application to multipoint fuel injection – ‘cautious’ OEMs



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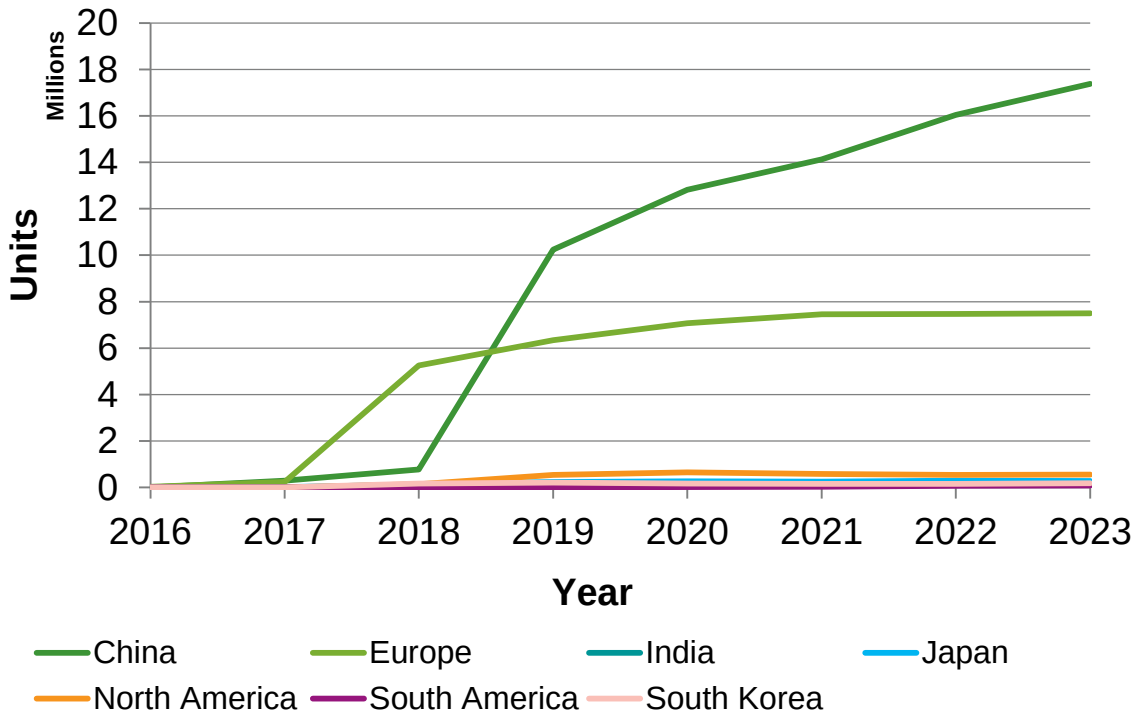
Focus: particulate filter

Forecast findings

Regional deployment of GPF



Note: data shown relates to Engine Production Region
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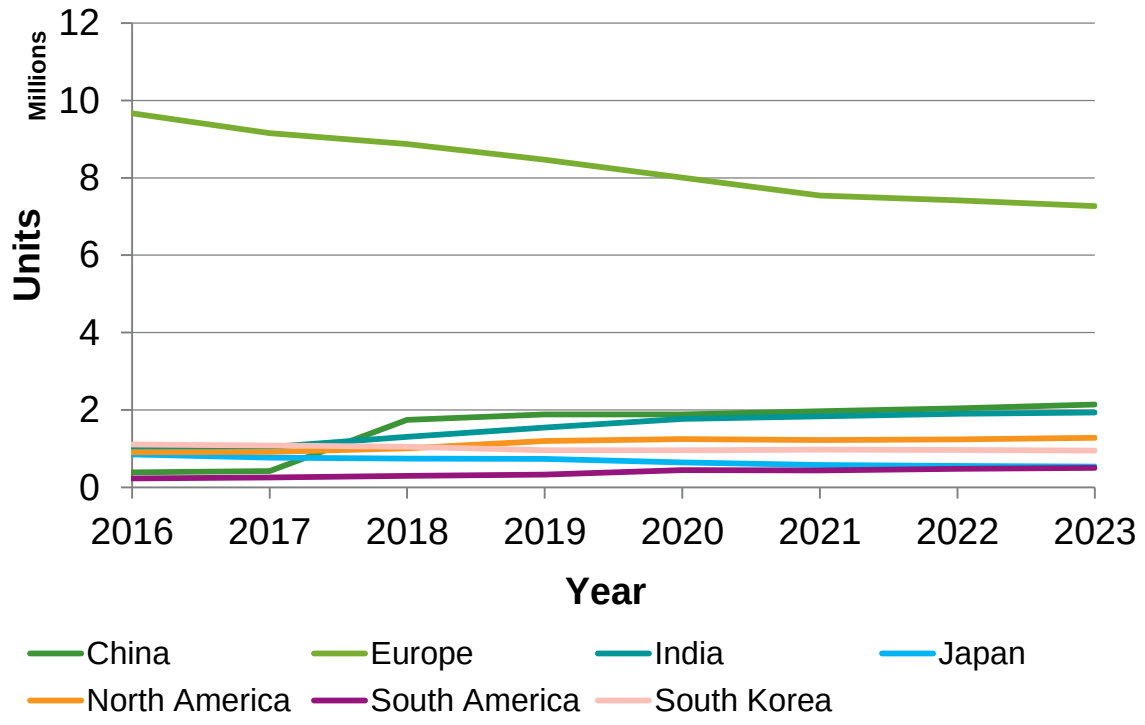
Regional deployment of DPF



Note: data shown relates to Engine Production Region
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Europe leads in GPF roll out, dictated by Euro 6d Temp legislation. Exponential growth forecast in Greater China with advent of CN6b. DPF decline aligned to diesel volume in Europe, growth in China LCV applications

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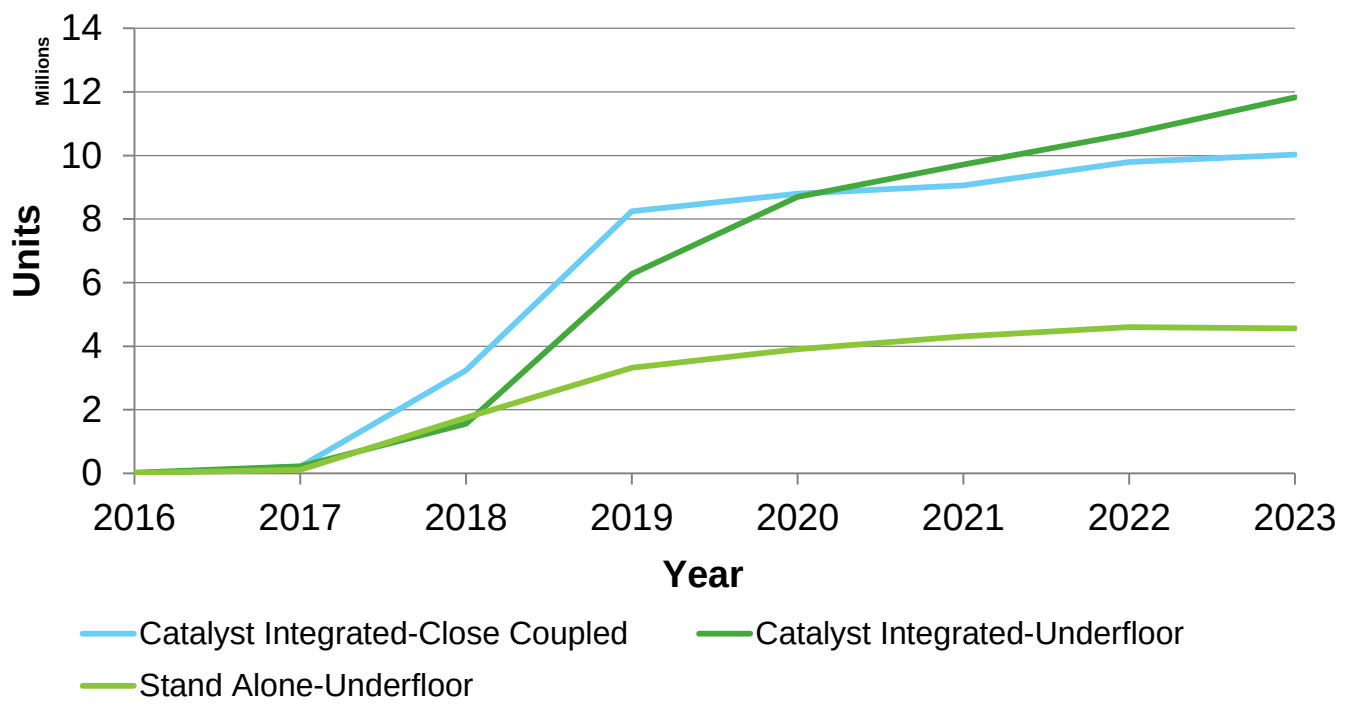
Focus: particulate filter

Forecast findings

Gasoline particulate filter "position" trend



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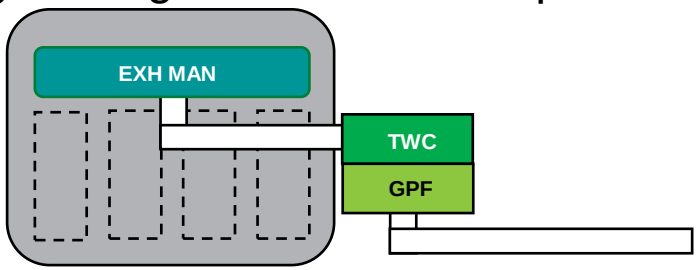
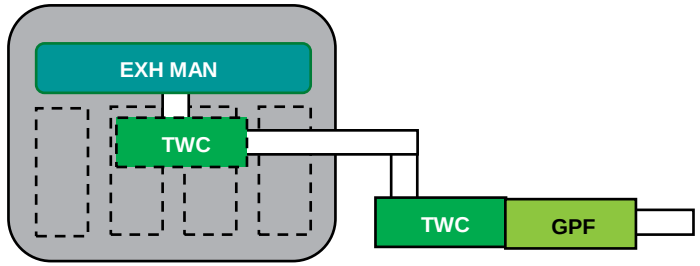
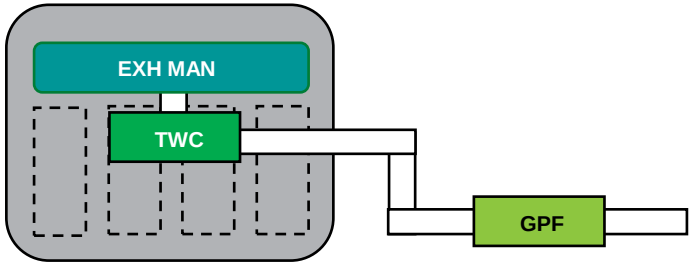
Catalyst-integrated—close-coupled



Catalyst-integrated—underfloor



Standalone—underfloor



OEMs, led by Volkswagen, will aim for close coupling of the GPF, preferably integrated into the catalyst can. Package restriction on existing vehicle platforms will restrict particular OEMs to underfloor locations

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Focus: selective catalytic reduction

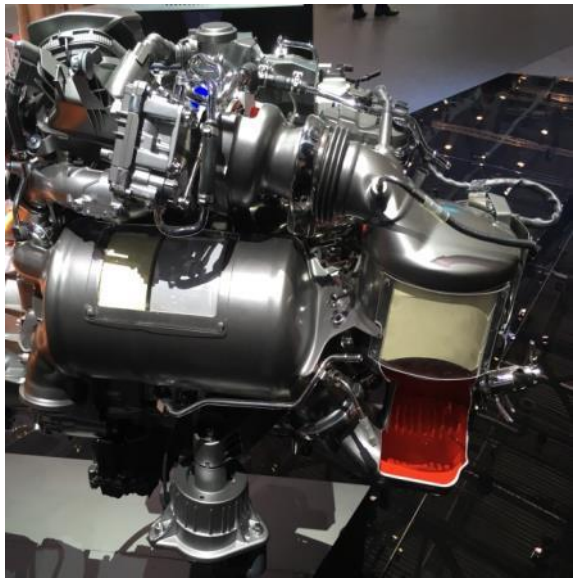
Technical overview

Key developments:

- Declining diesel demand
- Lack of regulatory clarity in India, but unlikely to be mandated

Key requirements driving development:

- Increasingly integrated AdBlue delivery module
- Closer coupling of SCR substrate, ideally amalgamated into engine envelope
- Improvements in AdBlue utilization
- Optimization for cold start NOx conversion through careful size selection and filter integration



Daimler OM 654 engine
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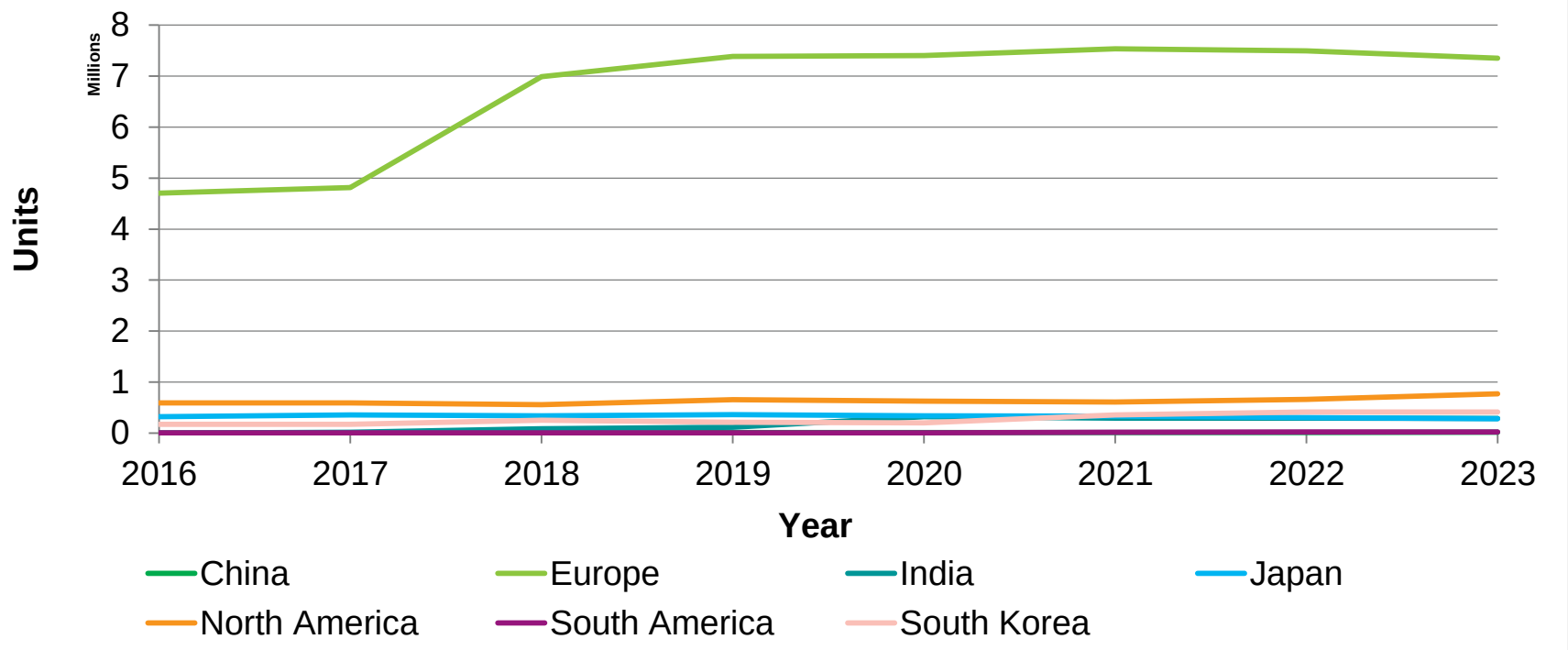
Focus: selective catalytic reduction

Forecast findings

Selective Catalytic Reduction global demand



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European demand for SCR systems is expected to plateau in 2021. Some growth in India post-Bharat IV introduction in India for larger diesel engine applications.

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Supply base opportunity

Some key statistics

USD400 mil.	Increased annual revenue opportunity in the catalytic converter market between now and 2023
157%	Compound annual growth rate (CAGR) of the gasoline particulate filter market between now and 2023
4.9 million	Increase in the number of particulate filters canned by Faurecia per annum between now and the end of 2019
USD155 mil.	The value of the diesel particulate filter business with the Volkswagen Group globally in 2023

Despite the current focus on electrification and hybridization within the automotive industry, exhaust aftertreatment continues to grow as a component business area.

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Supply base opportunity

How will the industry continue to move forward?

- For OEMs to turn a profit and achieve return on investment, ICE must continue to evolve.
  - Exhaust aftertreatment is a key part of this.
- Increased regulatory focus and diverse OEM strategies result in opportunities for suppliers.
  - Regulatory framework will continue to be key.
- Increasingly complex aftertreatment in a greater number of global regions means increased business potential
  - Growing demand of traditional EGR components
  - Canning of ‘mini’ particulate filters
- Potential applications for steel tubing products in cooling systems for Hybrids and EVs
- Despite the current industry focus surrounding electrification, the requirement for internal combustion engine power is still growing out to 2030
- Timeframe for diversification isn’t imminent, but makes sense to be considering it

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