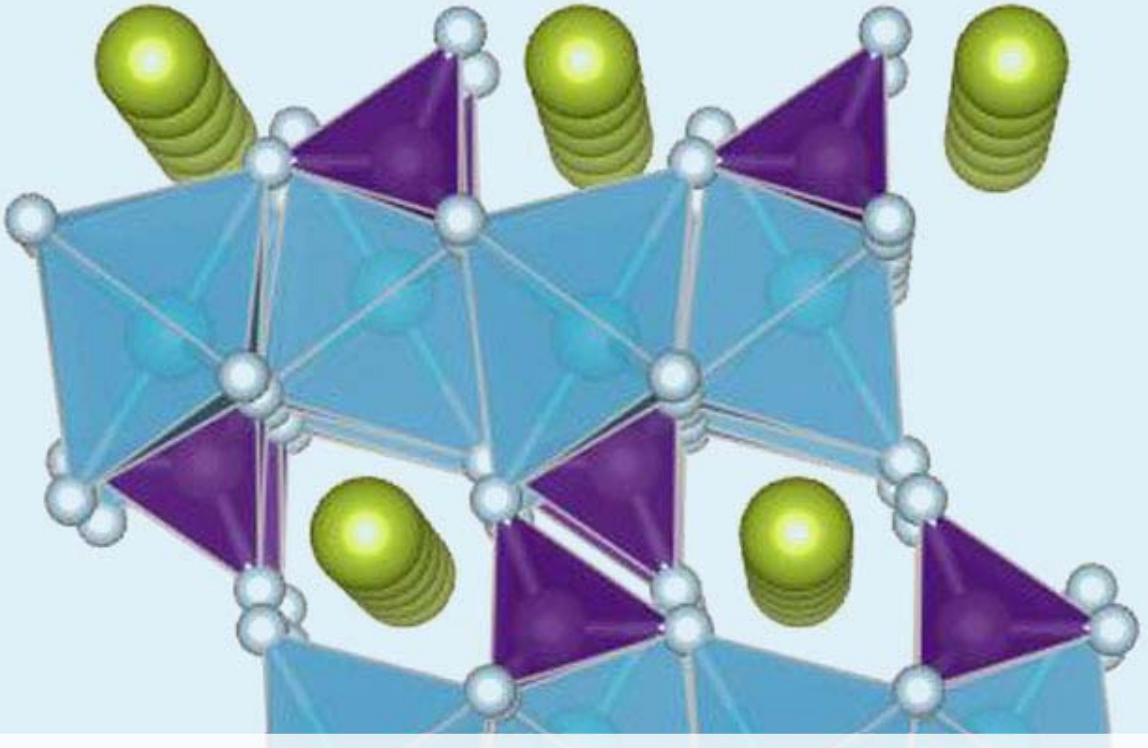
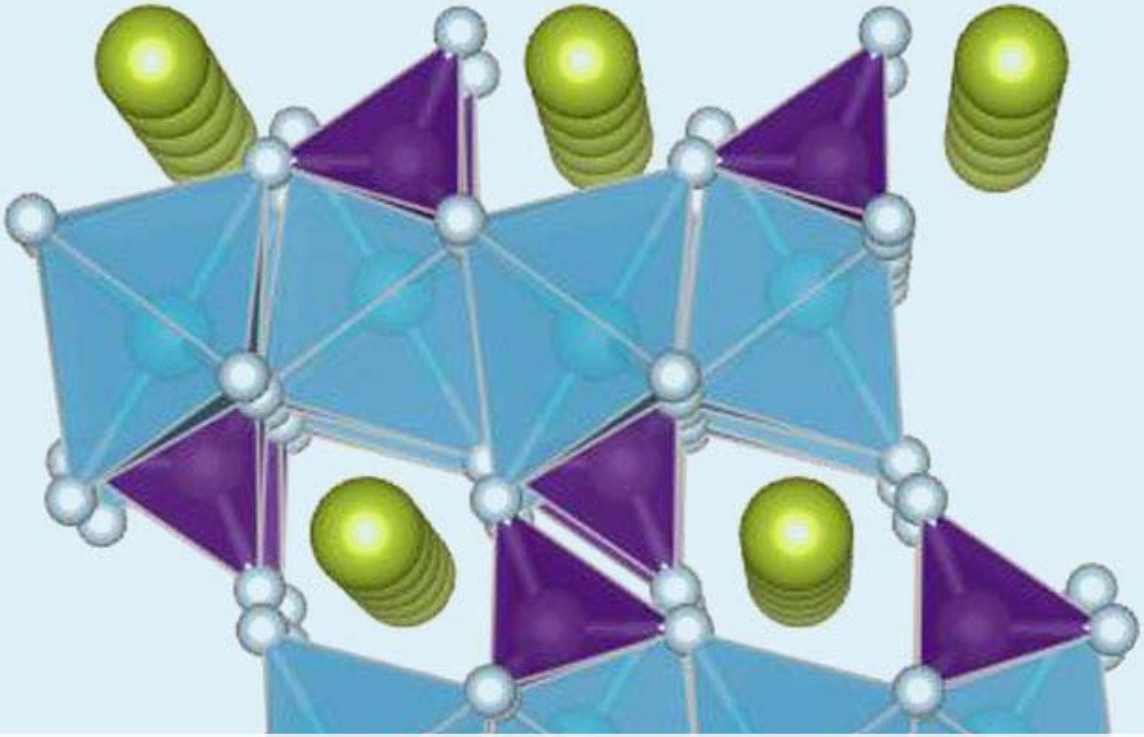


Presentation to Analysts / Investors

Johnson Matthey and the Evolving Powertrain

4th February 2016

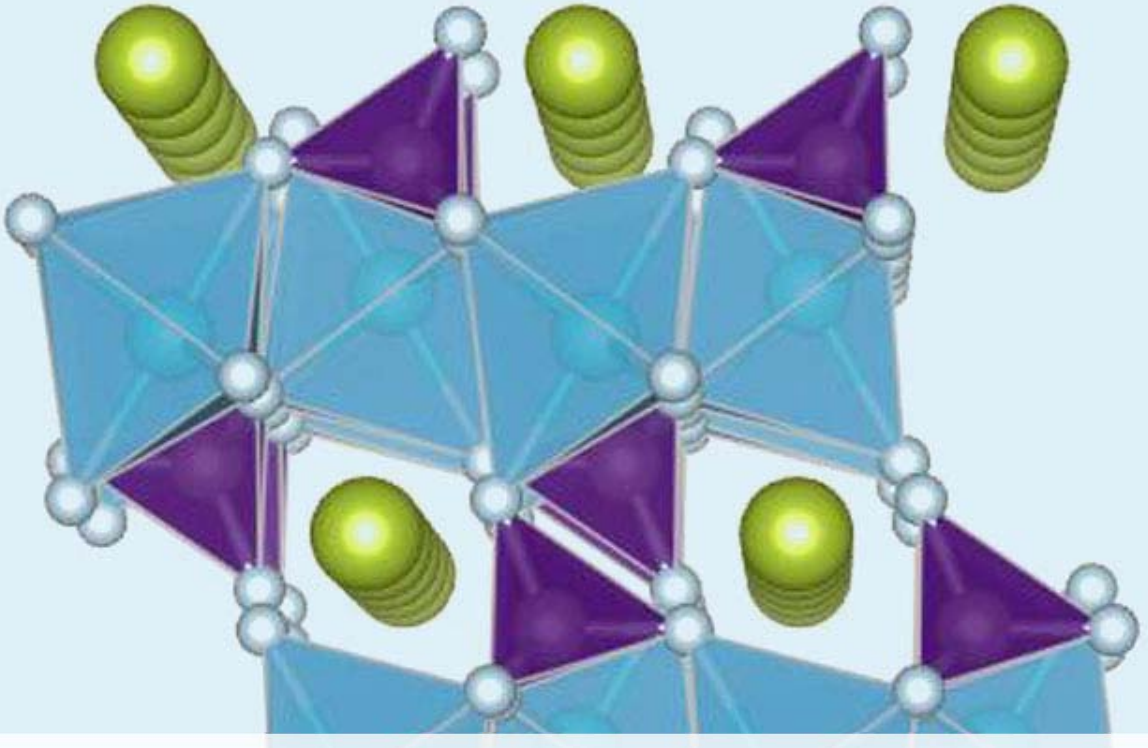
Johnson Matthey



Cautionary Statement

This presentation contains forward looking statements that are subject to risk factors associated with, amongst other things, the economic and business circumstances occurring from time to time in the countries and sectors in which Johnson Matthey operates. It is believed that the expectations reflected in these statements are reasonable but they may be affected by a wide range of variables which could cause actual results to differ materially from those currently anticipated.

JM Johnson Matthey



Introduction and Strategy Update

Robert MacLeod

Chief Executive

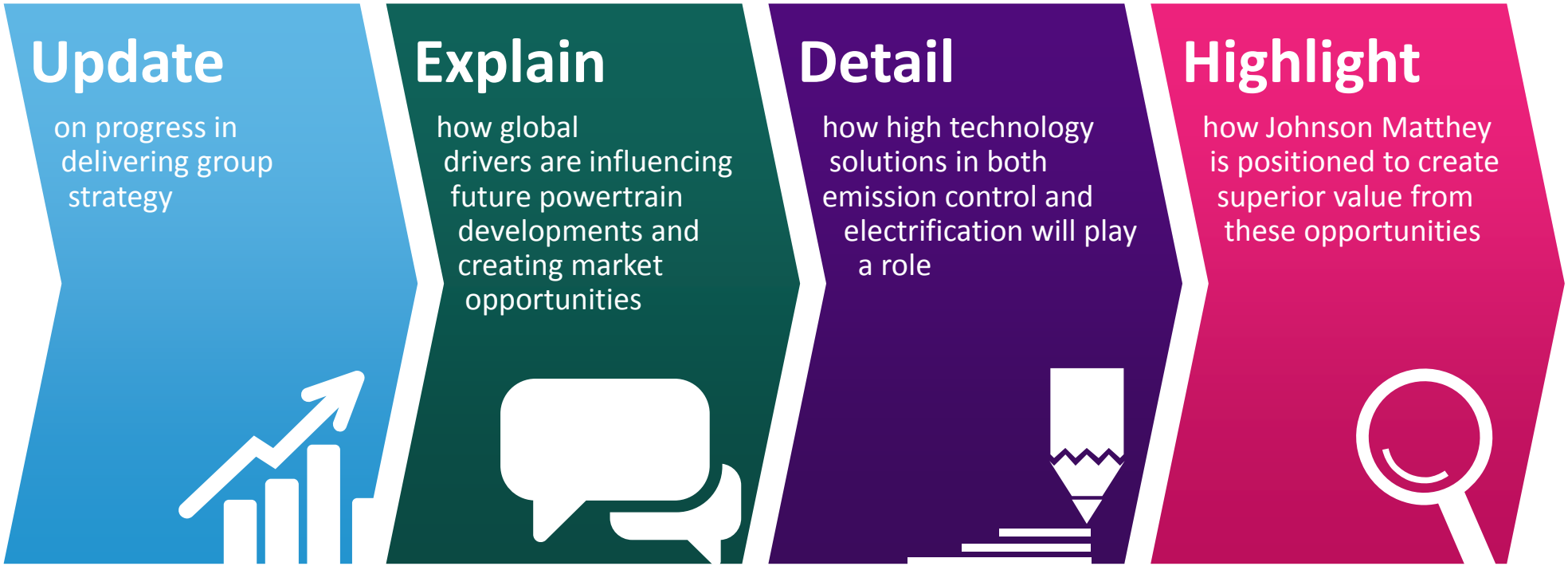
Johnson Matthey

Johnson Matthey

Programme

13.30	Introduction and Strategy Update	**Robert MacLeod**
13.50	Capturing Value from Powertrain Evolution *Q&A and coffee break after this session*	**Nick Garner and John Walker**
15.00	Automotive Emission Control Regulations and Technology Trends *Q&A and coffee break after this session*	**Chris Morgan and Andy Walker**
16.20	Creating Value from Market Opportunities in Battery Technologies	**Martin Green**
16.50	Science and Technology – Delivering Sustainable Solutions to Customers *Q&A after this session*	**Alan Nelson**
17.30	Summary and Final Q&A	**Robert MacLeod**
18.30	Drinks Reception and Dinner	

Purpose of the Day



Update on Current Trading

	Sales* up 3%; operating profit lower
	Action to reduce costs by £30m p.a. well underway
	Strong growth in ECT
	Difficult trading conditions persist in PT and PMP
	Good progress in FC and NB

Outlook for FY in line with current market expectations

*2014/15 and 2015/16 adjusted to exclude contribution of Gold and Silver Refining and Research Chemicals businesses which were sold in 2014/15.

Difficult Macroeconomic Climate

Oil price

- 40% fall in last 12 months

Investment delays in chemical industry

China

- Lower GDP growth forecast
- Sufficient chemical capacity
- Review of coal strategy

Delays and reduced market for coal to SNG

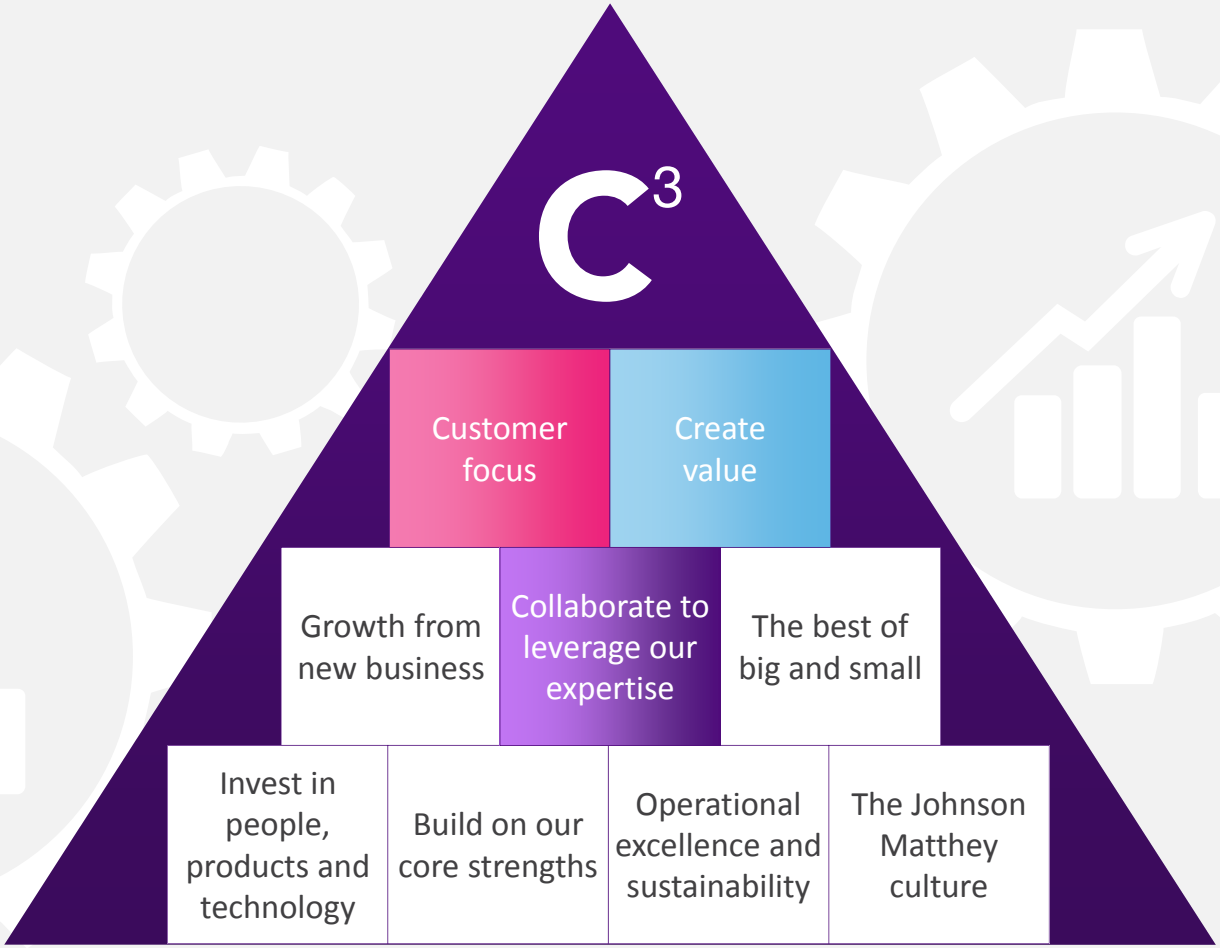
Pgm prices

- Pt and Pd down 30% and 35% since last year
- Lowest Pt prices since end 2008

Lower pgm refining volumes, reduced profitability

Current macro climate expected to limit group's short term growth opportunities
Long term strategy robust

Good Progress in Strategy Delivery



Good Progress in Strategy Delivery

Invest in people, products and technology

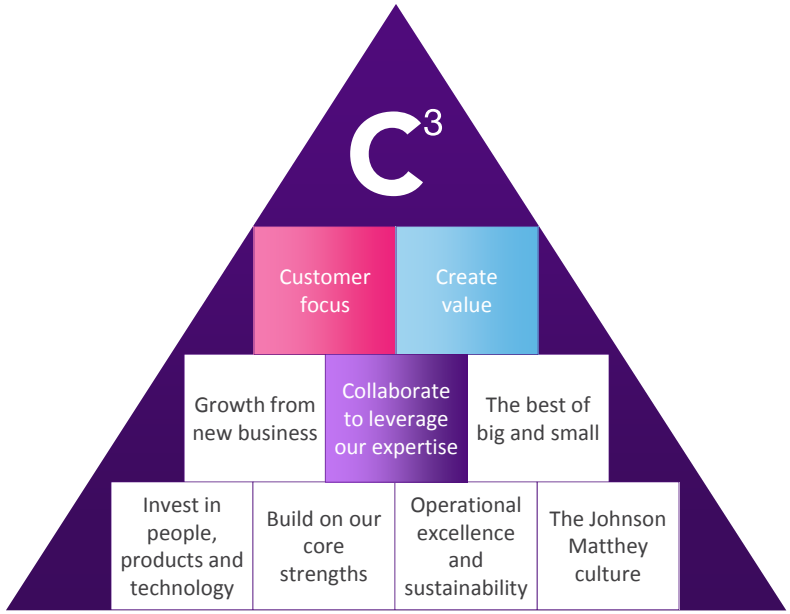
- Invest ~5% p.a. of sales in R&D
- Expect capex at ~1.5x depreciation

Build on our core strengths

- Disposal of two non-core businesses
- Medium term organic growth opportunities remain

Growth from new businesses

- Good progress in establishing Battery Technologies and ACT businesses



Good Progress in Strategy Delivery

Operational excellence and sustainability

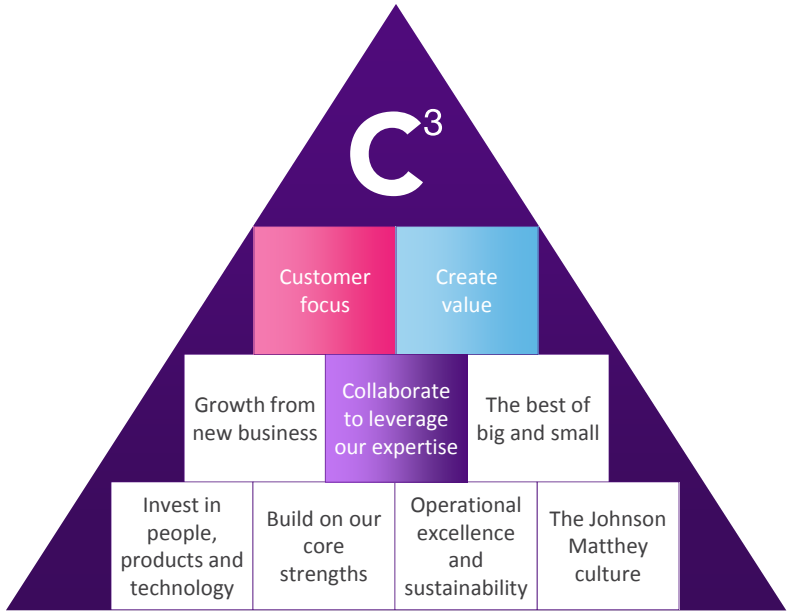
- Increased focus on health and safety
- Business systems upgrade on track

Customer focus

- Leverage more from value add and total JM offering
- Facilitate entry into new markets

Create value

- Special dividend 150p per share
- ROIC target of 20% remains
- **Growth opportunities from evolving powertrain**

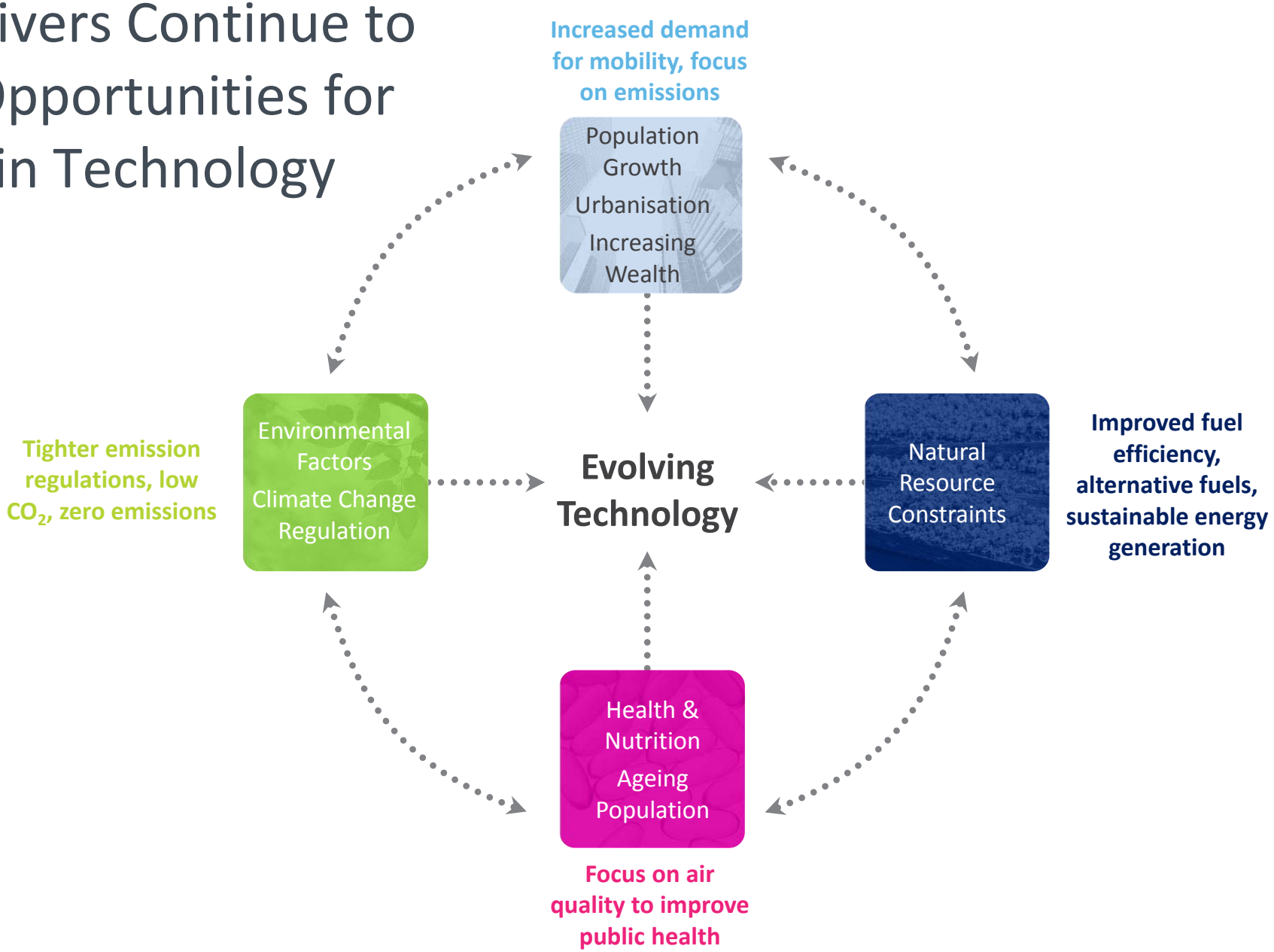


Sustainability Drivers Provide Superior Growth for JM

Global Drivers

Population Growth Urbanisation Increasing Wealth	• Provide opportunities across all businesses • JM well positioned in emerging markets
Natural Resource Constraints	• Energy security remains a major driver for PT's technologies • Recycling pgms is a strategic service
Environmental Factors Climate Change Regulation	• Continued tightening of emissions legislation as air quality and focus on emissions remain a priority • Electrification of powertrain creates additional opportunities
Health & Nutrition Ageing Population	• Ongoing pressure on healthcare costs drives increased use of generics • Enzymatic catalysis / more sustainable chemistry in pharma industry

Global Drivers Continue to Provide Opportunities for Powertrain Technology



Imperative for Improved Air Quality Supports Growth

Legislation continues to tighten at pace

- Regulated pollutants and CO_2 in focus
- ICE remains main powertrain technology for next decade; increased hybridisation
- Increased opportunity for JM from diversified powertrain

ECT

Increased demand for complex catalysts and hence more value over next decade

- JM a leading technology provider

Medium term targets remain

Battery Technologies

Growing market for battery materials expected to expand

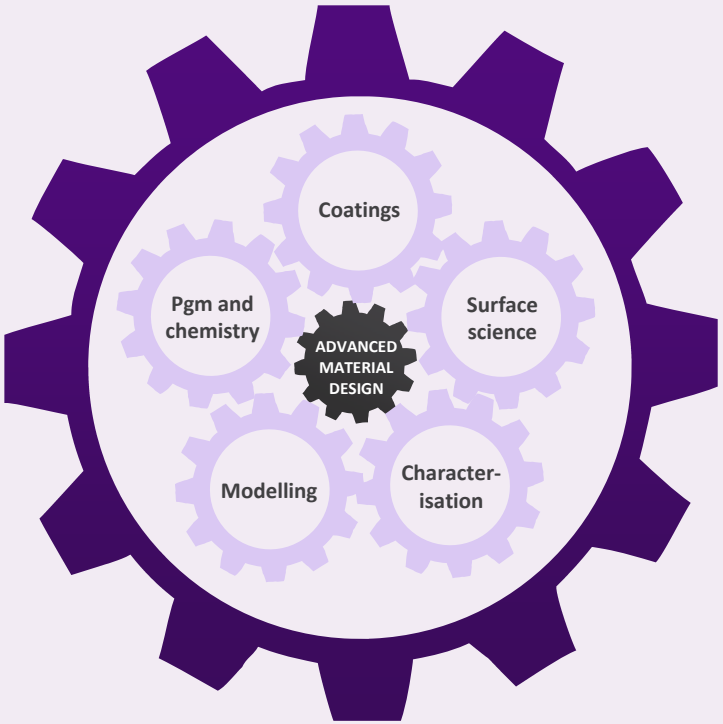
- JM player in current market
- Investing to capture value as market evolves

JM roadmap on track

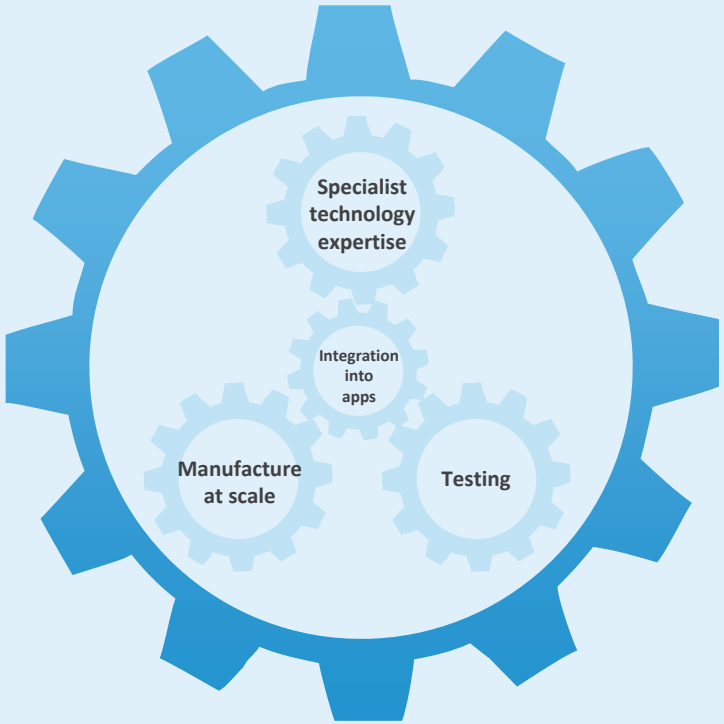
Driving Success in Evolving Powertrain Market

Chemistry and applications know how at heart of powertrain technology solutions

Chemistry…



…and its application



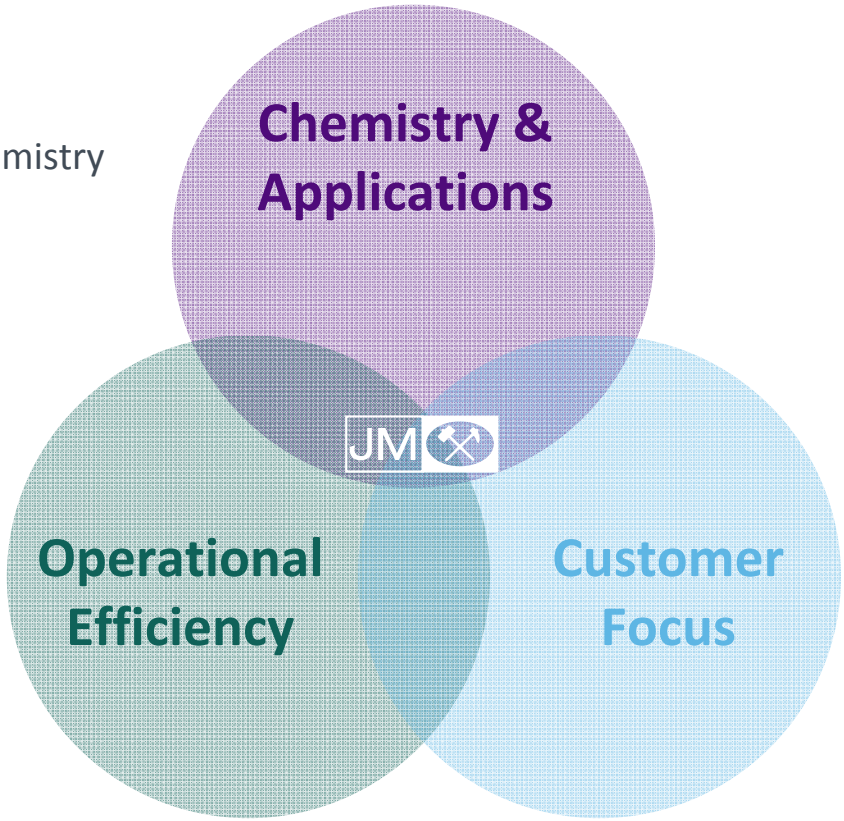
Cutting edge chemistry for emission control and battery technologies

JM differentiator – understanding how it can be used

That enables us to build multi million pound product businesses

The JM Advantage in Powertrain Solutions

- Strong expertise in translating metal chemistry solutions into auto applications



- Ability to scale up
- Efficient manufacturing
- Well positioned in supply chain

- Deep relationships with OEMs
- Strong reputation
- Understand future needs

JM well placed to capture value from evolving powertrain

Key Takeaways

JM remains well placed for sustained long term growth

Robust strategy and strong market drivers

Evolution of the powertrain requires high technology solutions

Capturing Value From Powertrain Evolution

Nick Garner

Division Director, New Businesses and Corporate Development

John Walker

Executive Director, Emission Control Technologies

Johnson Matthey

Overview

Explain

how tightening legislation and electrification offer strong growth opportunities for JM

Outline

how JM's gasoline and diesel emission control technologies will continue to play an important role in a more diversified powertrain

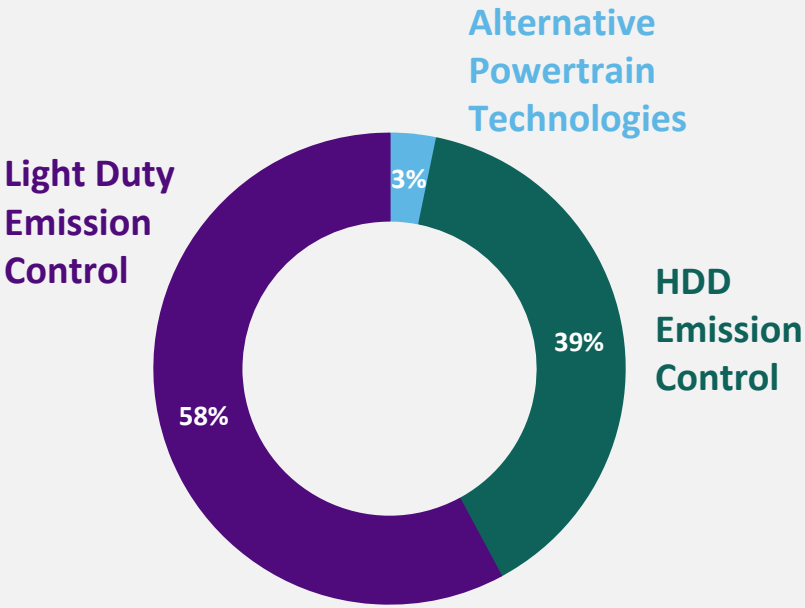
Highlight

how JM is well placed to benefit further from the expanding market for battery technologies

JM – Well Placed to Meet Future Powertrain Needs

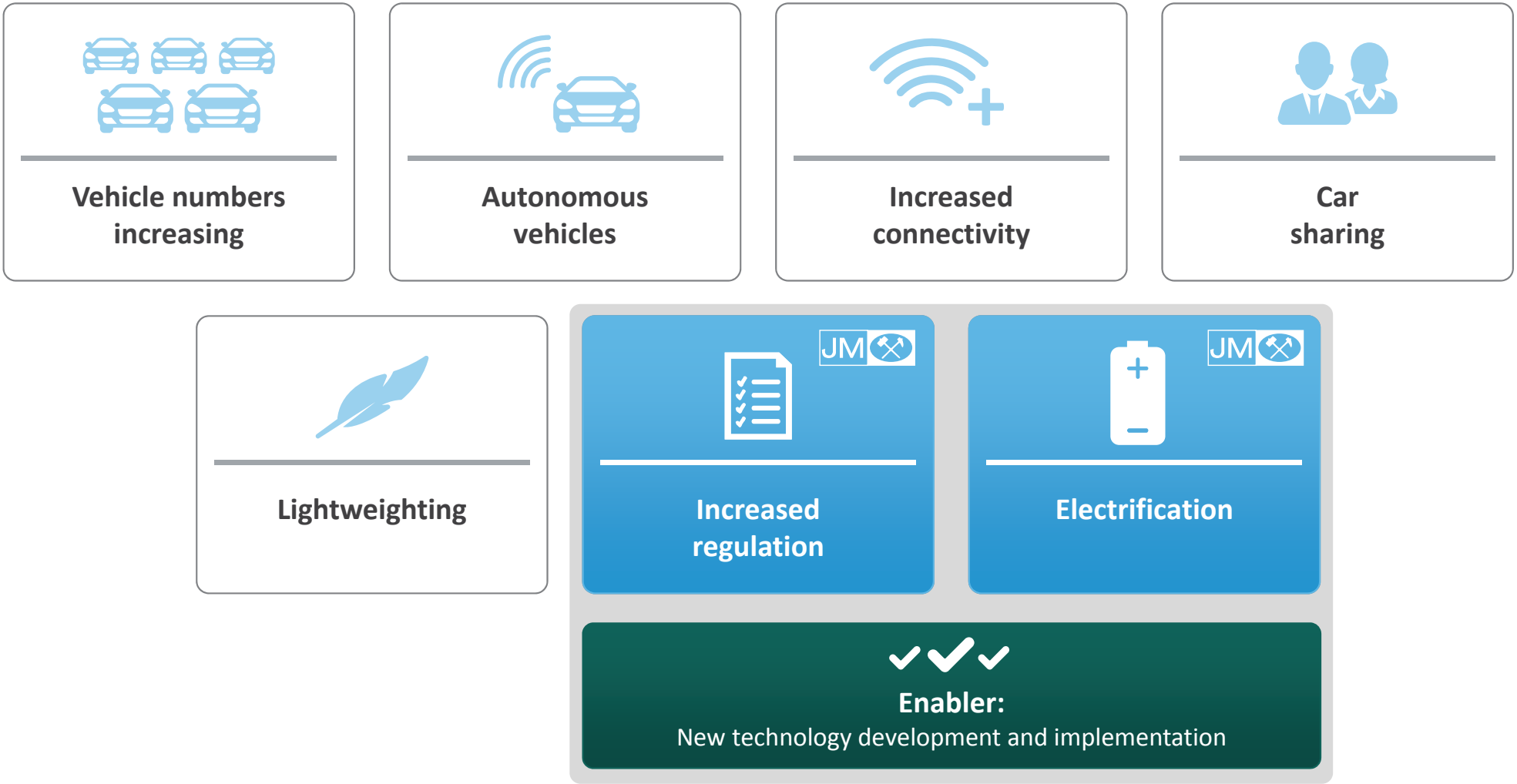
- Global leader in emission control
- Major lithium iron phosphate (LFP) supplier for automotive applications
  - Supplying / awarded 15 automotive platforms
- Extensive operations across the globe
  - 18 manufacturing sites and 11 technology centres
- ~5,000 employees; ~13% in R&D
- Ongoing investment in R&D and capex to support growth

JM Sales by Powertrain Application

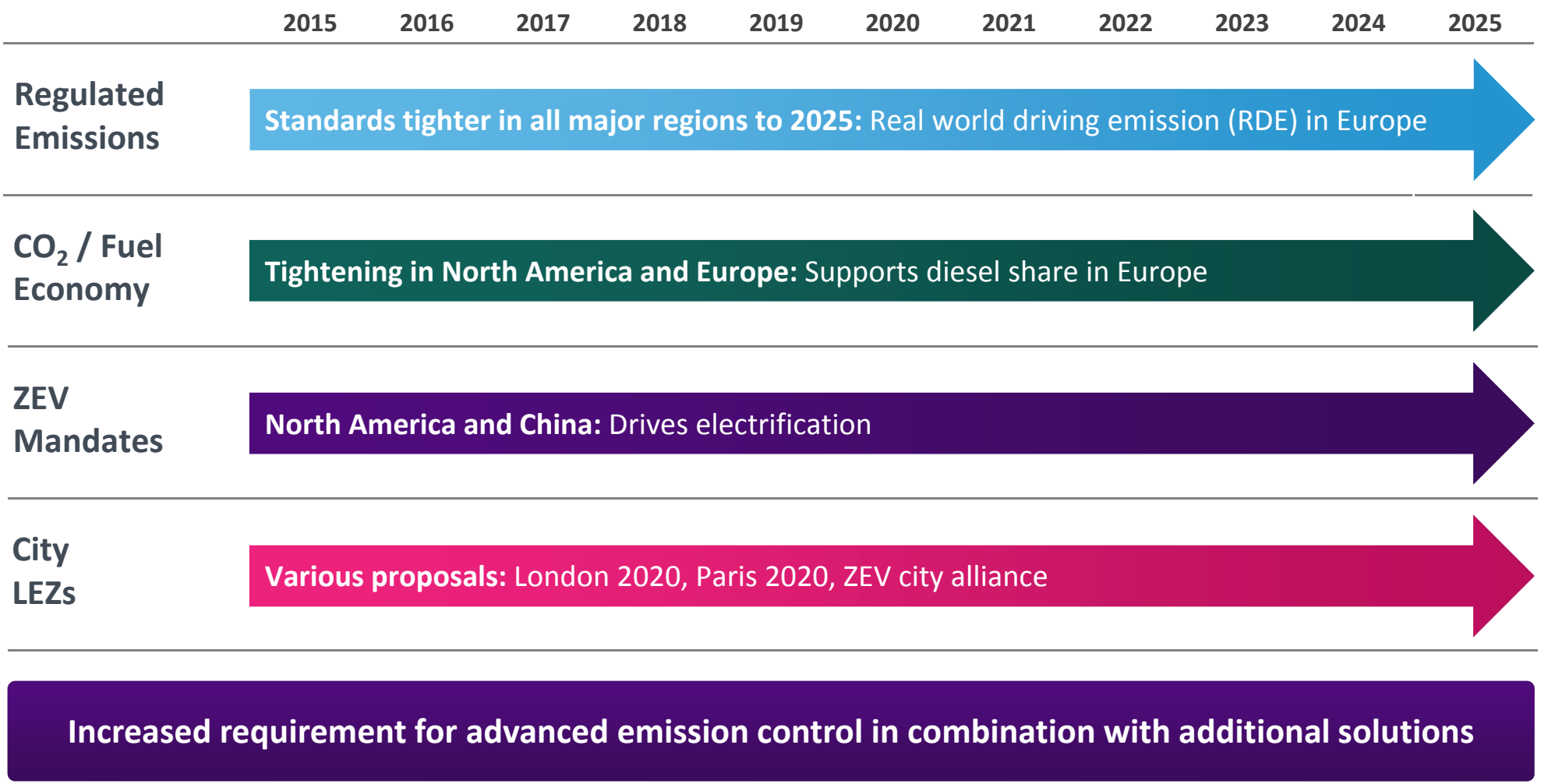


Legislation drives value growth with more new opportunities

Key Trends in Automotive

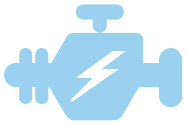


Legislation Continues to Tighten



Increased requirement for advanced emission control in combination with additional solutions

Diesel – Key to Meeting CO_2 Targets



Diesel engine inherently more fuel efficient than gasoline counterpart

- CO_2 emissions ~15% lower* than gasoline car

Diesel cars continue to get cleaner

- Advanced aftertreatment technology
- Proposed London / Paris emission zones will allow current (Euro 6b) diesel cars
- RDE will have further positive impact on emissions

Diesel's share of Western European car production steady at ~50%

- Continue to expect proportion to trend down in medium term

Total cost of ownership (TCO) will continue to favour diesel for higher mileage drivers

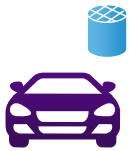
Diesel expected to remain important part of the mix for next decade and beyond

*JM estimates calculated for typical 1.6 litre hatchback diesel and gasoline cars

More Diverse Powertrain is Positive for JM

From this… to this…

IC Gasoline



IC Diesel

MHEV
Mild Hybrid Electric Vehicle
Honda Integrated Motor Assist
Buick LaCrosse EAssist

FHEV
Full Hybrid Electric Vehicle
Toyota Prius
Ford Fusion Hybrid

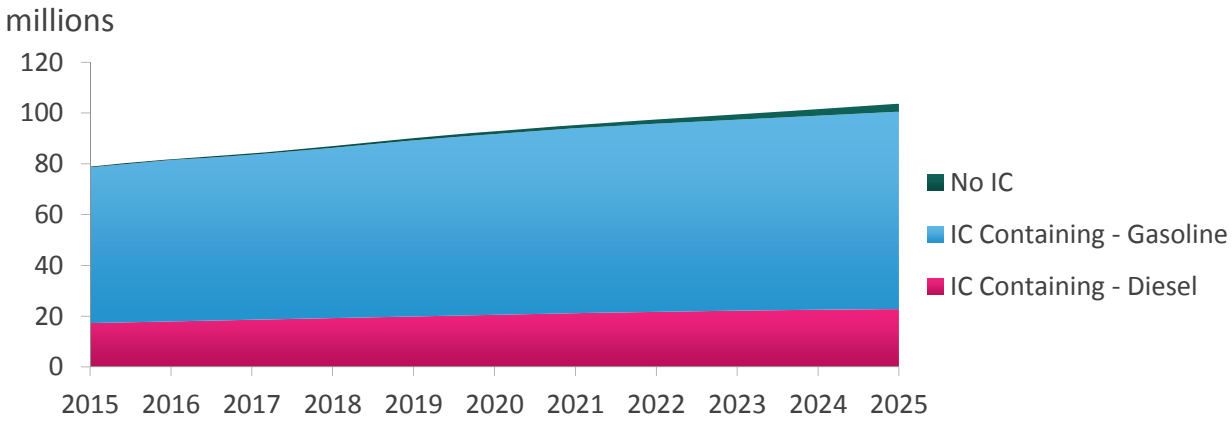
PHEV / EREV
Plug-in Hybrid / Extended Range Electric Vehicle
BYD Qin / BMW i3 RE

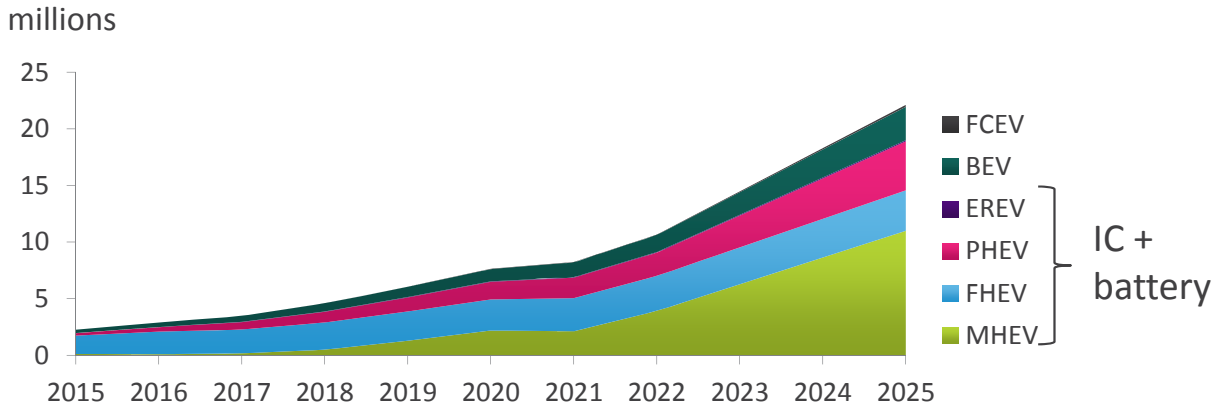
BEV
Battery Electric Vehicle
Tesla
Nissan Leaf

FCEV
Fuel Cell Electric Vehicle
Toyota Mirai
Hyundai ix35 Fuel Cell

Hybrids require emission control catalysts and battery technologies

In 2025 ~97% of Cars Still Have ICE





Gasoline and diesel ICE remain major technologies

- Absolute number of diesel cars continues to increase

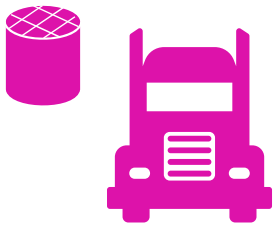
More electrification

- Increasing hybridisation in both gasoline and diesel powertrains (stop-start to full hybrids)
- FCEV remains niche until at least 2025

Pace of evolution beyond 2025 likely to depend on progression of CO_2 regulations

Chart Data Source: LMC Automotive

Similar Story in Heavy Duty Market Too



- Good growth in regulated heavy duty engines (6% CAGR)* to 2025
- Legislation continues to tighten
  - China – Euro VI from 2017, Tier 4a/b non-road from 2018, NEV targets for EV
  - Europe – Stage V non-road from 2019
  - India – Euro VI from 2020 to 2025
  - North America CARB – ultra low NOx from 2023

- Low emission zones to improve air quality in cities
  - Requirement for higher technology catalysts
  - Strong growth in BEV and PHEV buses / trucks, mainly in China
- Outside of cities, diesel expected to remain main technology

JM well placed to benefit as leading supplier to HDD sector

* LMC Automotive and JM estimates

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Added Value from Technology

	 IC Gasoline	 IC Diesel	 MHEV/FHEV (Gas / diesel)	 PHEV / EREV	 BEV	 FCEV	 Truck	 HEV / PHEV Truck / Bus	 Battery Electric Bus
JM technology presence	✓	✓	✓	✓	✓	✓	✓	✓	✓
Potential value - emission control	£ 1-2x	£ 5-7x	£ 1-7x	£ 1-7x	-	-	£ 20x	£ 20x	-
			SAME AS GAS / DIESEL						
Potential value battery material / MEA	-	-	£ 1x	£ Up to 12x	£ Up to 20x	£ Up to 120x	-	£ Up to 18x	£ Up to 80x

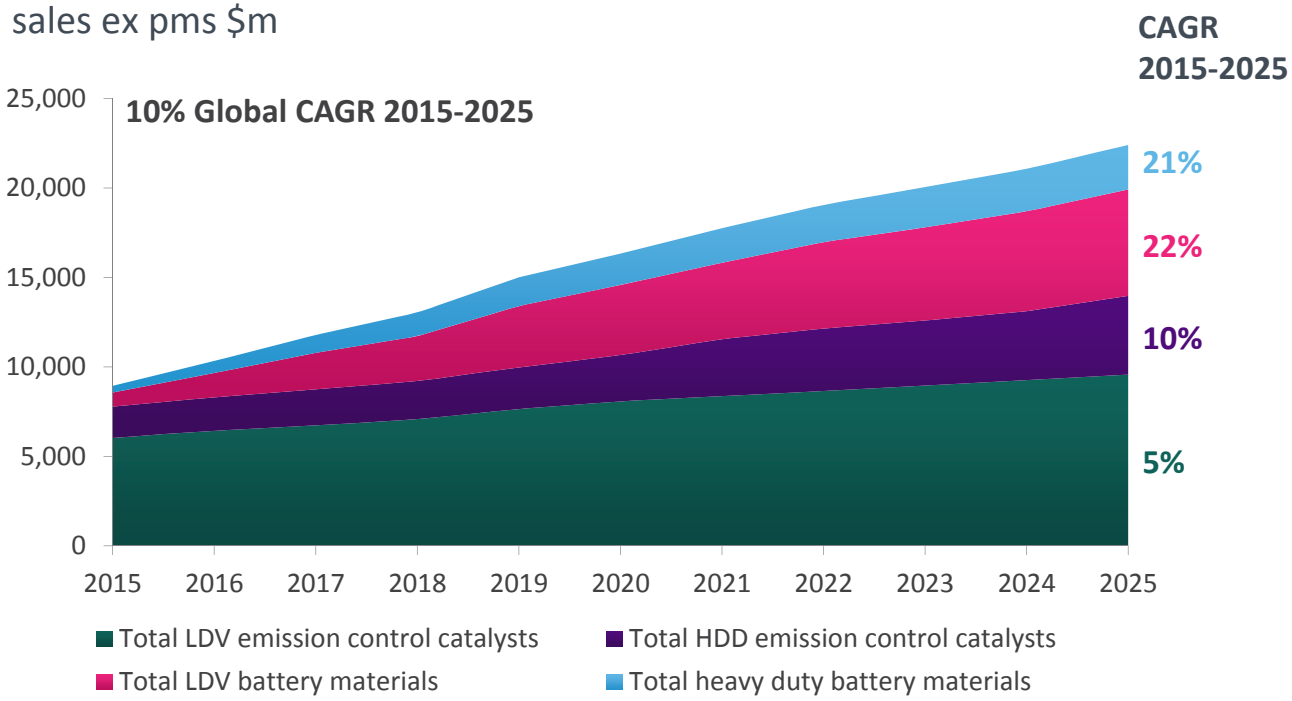
Electrification offers added value for JM

Market to Reach Over $20bn by 2025

Expanding market for emission control catalysts and battery materials

Market Outlook for Powertrain Technologies

sales ex pms $m



- Continued good growth in light duty catalysts market

($6bn in 2015 to >$9bn by 2025)

- HDD catalysts market offers strong growth

($1.75bn in 2015 to >$4bn by 2025)

- Significant expansion in battery materials markets for both light and heavy duty applications

($1bn in 2015 to >$8bn by 2025)

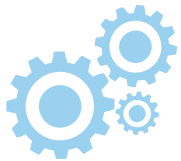
Powertrain technologies market offers good growth potential

Chart Data Source: LMC Automotive and JM estimates

Capturing the Value

Invest in R&D to develop next generation technologies

Exploit expertise in chemistry and applications



Optimise efficiencies in manufacturing and across supply chain

Use JM brand and reputation to broaden JM offering

Expand JM's position as key technology supplier for low emission / low carbon vehicles

Key Takeaways

Increasing opportunities for JM technologies from automotive trends

Emission control technologies continue to be key enabler – ICE remains major powertrain technology

Battery technologies market set to expand – JM business on track

JM well placed to capture value

Q&A

Johnson Matthey

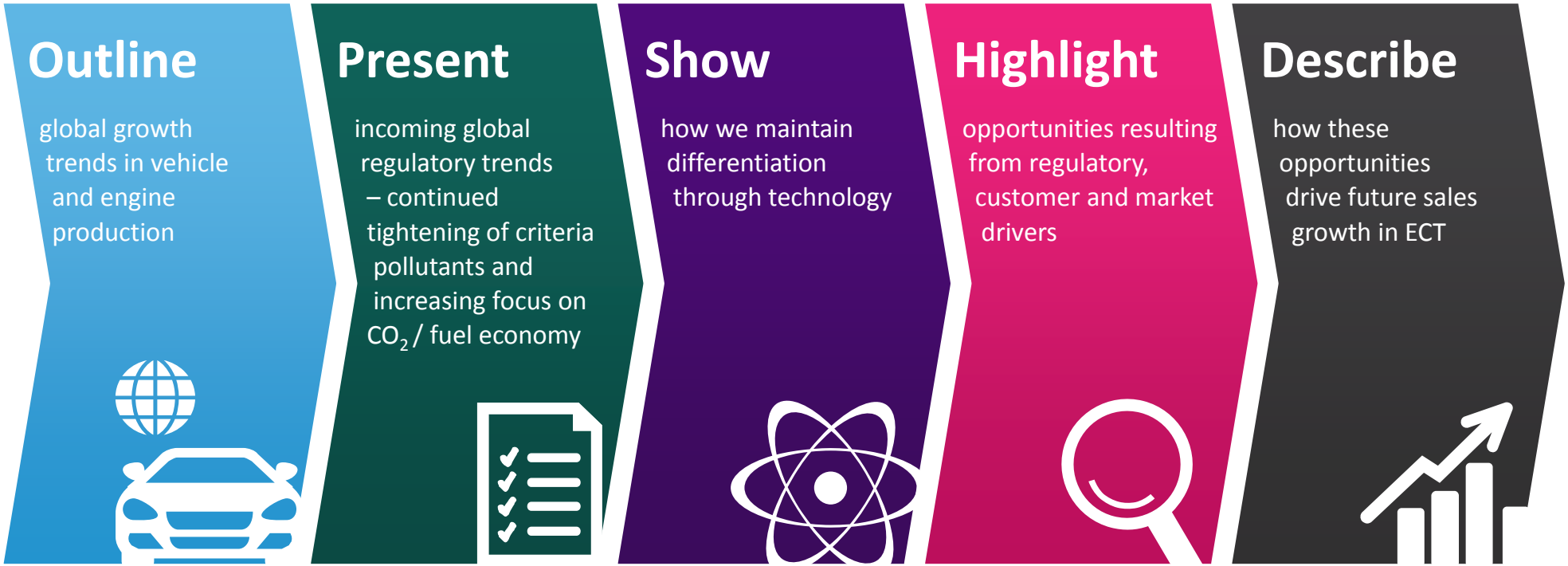
Automotive Emission Control Regulations and Technology Trends

Dr Chris Morgan
European Technology Director, Emission Control Technologies

Dr Andy Walker
Divisional Technology Director, Emission Control Technologies

Johnson Matthey

Overview

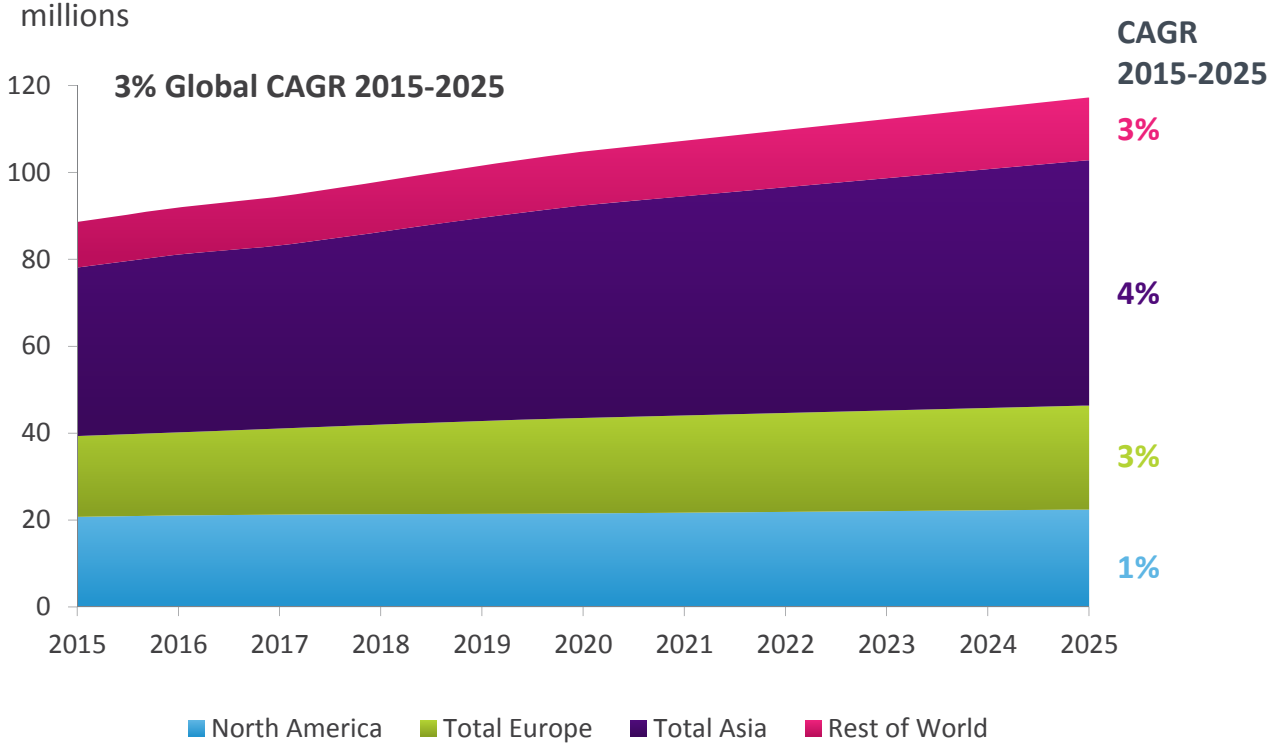

Outline
global growth trends in vehicle and engine production
Present
incoming global regulatory trends – continued tightening of criteria pollutants and increasing focus on CO_2 / fuel economy
Show
how we maintain differentiation through technology
Highlight
opportunities resulting from regulatory, customer and market drivers
Describe
how these opportunities drive future sales growth in ECT

Vehicle Numbers Continue to Increase

Light Vehicle Sales Outlook by Region

(calendar years)

millions



- Continued steady global growth
- Good growth in BRICs
- Shared mobility models likely to increase
  - Shorter holding times and faster wear

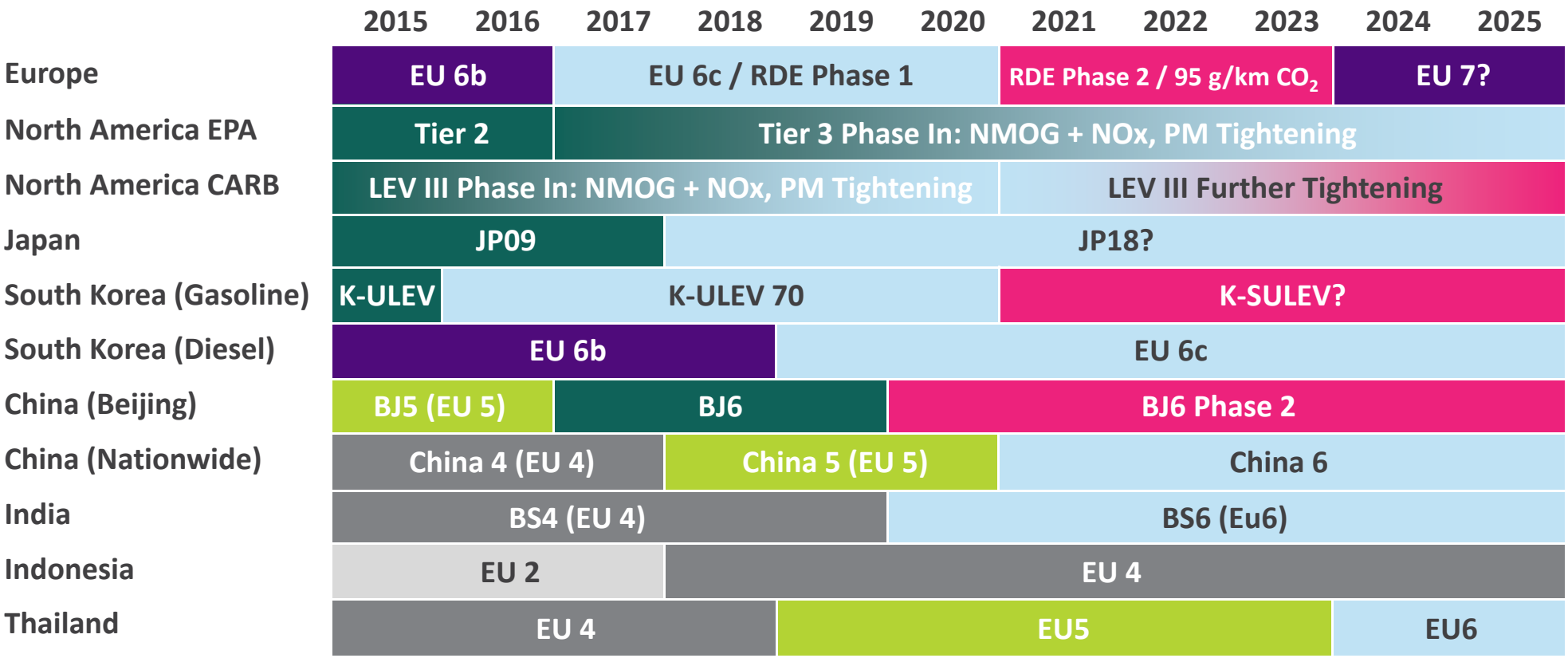
Continued growth in vehicle production drives demand for JM's powertrain technologies

Chart Data Source: LMC Automotive

Johnson Matthey

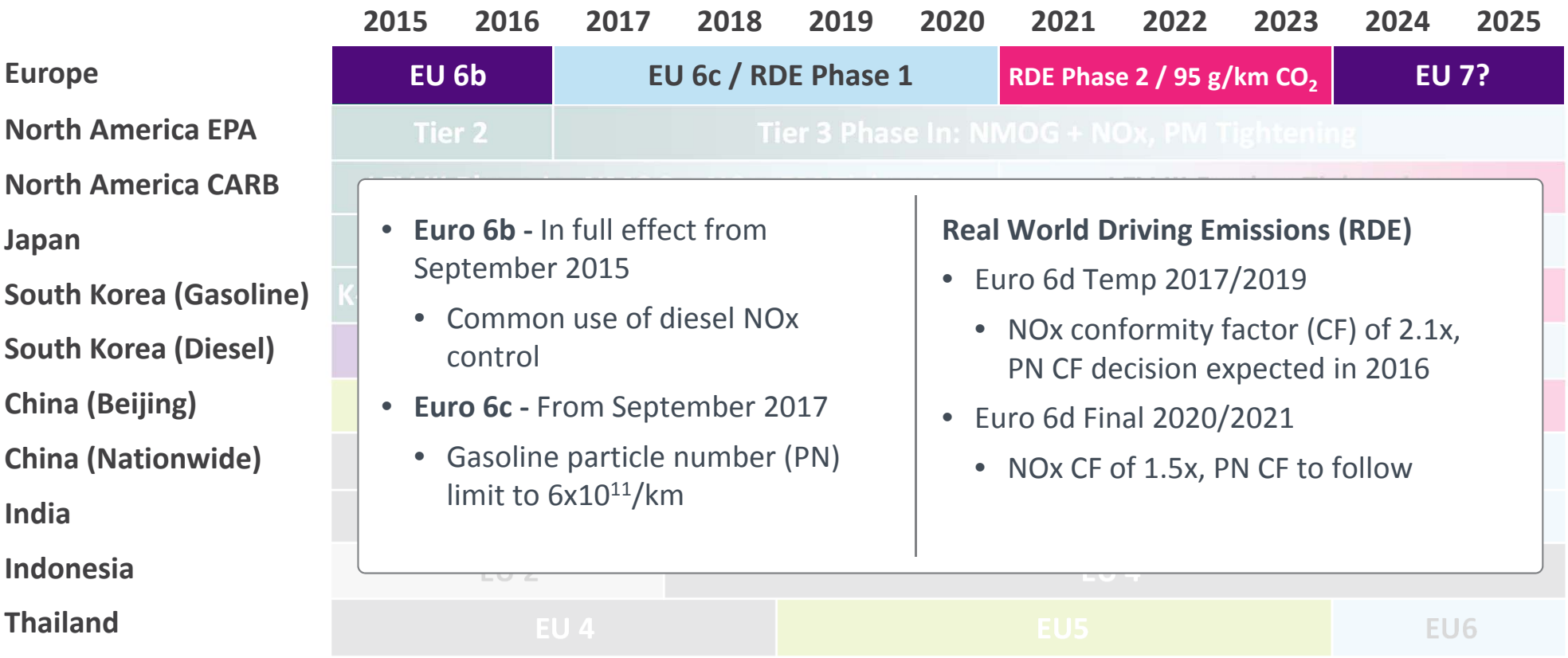
Legislation Continues to Tighten Around the World

Light Duty Emissions Control Legislative Roadmap



Focus on Gasoline and Diesel Emissions in Europe

Light Duty Emissions Control Legislative Roadmap



- **Euro 6b -** In full effect from September 2015
  - Common use of diesel NOx control
- **Euro 6c -** From September 2017
  - Gasoline particle number (PN) limit to $6x10^{11}$/km

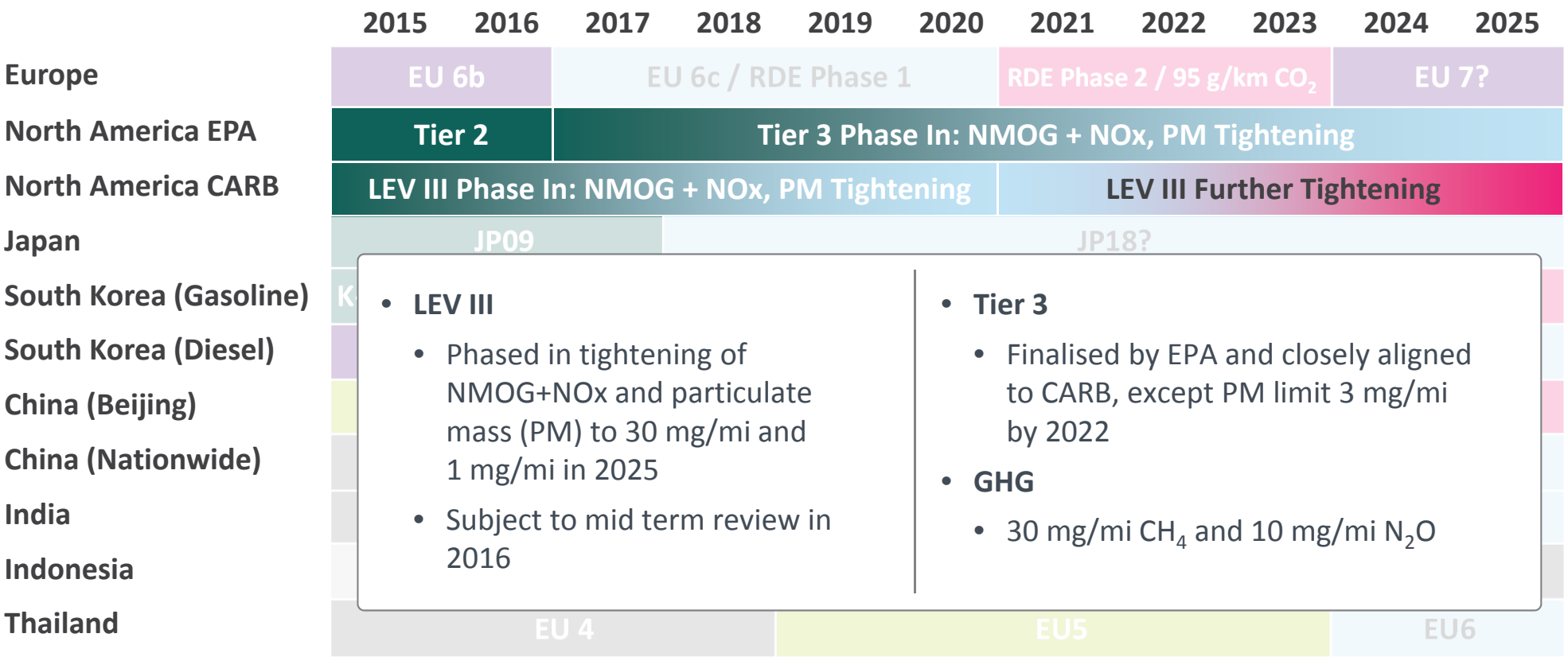
Real World Driving Emissions (RDE)

- Euro 6d Temp 2017/2019
  - NOx conformity factor (CF) of 2.1x, PN CF decision expected in 2016
- Euro 6d Final 2020/2021
  - NOx CF of 1.5x, PN CF to follow

Gasoline particulate filters and advanced diesel NOx control required

North America – California Still Leads the Way

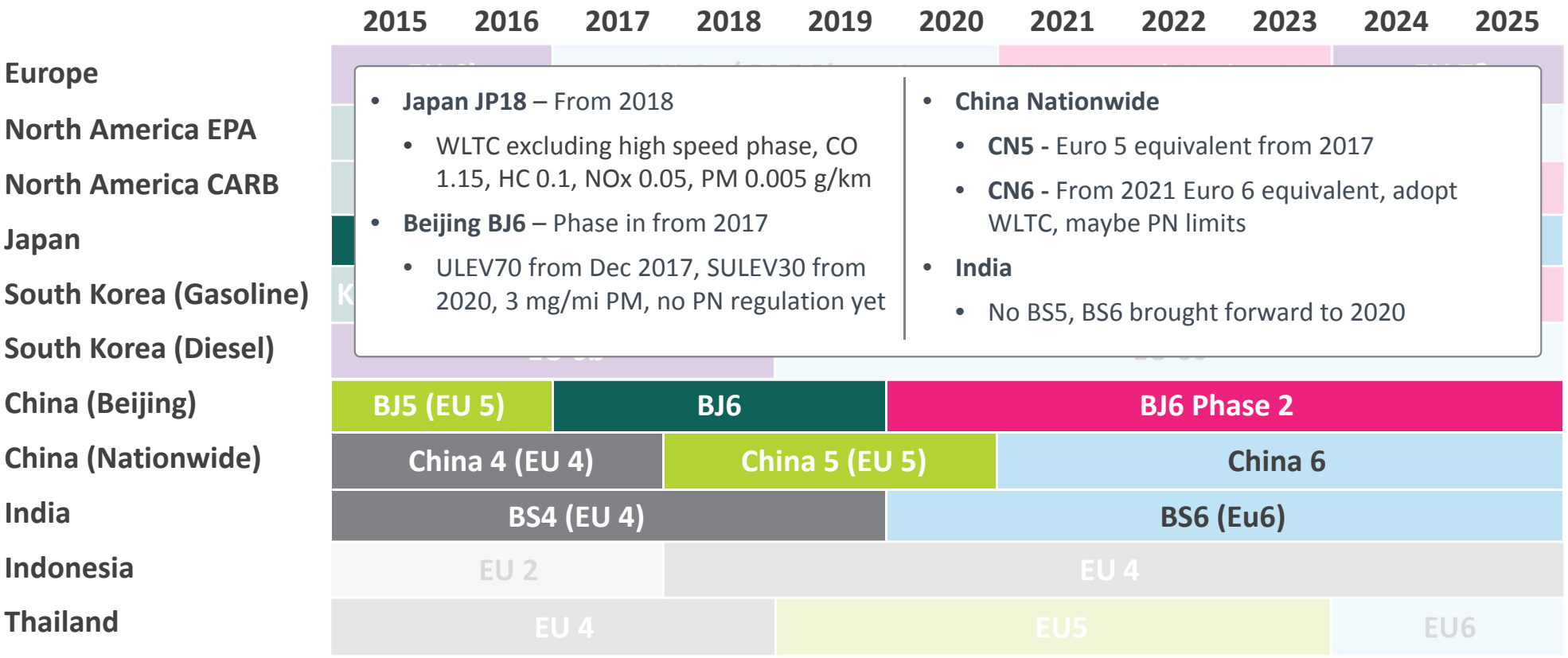
Light Duty Emissions Control Legislative Roadmap



More complexity in current catalyst systems

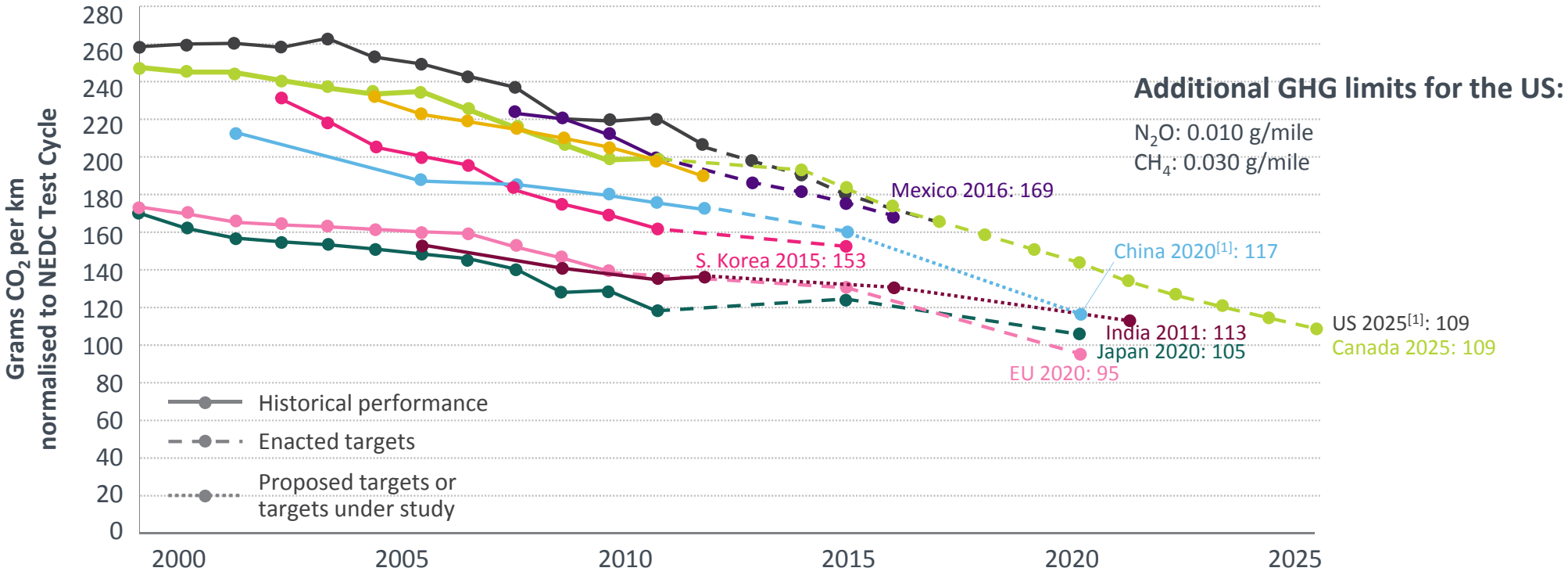
Tightening Legislation Continues at Pace in Asia

Light Duty Emissions Control Legislative Roadmap



More advanced gasoline systems required, including particulate filters in China

Tightening CO_2 / Fuel Economy / GHG Requirements



[1] China's target reflects gasoline vehicles only. The target may be higher after new energy vehicles are considered.
[2] US, Canada and Mexico light-duty vehicles include light-commercial vehicles.
[3] Supporting data can be found at: http://www.theicct.org/info-tools/global-passenger-vehicle-standards

Leads to lower catalyst temperatures and increased electrification

Euro 7?

Formal discussions on Euro 7 delayed until RDE legislation is fixed

Likely topics include:

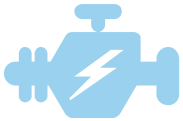
- Fuel neutral limits (i.e. lower diesel NOx)
- Further tightening of RDE CFs
- (Urban?) NO_2 limits
- Addition of criteria pollutants including N_2O and NH_3

CO_2

The European Commission also has an ambition to reduce CO_2 emissions further, e.g. to 75 g/km by 2025

- Drives further hybridisation

Other Technology Drivers



Engine technology developments

- More downsized, turbocharged engines
- Stop-start, more energy recuperation, mild and plug-in hybrids
- GDI increases, lean burn gasoline remains niche
- Improved injectors and cylinder design to reduce gasoline PN
- Cooled EGR to reduce diesel engine out NOx emissions
- NA fuel economy targets lead to diesel penetration into large SUV / light truck market

Fuels

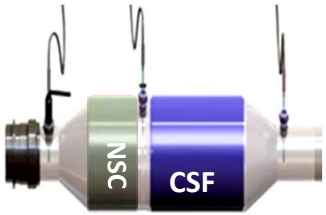
- CNG, LPG, ethanol remain small except for certain local markets

System costs

- OEMs want to minimise additional costs for more complex or advanced aftertreatment systems

Johnson Matthey Clean Diesel Technologies

Solutions to control NOx emissions

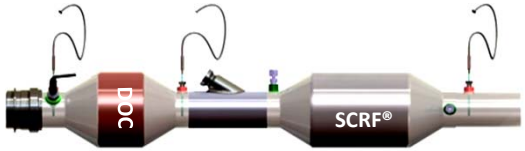


NOx Adsorber Catalysts (NAC)

- Pgm based catalyst
- Requires fuel addition, hence penalty on fuel consumption
- Favoured on smaller vehicles

Selective Catalytic Reduction (SCR)

- Metal-zeolite based catalyst
- Requires urea injection system, with tank, doser and injection systems
- Favoured on larger vehicles
- More reliable at higher speeds



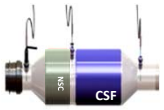
Advanced SCR

- Allows improved thermal management of catalyst on vehicle
- Technically very demanding system
- May require additional SCR / ammonia slip catalyst (ASC) to maximise NOx conversion
- Higher technology product adds value

- Johnson Matthey well positioned in all technologies
- All three approaches being used to meet Euro 6b regulations

Johnson Matthey Clean Diesel Technologies

Solutions to control NOx emissions



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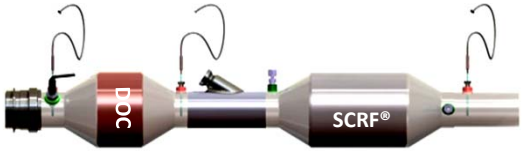
- Favoured on larger vehicles
- More reliable at higher speeds



Advanced SCR

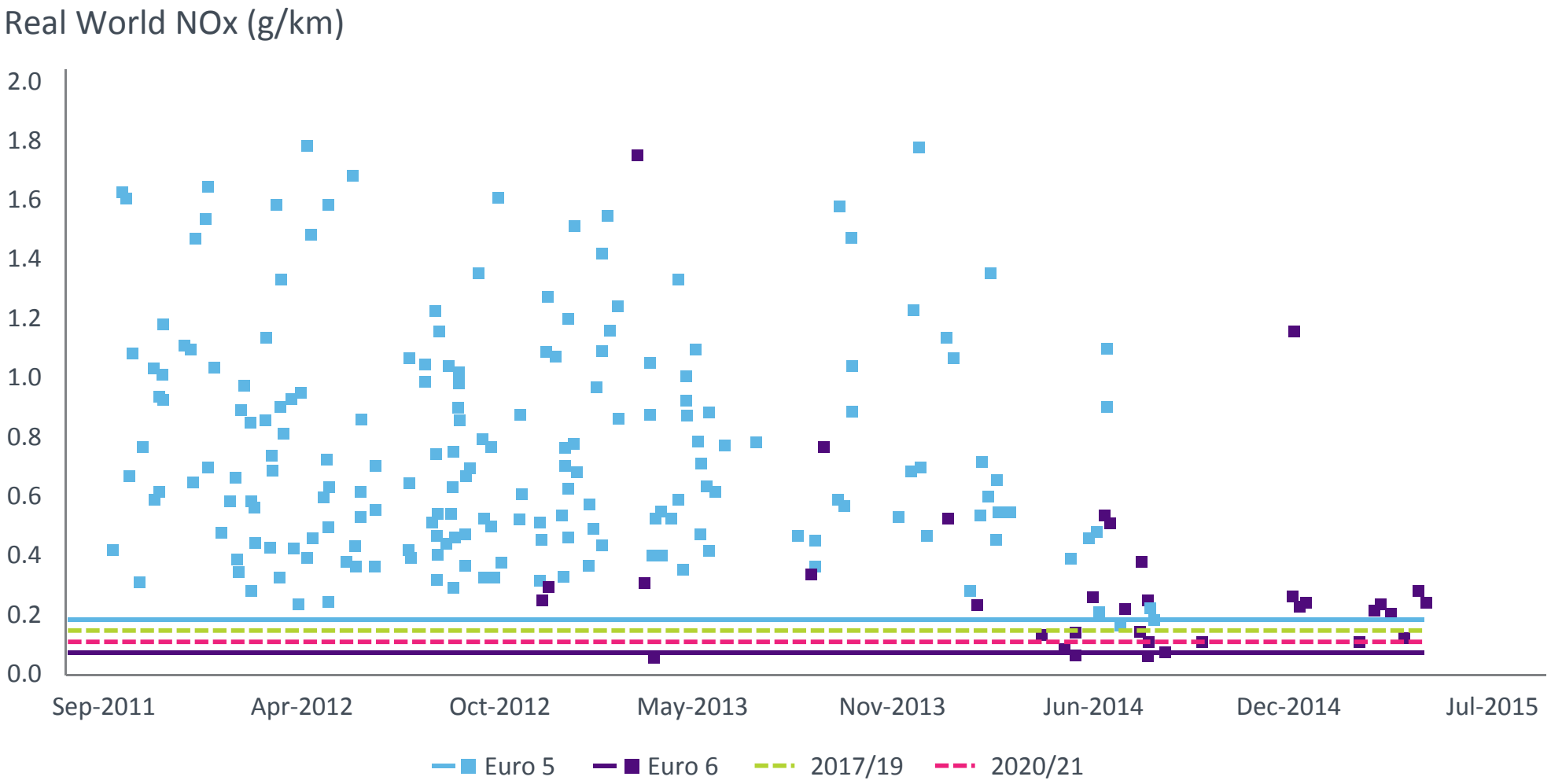
- Allows improved thermal management of catalyst on vehicle
- Technically very demanding system
- May require additional SCR / ammonia slip catalyst (ASC) to maximise NOx conversion
- Higher technology product adds value

Expect shift towards SCR and Advanced SCR for RDE compliance

- Plus some NOx adsorber capability to be incorporated into the DOC for urban NOx control

Euro 6 Technology Already Improving Real World NOx

A third of Euro 6b diesel (and all Euro 6 gasoline) cars tested met 2.1x NOx CF



Source: www.emissionsanalytics.com

Johnson Matthey Gasoline Filter Technologies

Solutions to control gasoline PN emissions

JM to launch two types of coated Gasoline Particulate Filter systems in 2016:

Three Way Catalyst (TWC) plus coated Gasoline Particulate Filter (cGPF)

Three Way Filter (TWF™) plus downstream TWC

- Development partnerships continue with OEMs
- Some applications to meet Euro 6c PN limit through improved engine technology or use of an uncoated GPF
- Expect TWF™ / cGPF uptake to increase with RDE PN limits

Additional technology increases the value of gasoline aftertreatment systems

JM Catalyst Development Focus

Similar themes for both diesel and gasoline catalyst development:

Temperature

- Lower catalyst light-off temperatures and improved cool efficiency
  - Improved fuel efficiency reduces catalyst operating temperatures
  - Increased focus on urban driving

Increased thermal durability

- Gasoline peak ageing temperatures increasing with latest engines
- Effect of soot and sulfur regeneration strategies in diesel systems

Reduced system backpressure

- To maximise power delivery from engine

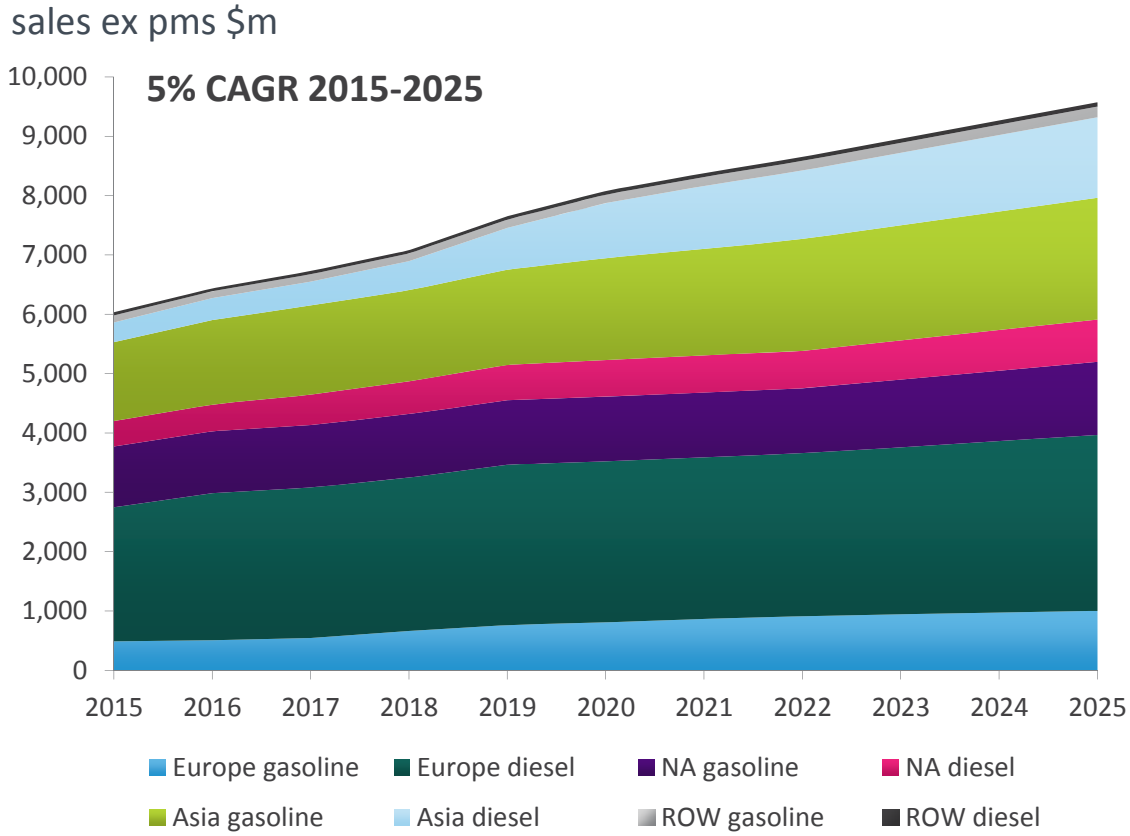
Reduced precious metal content

- Cost control for multi-catalyst systems

Enables JM to offer competitive products to OEMs, protecting our market position

Good Sales Growth Continues in Light Duty

- Market size $6bn in 2015 growing to over $9bn by 2025
- European diesel remains a very important sector
- RDE legislation and GPFs provide opportunities in Europe
- Increasing Asian car sales and tighter legislation adds further growth



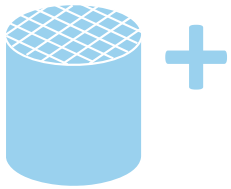
Light duty market continues to grow ahead of global vehicle sales

Chart Data Source: LMC Automotive and JM estimates

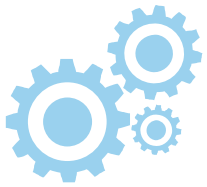
Summary

Emissions legislation continues to tighten around the world

Political and public pressure for clean vehicles



Increased uptake of latest catalyst technologies



Further catalyst development required

Opportunity for growth into next decade, supported by vehicle production, legislation and improved technologies

Regulatory and Technology Trends in the Global HDD Market

Dr Andy Walker
Divisional Technology Director, Emission Control Technologies

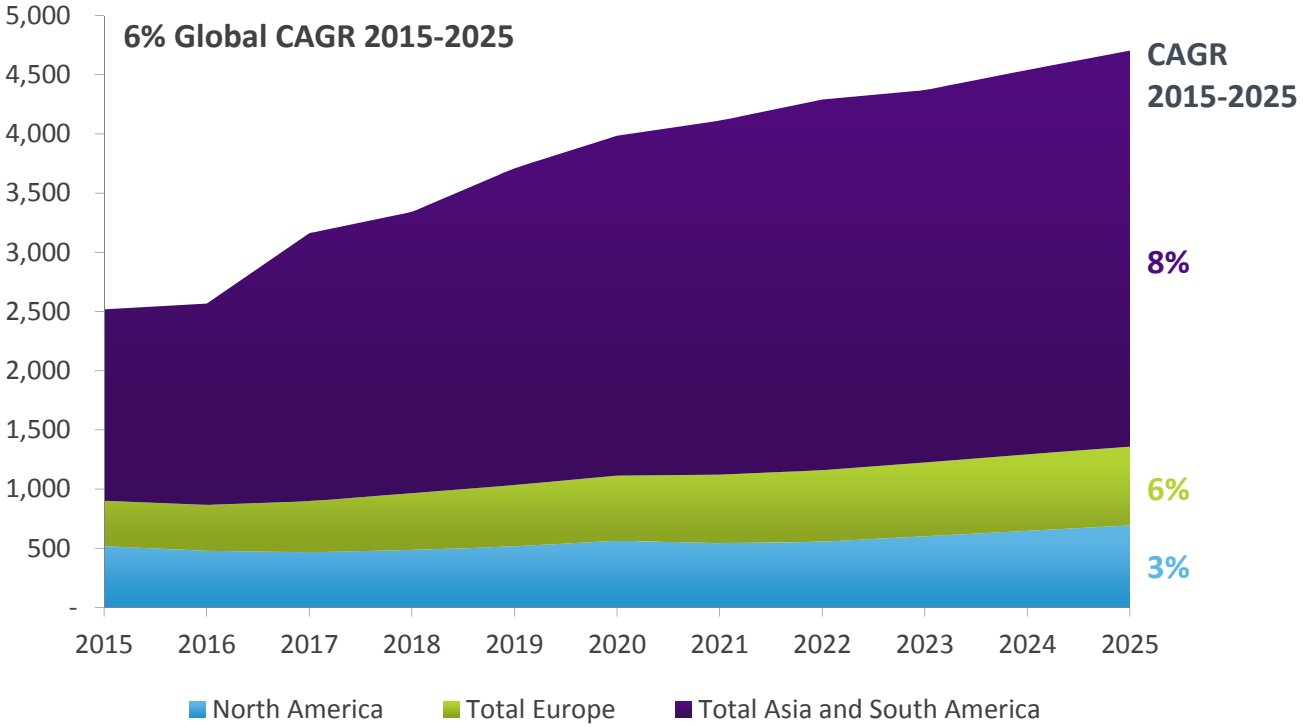
Johnson Matthey

Heavy Duty Vehicle Regulated Engines To Increase

Heavy Duty Regulated Engines Outlook by Region

(calendar years)

thousands



Continued growth to 2025

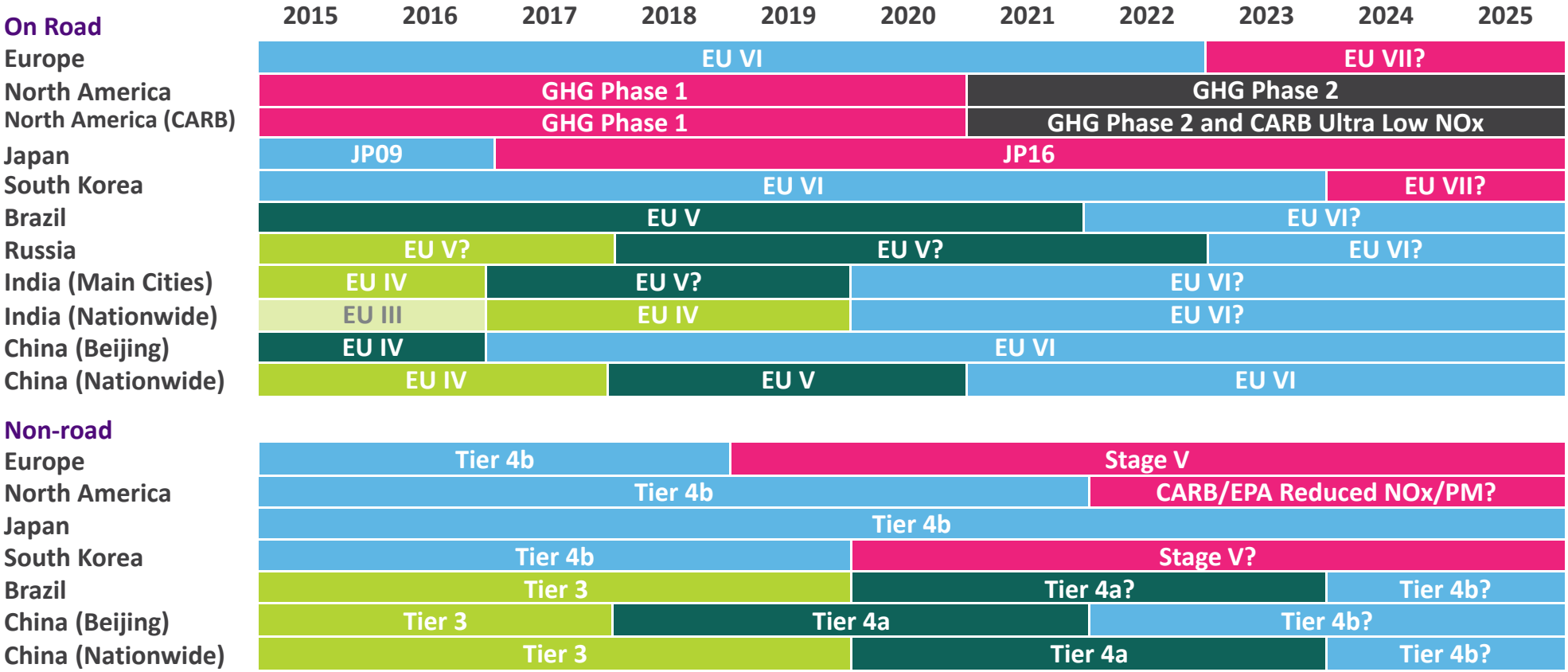
- Rapid growth in Asia, led by China and India
- Good growth in Europe

Continued strong growth in regulated engine production increases demand for JM technologies

Chart Data Source: LMC Automotive and JM estimates for proportion regulated

Further Tightening of Heavy Duty Regulation

Heavy Duty Diesel Emission Control Legislative Roadmap

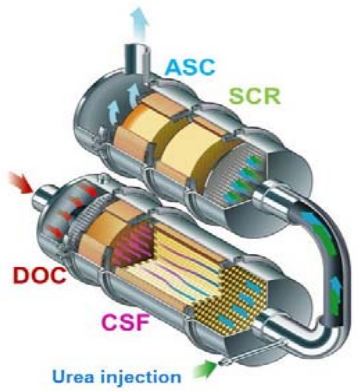


Incoming Europe and North America Regulations

Heavy Duty Diesel Emission Control Legislative Roadmap

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
On Road											
Europe	EU VI								EU VII?		
North America	GHG Phase 1						GHG Phase 2				
North America (CARB)	GHG Phase 1						GHG Phase 2 and CARB Ultra Low NOx				
Japan	JP09		JP16								
South Korea	EU VI								EU VII?		
Brazil											
Russia											
India (Main Cities)											
India (Nationwide)											
China (Beijing)											
China (Nationwide)											
Non-road											
Europe											
North America											
Japan											
South Korea											
Brazil	Tier 3					Tier 4a?				Tier 4b?	
China (Beijing)	Tier 3			Tier 4a						Tier 4b?	
China (Nationwide)	Tier 3					Tier 4a				Tier 4b?	

- **EU VII**
  - Possible NO_2, N_2O and fuel economy regulation to drive new systems design opportunities
- **EPA GHG Phase 2**
  - Further increases in fuel efficiency mandated from engines,
  - Lower catalyst operating temperatures and increased catalyst system NOx conversion needs



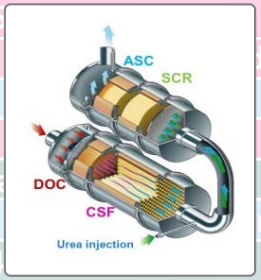
Optimised systems with improved NOx conversion and low temperature performance

China / India EUVI Adds Filters

Heavy Duty Diesel Emission Control Legislative Roadmap

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
On Road											
Europe	EU VI								EU VII?		
North America	GHG Phase 1						GHG Phase 2				
North America (CARB)	GHG Phase 1						GHG Phase 2 and CARB Ultra Low NOx				
Japan	JP09		JP16								
South Korea	EU VI									EU VII?	
Brazil	EU V							EU VI?			
Russia	EU V?			EU V?					EU VI?		
India (Main Cities)	EU IV		EU V?			EU VI?					
India (Nationwide)	EU III		EU IV			EU VI?					
China (Beijing)	EU IV		EU VI								
China (Nationwide)	EU IV			EU V			EU VI				
Non-road											
Europe	Tier										
North America									duced NOx/PM?		
Japan											
South Korea											
Brazil										Tier 4b?	
China (Beijing)	Tier 3								r 4b?		
China (Nationwide)										Tier 4b?	

- **India EUVI:** Filters and SCR on all HDD vehicles
- **China EUVI:** Filters and SCR on all HDD vehicles

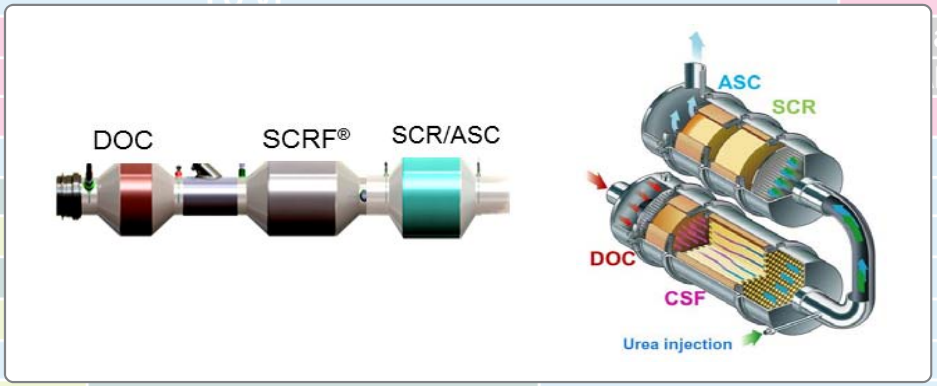


Transition from SCR to SCRT systems increases JM value

EU Non-road Stage V Mandates Filter Fitment

Heavy Duty Diesel Emission Control Legislative Roadmap

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
On Road											
Europe	EU VI								EU VII?		
North America									ase 2		
North America (CARB)									RB Ultra Low NOx		
Japan	JP09										
South Korea										EU VII?	
Brazil									EU VI?		
Russia	EU V?								EU VI?		
India (Main Cities)	EU IV										
India (Nationwide)	EU III										
China (Beijing)	EU IV										
China (Nationwide)	EU IV			EU V			EU VI				
Non-road											
Europe	Tier 4b						Stage V				
North America	Tier 4b							CARB/EPA Reduced NOx/PM?			
Japan											
South Korea											
Brazil											
China (Beijing)	Tier 3			Tier 4a				Tier 4b?			
China (Nationwide)	Tier 3					Tier 4a			Tier 4b?		



- **EU Stage V:** Filters and SCR on all HDD Non Road Mobile Machinery

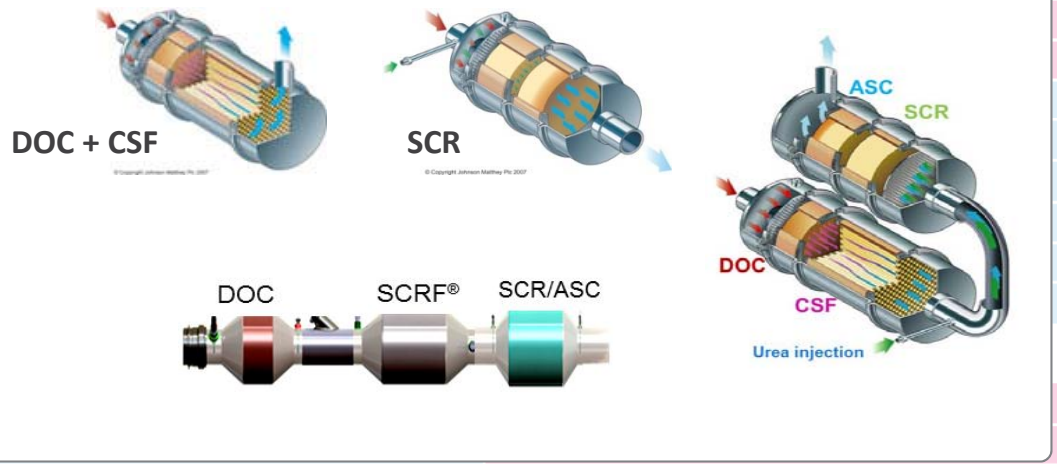
Transition to SCRT and SCRF systems increases JM value

China Non-road Regulations Require Emission Control

Heavy Duty Diesel Emission Control Legislative Roadmap

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
On Road											
Europe	EU VI								EU VII?		
North America	GHG Phase 1								GHG Phase 2		
North America (CARB)											
Japan											
South Korea											
Brazil											
Russia											
India (Main Cities)											
India (Nationwide)											
China (Beijing)											
China (Nationwide)											
Non-road											
Europe											
North America											
Japan	Tier 4b										
South Korea	Tier 4b							Stage V?			
Brazil	Tier 3							Tier 4a?		Tier 4b?	
China (Beijing)	Tier 3			Tier 4a				Tier 4b?			
China (Nationwide)	Tier 3					Tier 4a				Tier 4b?	

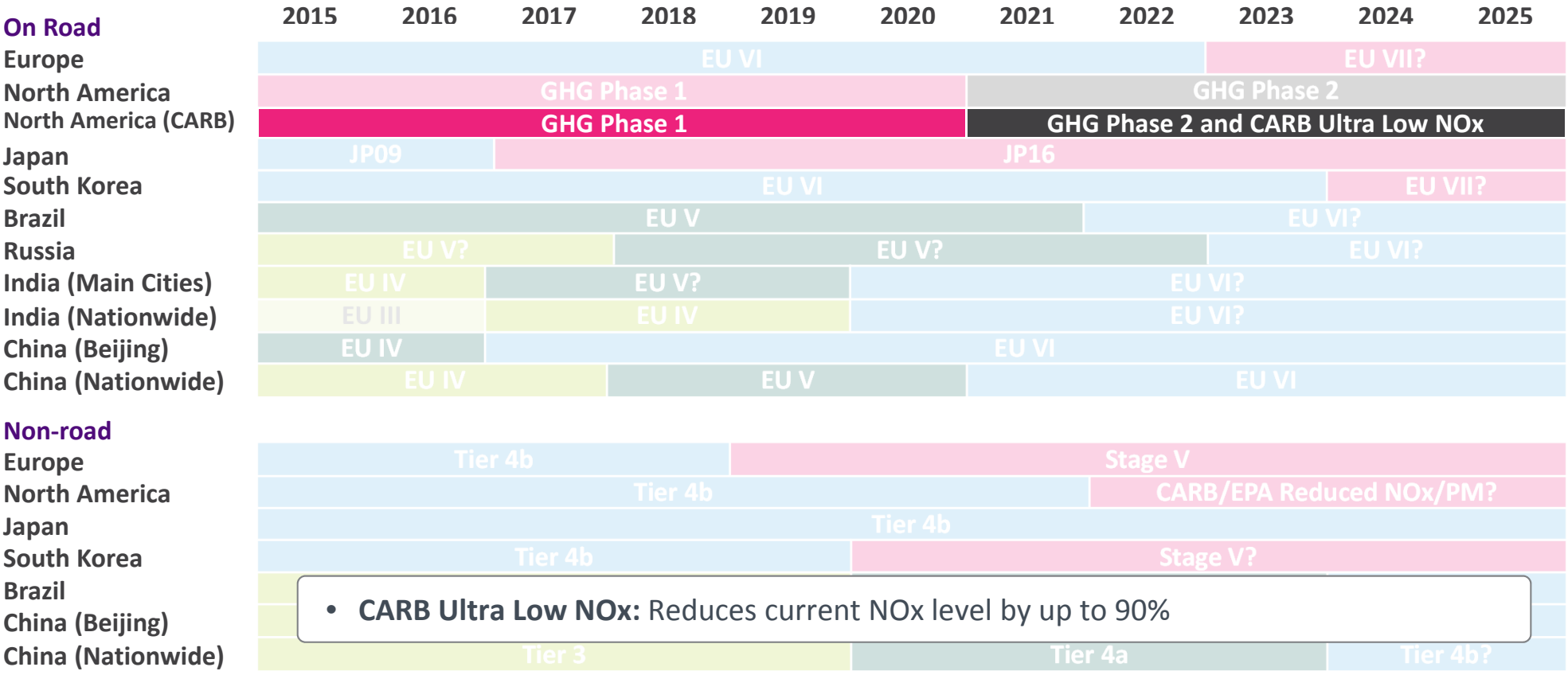
- **China Tier 4a/b:** Filters and/or SCR on all HDD non-road mobile machinery



Introduction of emission control technology brings value to JM

CARB Ultra Low NOx Regulation Proposals

Heavy Duty Diesel Emission Control Legislative Roadmap



- **CARB Ultra Low NOx:** Reduces current NOx level by up to 90%

Complex emission control systems required, likely involving advanced cold start NOx control and SCRF® technology

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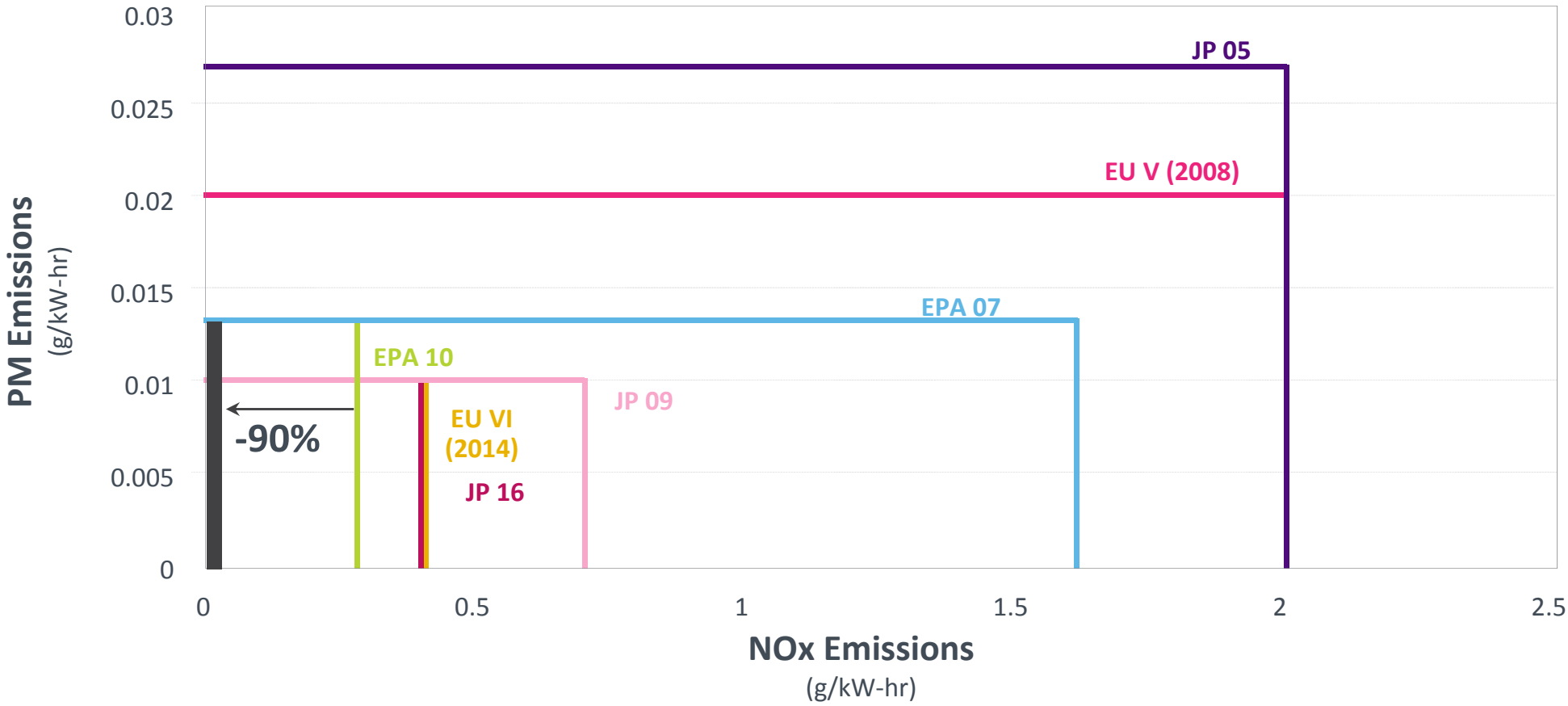
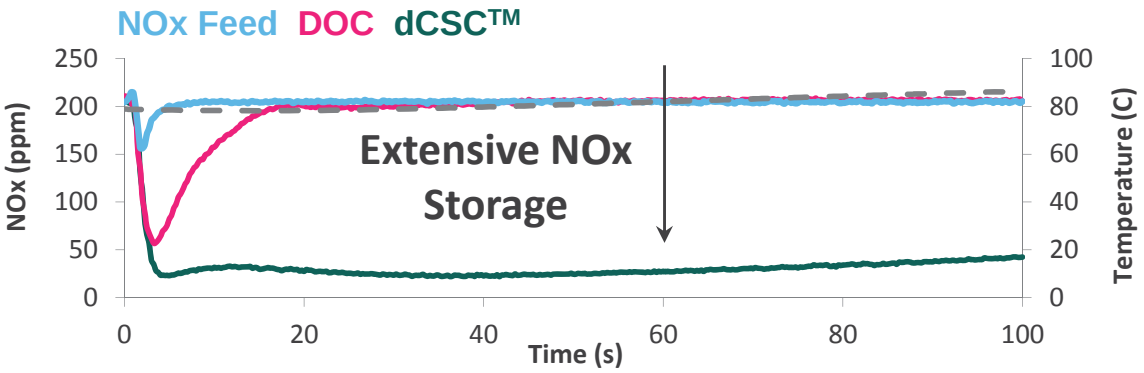
Regulations in the Global On Road HDD market



Focus from NOx control at speed to NOx control at cold start – requires new family of technologies

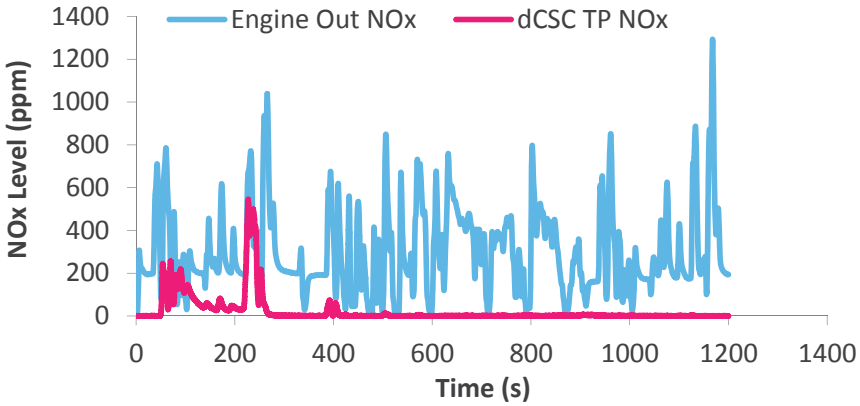
Potential Future Systems Design

Next generation of catalyst technologies



JM's diesel Cold Start Concept (dCSC™) stores NOx at very low temperature, before the downstream SCRF®/SCR system is hot enough to convert NOx

This low temperature NOx storage enables outstanding NOx conversion from cold start, when using the dCSC™ in combination with SCRF® and SCR technology



Potential regulation from 2023 – Increased JM value from more advanced systems

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Ongoing Catalyst System Development Opportunities

Systems for enhanced NOx reduction

Better fuel efficiency / lower CO_2 typically leads to increased engine-out NOx emissions

Lower temperatures

The drive for improved fuel efficiency / reduced CO_2 leads to lower catalyst operating temperatures

Lower N_2O (potent GHG)

Catalyst systems which generate lower N_2O levels

Smaller, lighter systems at lower cost

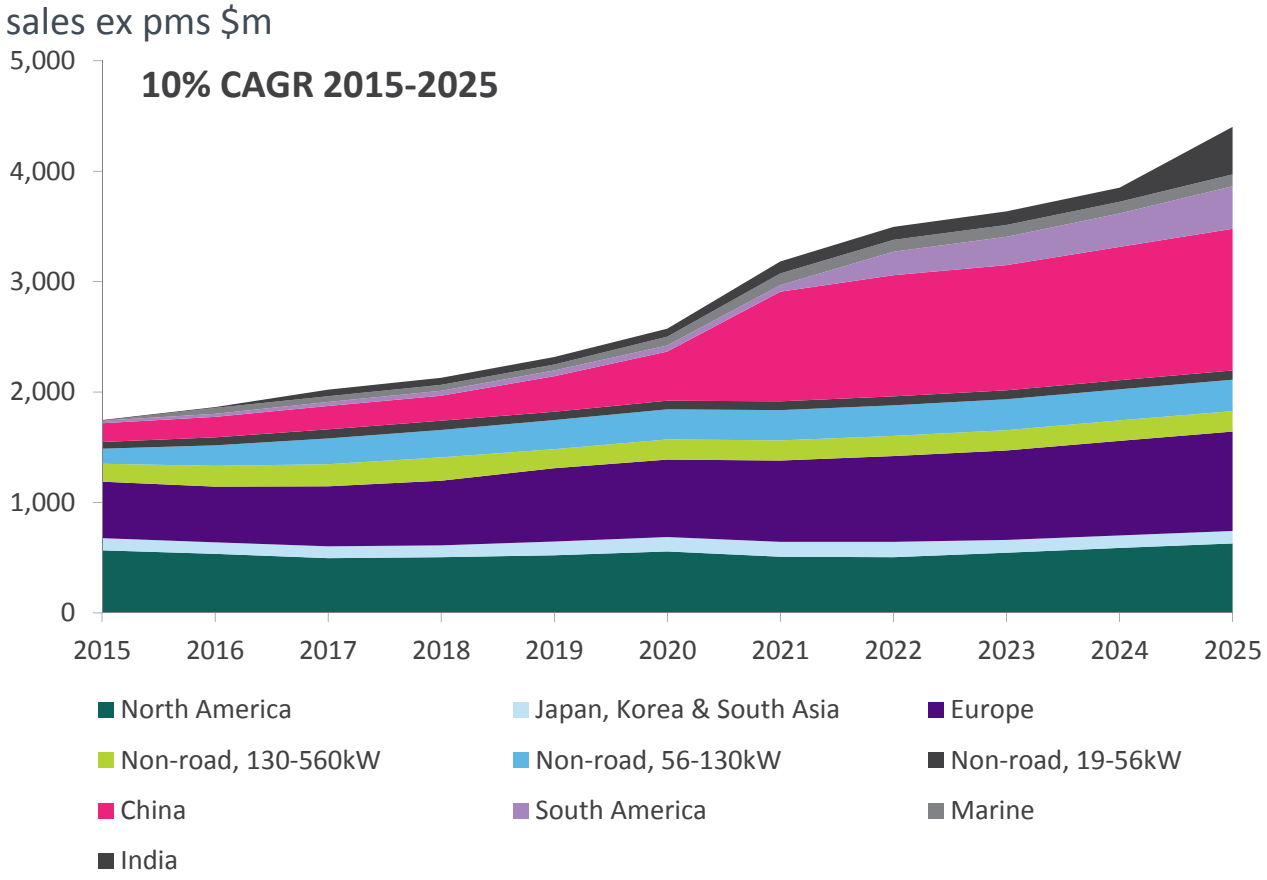
Cost reductions, through e.g. size reduction and pgm reduction

Reduced system backpressure

To maximise power delivery from engine and minimise fuel consumption

A $1.75bn Market in 2015, Growing to Over $4bn by 2025

- Significant growth in China driven by EU VI equivalent implementation
- Europe remains strong contributor
- Regulatory tightening in India and South America adds further growth
- Non-road sector continues to add value



Significant further growth in HDD market driven by tightening legislation and increased production of regulated engines

Chart Data Source: LMC Automotive and JM estimates

Summary

Regulations continue to tighten in the light and heavy duty areas

Criteria pollutants plus fuel economy / CO_2

Regulations drive technology opportunities

R&D and applications expertise leveraged to maintain strong position

Strong customer relationships and regulatory knowledge aligns development to future needs

ECT well placed to drive future growth and capture value

Q&A

Johnson Matthey

Creating Value from Market Opportunities in Battery Technologies

Martin Green

Director, Battery Technologies

Johnson Matthey

Overview

Update

on JM's Battery Technologies business and its position as a credible supplier to the auto industry

Explain

the market opportunities for high performance battery technologies in the transportation sector

Detail

the complexity of the battery materials landscape, current limitations and opportunities to develop next generation products

Highlight

How JM is well placed to capture value as a battery technologies supplier over the next decade

Battery Technologies

Business vision

Vision to be a leading supplier of battery technologies to the LiB sector

- Functional materials
- Automotive focus

Start with M&A to build initial position as a credible supplier

- Internal R&D and further technology acquisitions to build the business

October 2012

Axeon (£41m)

- Applications

October 2014

A123 Assets (£16m)

- Manufacturing
- China
- Exclusive supply

February 2015

Clariant Battery Materials (£49m)

- IP
- Prod development
- Manufacturing
- Established customer base

JM Battery Technologies

Current status

Global business established

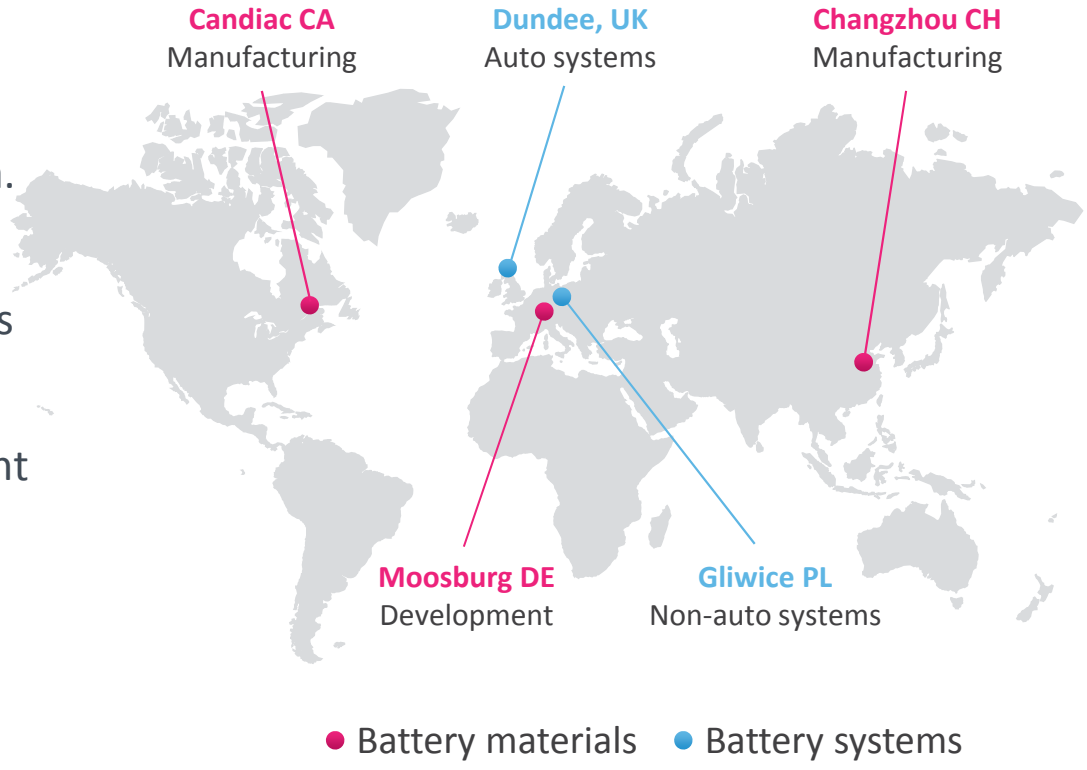
- Customer relationships and sales
- Installed materials capacity ~5,000 tonnes p.a.

Solid automotive position

- Materials supplier to 15 automotive platforms

Continue to invest in the business

- Increased R&D materials product development
- Capacity expansion to meet growing demand
- Technology acquisition / licensing



Battery Technologies 2015/16:
On track for £150m sales (incl. £40m sales of auto battery materials)

JM Position in Automotive Value Chain

Linking chemistry and applications

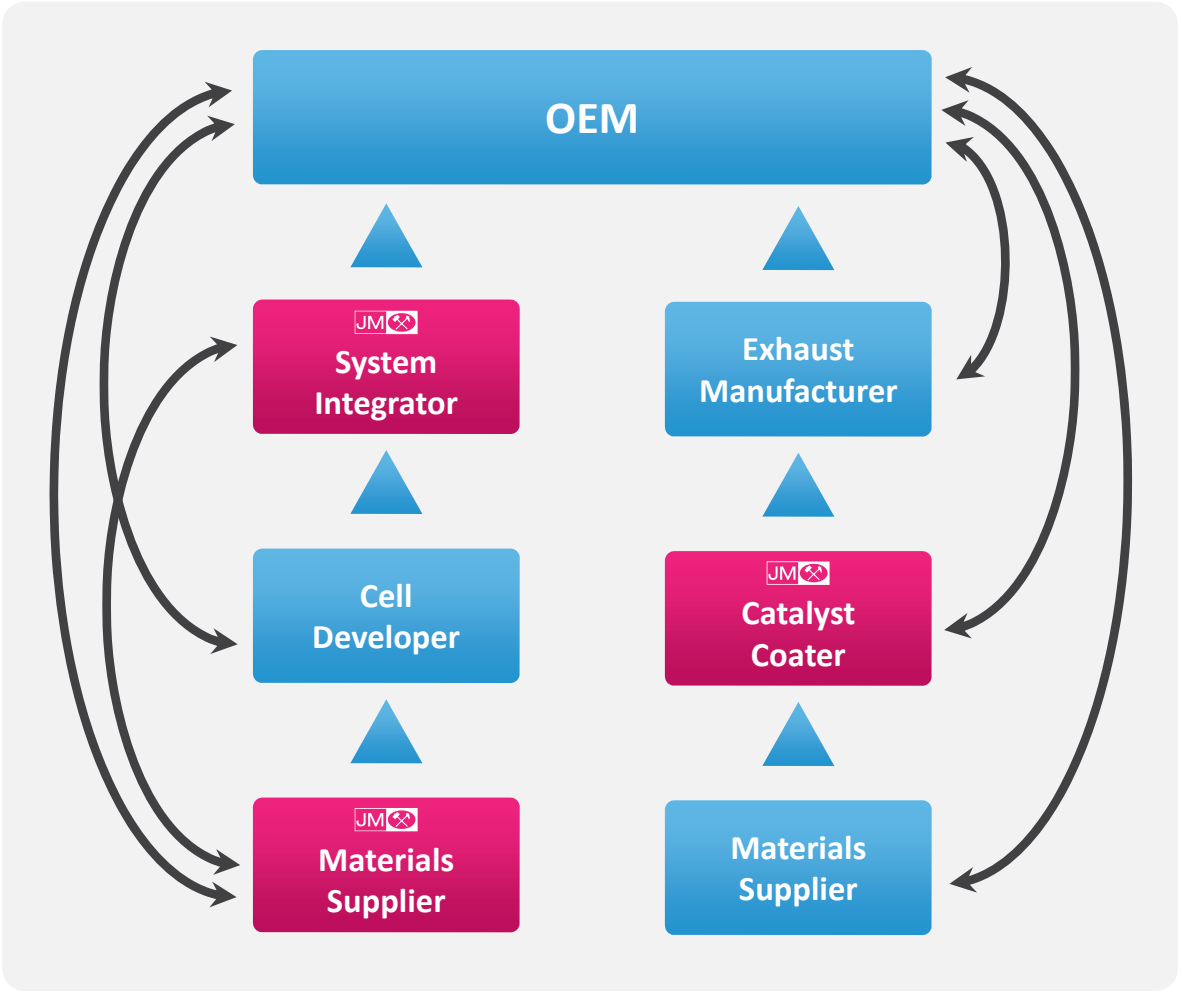
Strong relationships across the value chain

- OEMs
- Cell developers

Proven, long term supplier to the sector

- 8 years in series supply for battery materials
- JM reputation in automotive sector

Deep understanding of automotive supply chain dynamics



Automotive Battery Materials Sector Growing Strongly

Largest materials market today is still the electronics sector

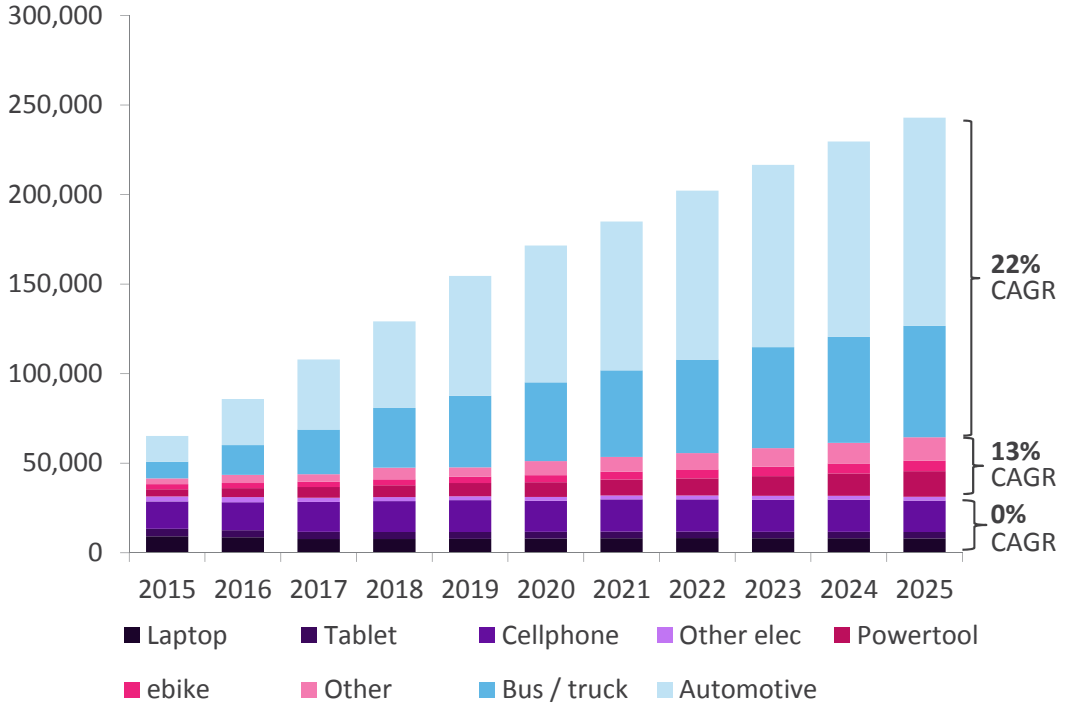
- Mature

xEV sales now substantial and growing strongly

- Automotive
- Bus / truck

Cathode Materials

Market size (MWh)



JM positioned towards high growth sectors

Automotive | Powertool and ebike

Source : B3, JM estimates

Materials Landscape Highly Complex

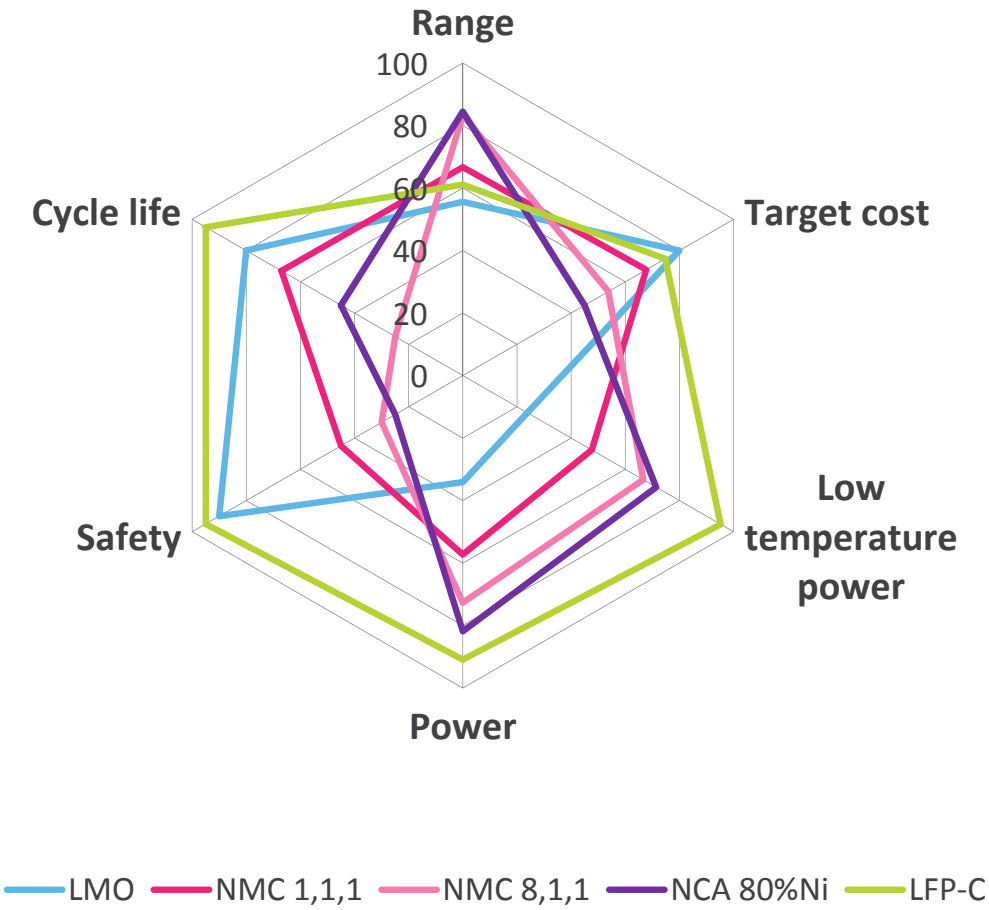
	LCO Lithium cobalt oxide	LMO Lithium manganese oxide	NMC Lithium Ni Mn Co oxide	NCA Lithium Ni Co Al oxide	LFP Lithium iron phosphate
	None 	Chevy Volt  Nissan Leaf 	BMW i3 	Tesla Model S 	Volvo Bus  BYD Qin 
	Legacy		Energy		Power
Base Composition			NMC 1,1,1 NMC 5,3,2 NMC 8,1,1	NCA 80% Ni NCA 85%Ni	LFP LFMnP LCoP
Detailed Composition	Dopants, core shell gradients, surface dopants				
Structure	Nanostructure, particle size, channel structure, porosity				

JM expertise fits with know how required

Images copyright of relevant manufacturer

No Single Material Meets All Requirements

- Different applications demand different properties
- Match material type to performance requirements application
- Optimise material for specific application
- JM current supply position based on LFP



JM estimates. Base bulk material properties, no dopants or optimised metal coatings

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Current Material Landscape

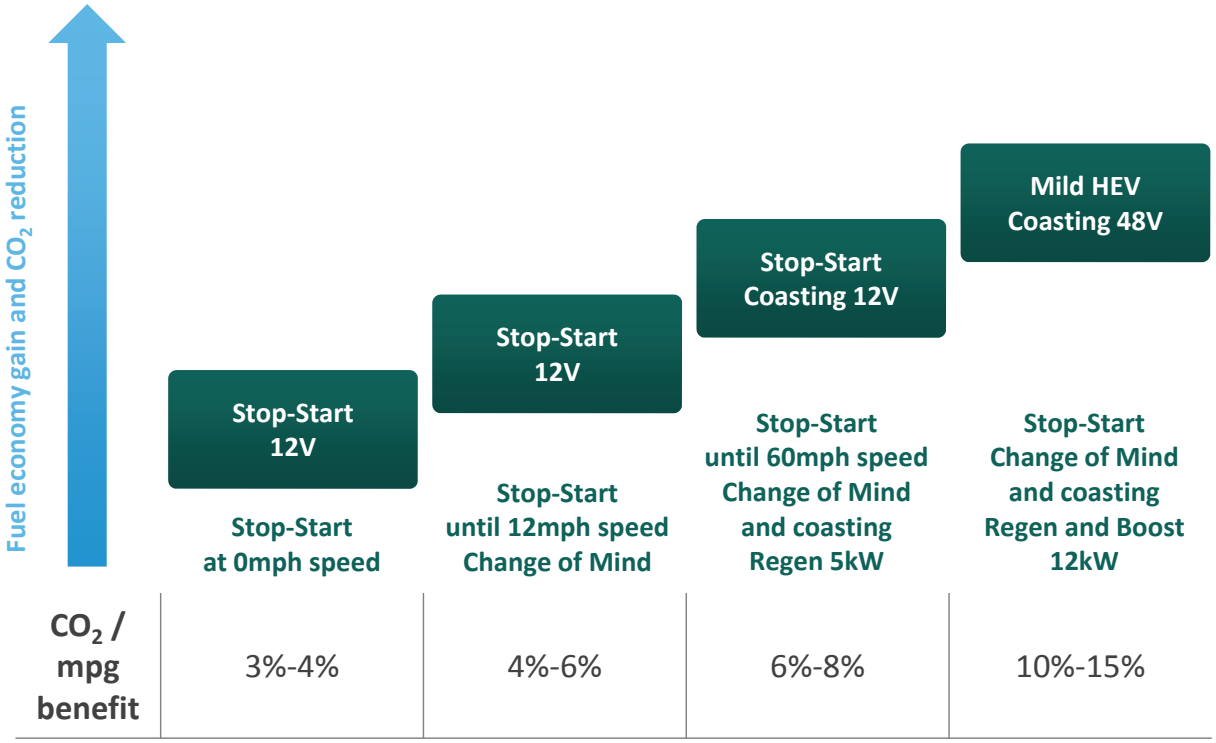
	12v Starter	Micro HEV	HEV	PHEV	BEV medium	BEV long	Delivery van	E-bus
LFP	Major	Major	Major	Major	Minor		Major	Major
NMC		Minor	Major	Major	Major	Major	Minor	
NCA			Minor	Minor	Minor	Major	Minor	
LMO			Minor	Major	Major			

Major Minor

Micro / Mild Hybrids

Moving to the mainstream

- Multiple options for a conventional powertrain
- Driven by CO_2 / mpg regulations
  - Cost effective
- Rapid growth expected in EU and US
- LFP well suited to these applications



JM Strategy

Opportunity for JM at both material and systems level | Incremental market £100m p.a. by 2025

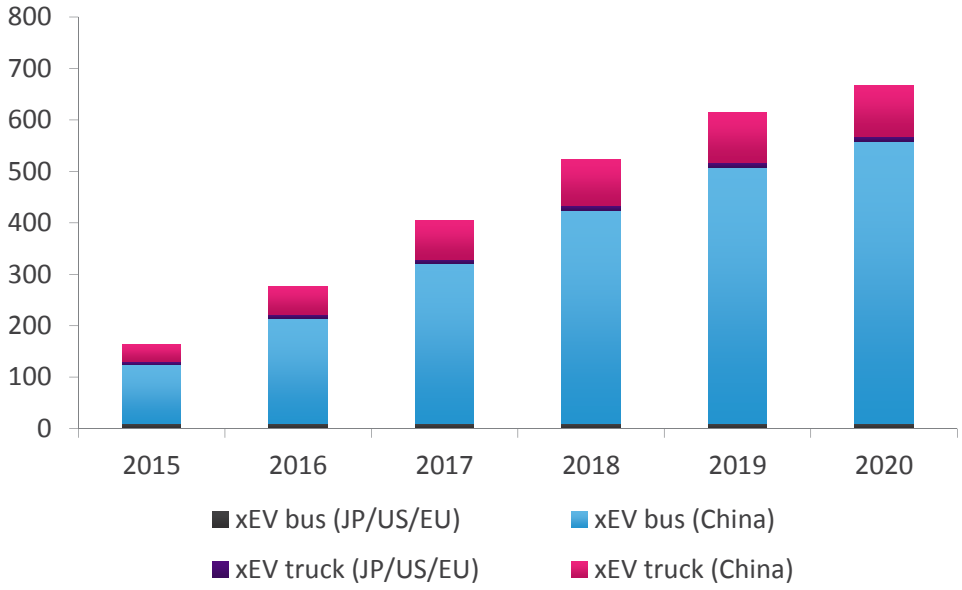
EV Bus / Truck

Meeting the challenge of clean cities

- Substantial and growing market
- Most activity in China
  - Domestic and export market
- Safety is critical
  - High quality LFP is required
- JM well placed today with major bus producers

Market Size

(000s vehicles)



JM Strategy

Build on existing relationships and supply position | Optimised materials for enhanced performance

Incremental market £1bn p.a. by 2025

Source: B3

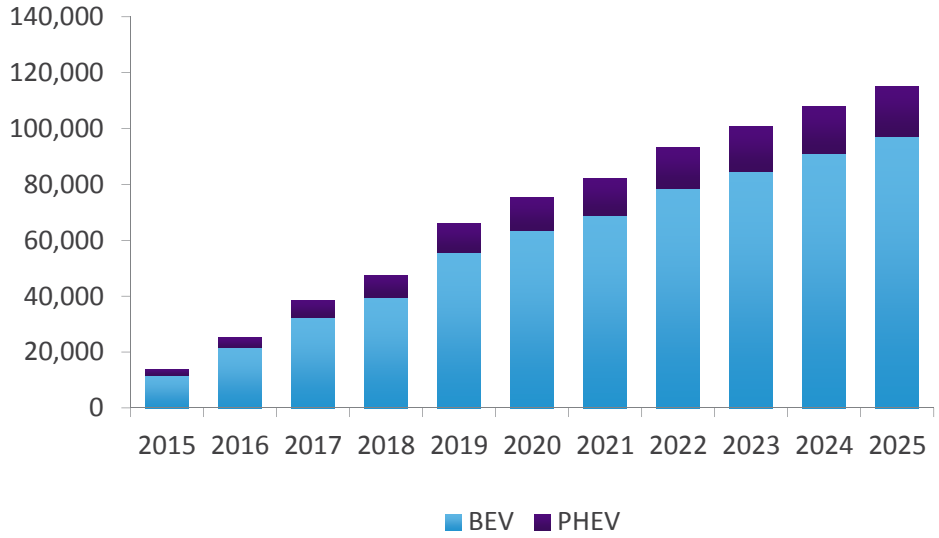
BEV/PHEV

Rapid growth will continue

- Wide range of materials used currently
  - LMO, NMC, NCA, LFP
- Substantial gap between performance and OEM requirements
- JM participates in China (LFP)
- Major growth opportunity, building on existing relationships

Global Automotive BEV/PHEV

Market size (MWh)



JM Strategy

Advanced discussions in progress to secure IP and commercial position

Maintain and grow existing position in LFP-based BEV/PHEV

Source: B3

Johnson Matthey

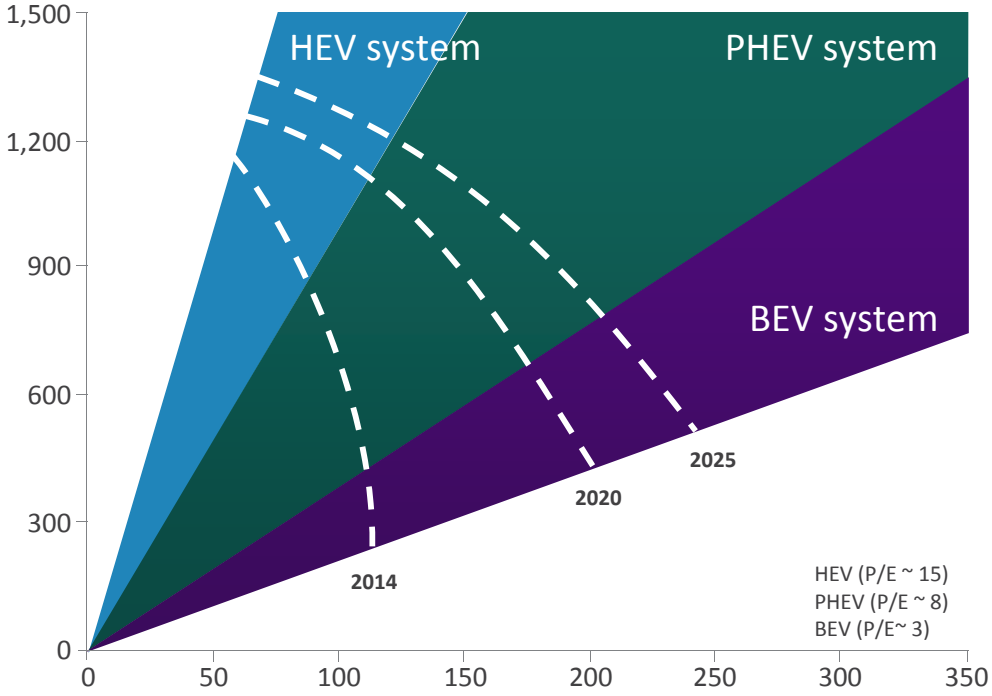
Adding Value Through Technology

Meeting market needs

- Performance improvements from
  - Materials
  - Cell design
  - System engineering
- Collaboration across the value chain required to deliver these improvements
- JM's relationships with cell companies and OEMs is already building this collaboration
- JM's applications knowledge provides insight into delivering improvements at systems and material level

An OEM Perspective

Specific power @ systems level / Wkg^{-1}



Specific energy @ systems level / $Whkg^{-1}$

Chart source: Andre et al., J. Mater. Chem A, 2015,3, 6709

Battery Technologies – Key Takeaways

Credible Player
£150m sales 2015/16
15 automotive platforms

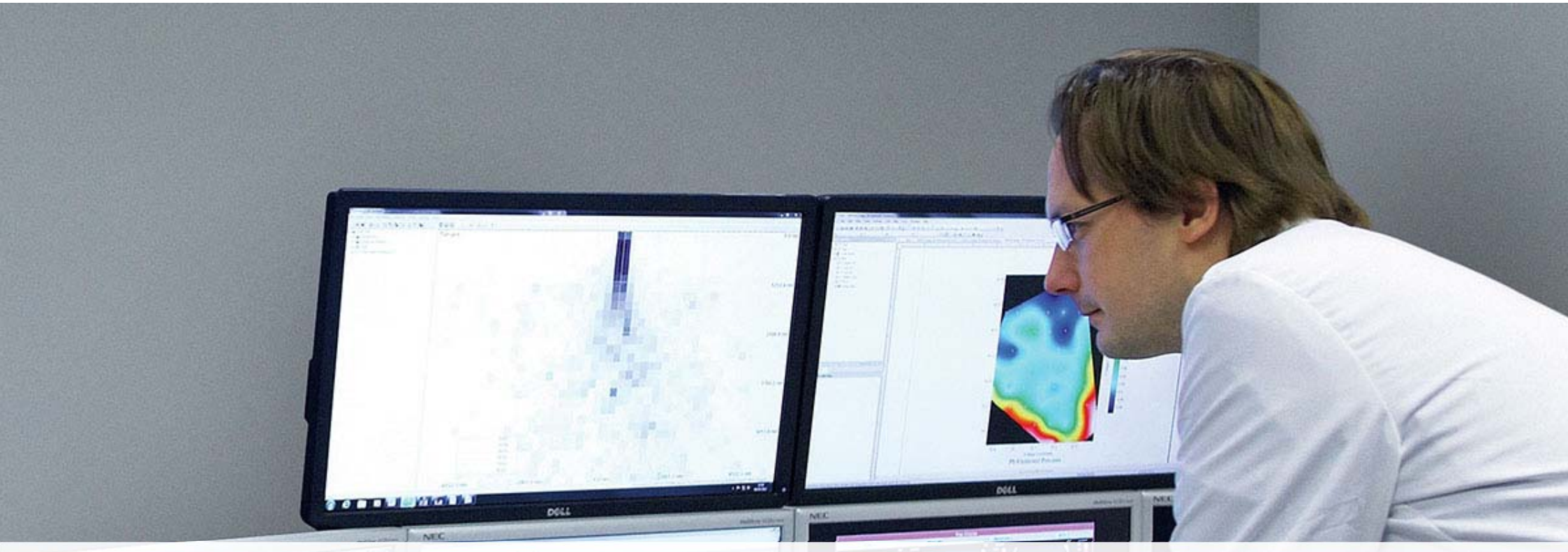
Strong Market Focus
Automotive and other high performance sectors

Positive Contribution
Profitable today, increased R&D

Good Foundation for Growth
Technology, applications, OEM relationships

Broadening Technology Base
Advanced discussions underway

Excellent Prospects
On track to deliver long term sales targets



Science and Technology

Delivering Sustainable Solutions to Customers

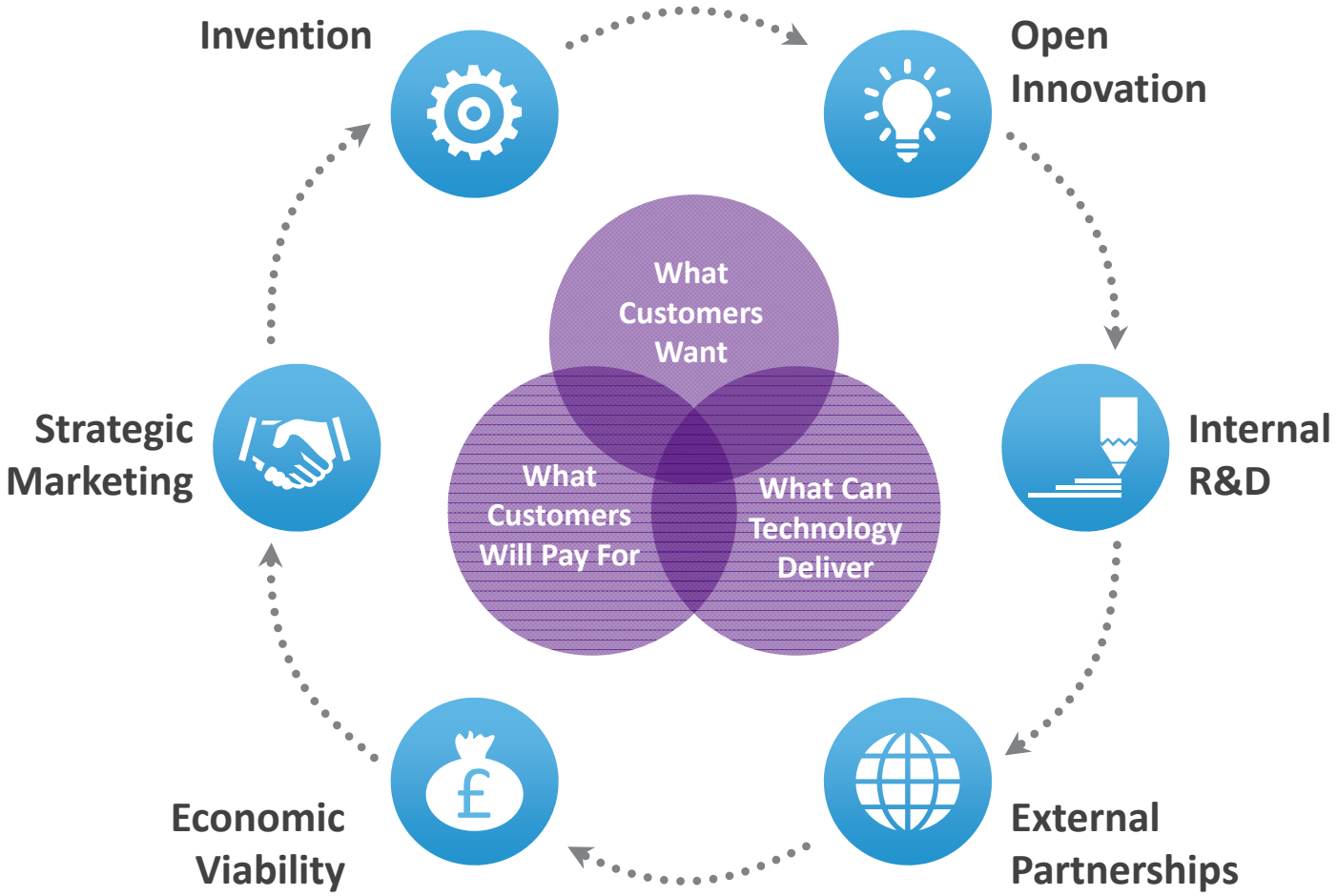
Alan E Nelson, Ph.D., P.Eng.

Chief Technology Officer

Johnson Matthey

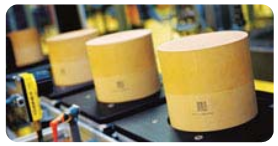
Innovation Ecosystem

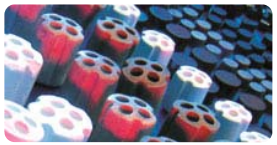
Innovation translating to revenue

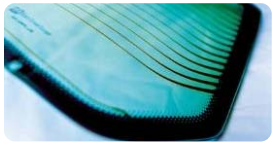


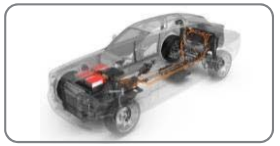
Science and Technology Integration

Technical capabilities and applications expertise









Emission Control Technologies	Process Technologies	Precious Metal Products	Fine Chemicals	New Businesses
Automotive	Chemicals Oil and Gas	Chemicals Automotive Life Sciences	Life Sciences Chemicals	Automotive Life Sciences Chemicals

Chemistry and Catalysis

Functional Materials

Formulation Sciences

Pgm and Base Metals

Advanced Characterisation

Innovation Portfolio Management

R&D Innovation Portfolio Management

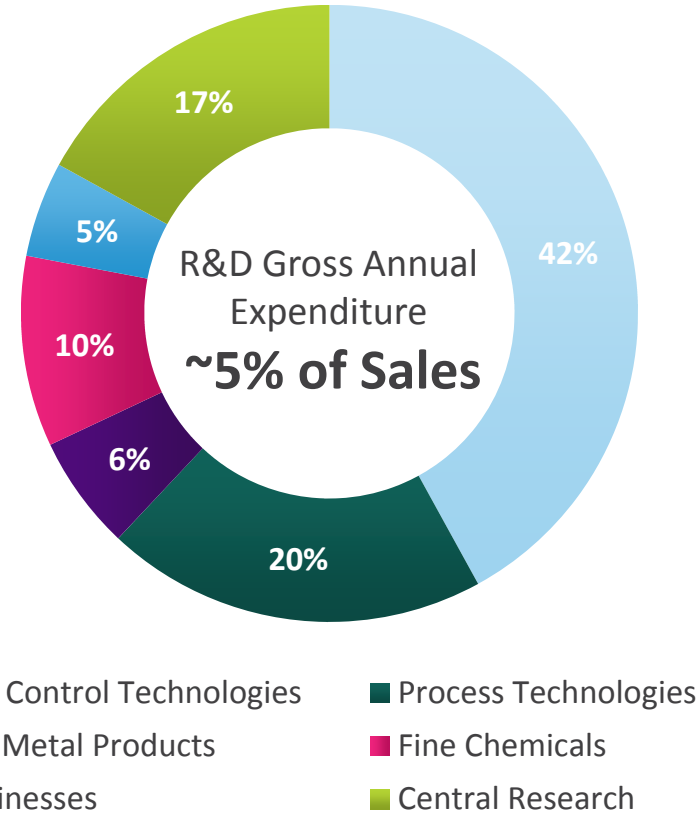
Sustained value capture and growth

NPV portfolio valuation to quantify return on R&D investment

Innovation margin to ensure new products capture value and growth

Patent advantaged sales to ensure patents protect competitive advantage

Distribution of Research and Development Expenditure



Opportunity Landscape in Automotive Powertrain

Leading solutions provider to the automotive industry

Advanced Materials

Industry leading emission control catalysts, lighter and stronger materials to reduce vehicle weight

Alternative and Low Carbon Fuels

Increased production and utilisation of low carbon and renewable fuels (incl. blends)

Energy Storage Devices

Improved performance and cost of lithium-ion batteries and hydrogen fuel cells

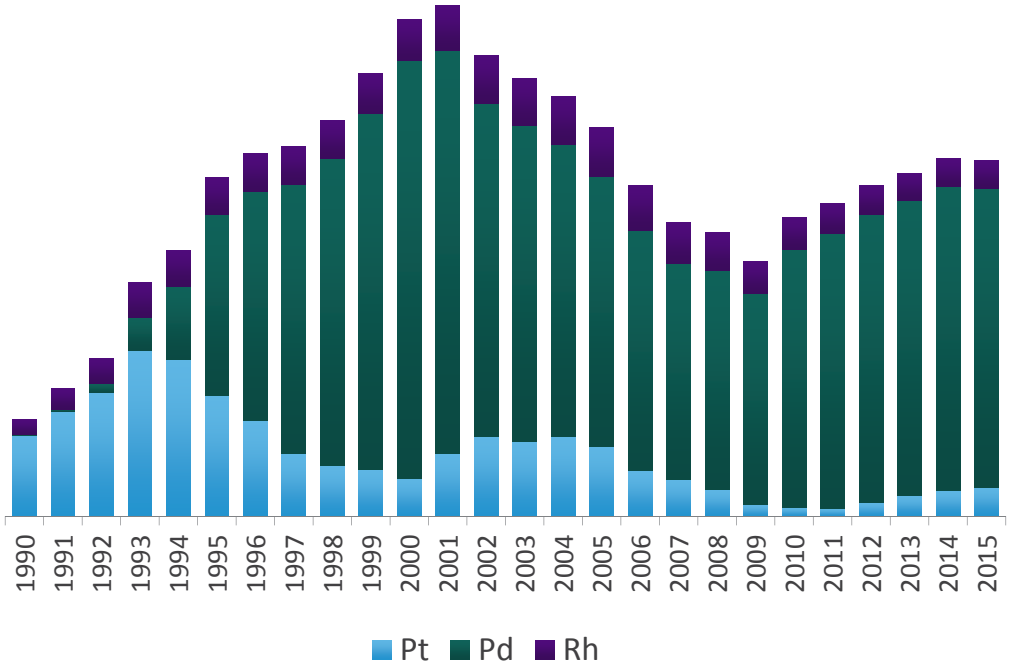
Autonomous and Driver Assist Systems

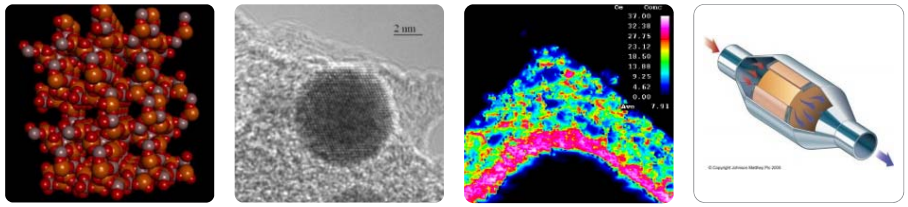
Improved fuel efficiency and emission control systems resulting from predictive acceleration and braking

Emissions Control Systems

Successful technology development with customers

Gasoline Pgm Demand (Europe)





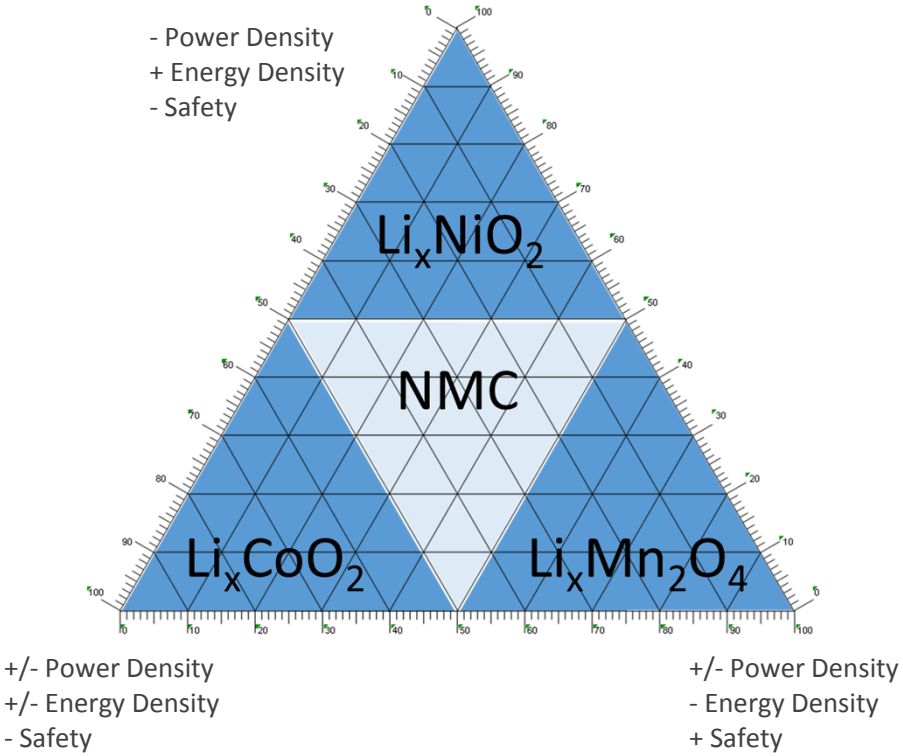
- **Sustained investment** in emission control technology to develop customer focused solutions
- Unique combined strengths in **science and application development** to drive innovation
- Continued **optimisation of materials and catalysts** in partnership with industry – higher performance with lower pgm usage

Material science + applications know how = innovative solutions

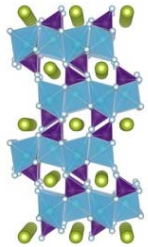
Lithium-Ion Battery Materials

Innovating the optimum cathode material

NMC Cathode Chemistry



- **Cathode**
- Anode
- Electrolyte
- Separator



LFP: $LiFePO_4$
+ High Power Density
+ Excellent Safety
+ Long Cycle Life

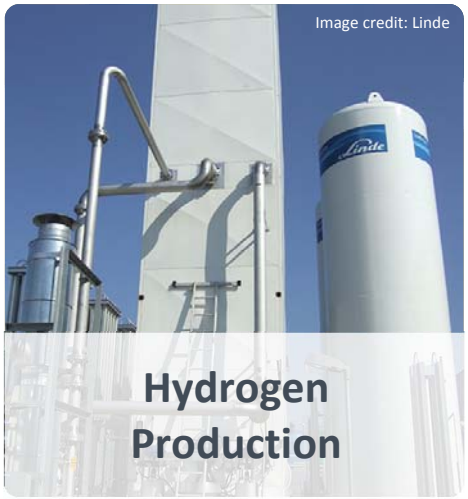
- Energy storage applications require **unique cathode materials** – safety, power, energy, lifetime
- Key **technology challenge** to develop a cathode material with the best of all properties
- Our materials science expertise and integration in battery systems are an **innovation differentiator**

Material science + applications know how = innovative solutions

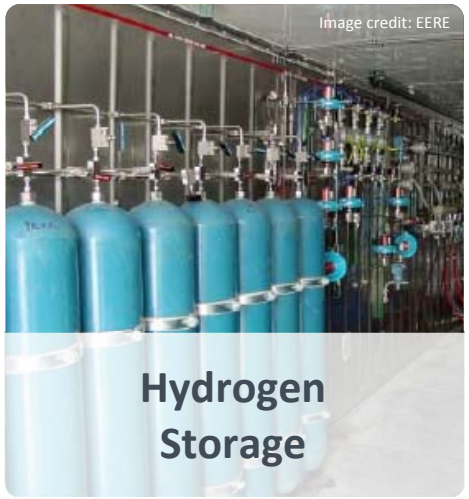
Johnson Matthey

Fuel Cell Materials and Systems

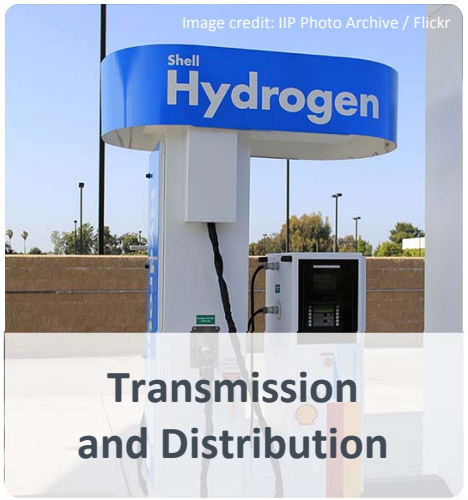
Harnessing the power of clean energy



- Hydrogen is an energy storage material
- Must be produced from another source of energy



- Low volumetric energy density
- Pressurisation into compressed gas or liquid



- Lack of current infrastructure
- Point source generation and / or supply is desirable

Johnson Matthey is an innovation leader in hydrogen fuel cell science and technology

Innovation required throughout the hydrogen value chain

Alternative and Low Carbon Fuels

Innovation beyond the powertrain system

Catacel highly energy efficient catalyst solutions for clean fuel production

- Catacel's SSR® (Stackable Structural Reactor) technology is novel catalyst technology
- Ability to increase output **10-25%** in existing hydrogen plants
- Reduction in overall OpEx due to **higher operating efficiency**

Ultra low emissions methanol catalyst and process technology

- Industry leading reforming technology can reduce greenhouse gas (GHG) **emissions at a methanol facility up to 75%**
- Process technology enables **2.3-3.5%** lower total gas usage in comparison to competitive schemes (US $1.8-2.8 m/year for 100mSCFD)

Double Green Bridge NW INNOVATION WORKS cecc 上海碧科

Advanced Materials and Lightweighting

Long term research investment for growth

Precursors for 3-D printing and additive layer manufacturing (ALM)

- Unique expertise in **metals and powder metallurgy** to enable the development of spherical powders
- ALM has the potential for **60-70%** reduction with equal strength – key lightweighting opportunity
- Potential **£100m** market opportunity for ALM materials in 2025

Renewable materials for the production of engineering plastics

- Key external partnerships with Rennovia and BioAmber
- Lower energy requirement than traditional petrochemical processes – up to **50%**
- GHG emissions reduction of **85%** for adipic acid production (significant reduction in NO_2)

How We Deliver Innovation

Industry leadership in science and technology

Customer focus

Customer focused new product design and development

Strategic relationships with customers to drive long term growth

Science and Technology

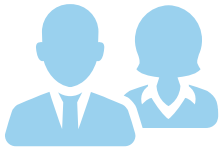
Industry leading expertise in materials science and engineering

Innovate where material science and engineering drives success

Portfolio Management

Innovation metrics to drive productivity and value capture

Governance across all areas of corporate technology



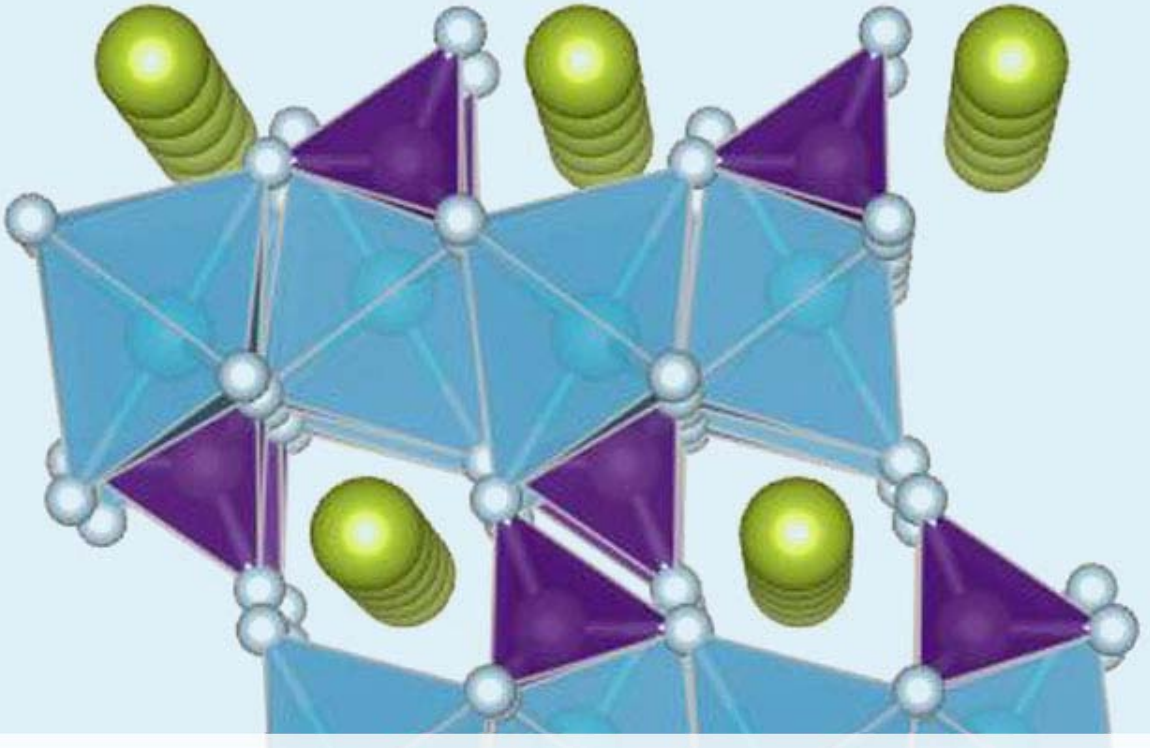
People and Culture

200 years of innovation in material science and engineering

Outstanding scientific and technical talent close to customers

Q&A

Johnson Matthey



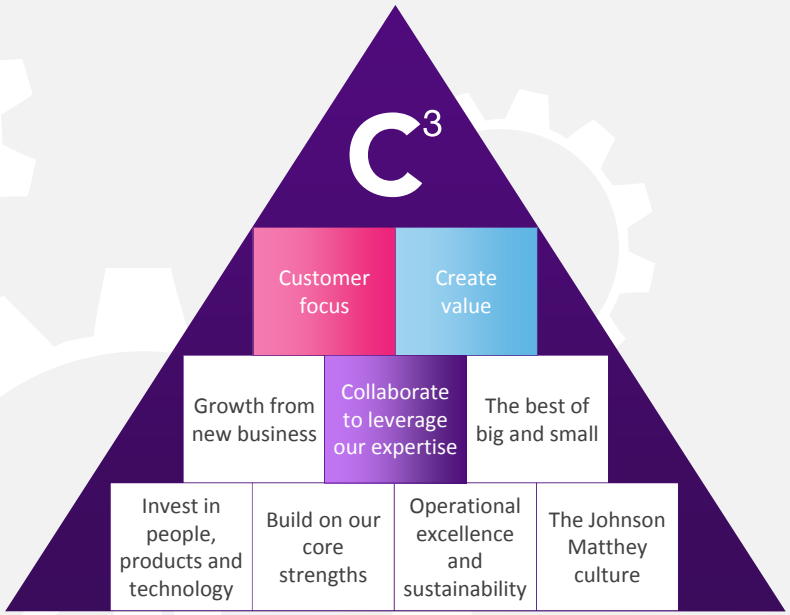
Closing Remarks

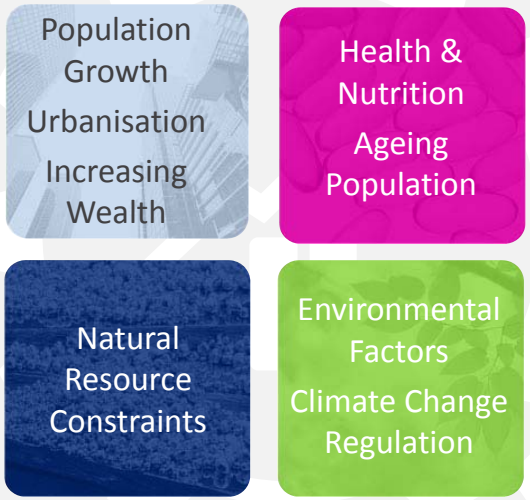
Robert MacLeod

Chief Executive

Johnson Matthey

Robust Strategy and Strong Market Drivers





JM is high technology solutions provider into growth markets

Imperative for Improved Air Quality Supports Growth

Legislation continues to tighten at pace

- Regulated pollutants and CO_2 in focus
- ICE remains main powertrain technology for next decade; increased hybridisation
- Increased opportunity for JM from diversified powertrain

ECT

Increased demand for complex catalysts and hence more value over next decade

- JM a leading technology provider

Medium term targets remain

Battery Technologies

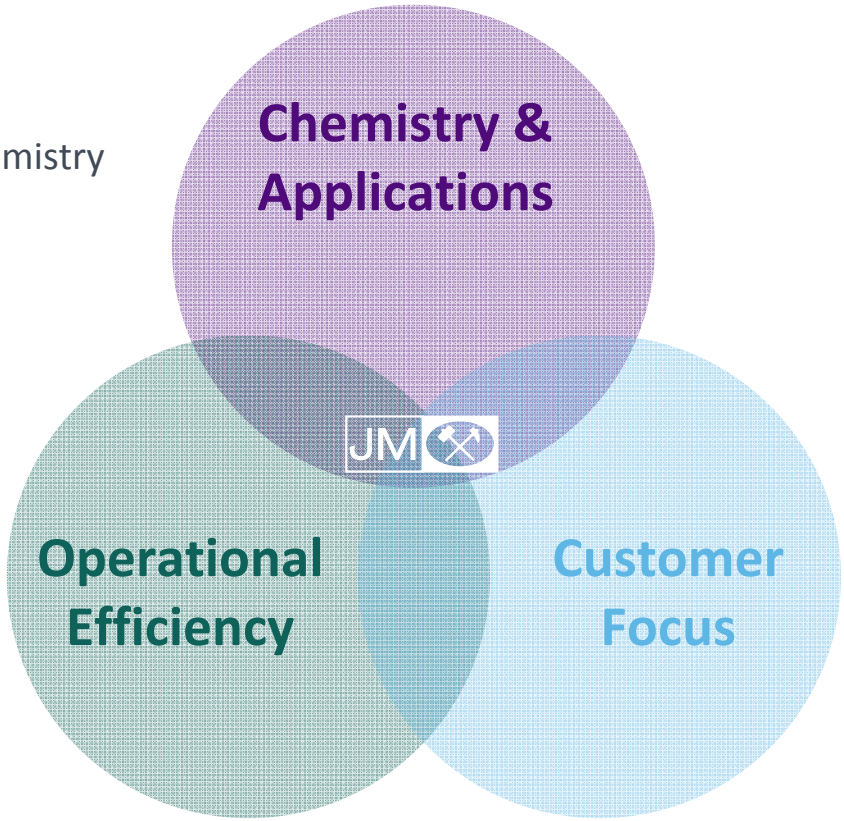
Growing market for battery materials expected to expand

- JM player in current market
- Investing to capture value as market evolves

JM roadmap on track

The JM Advantage in Powertrain Solutions

- Strong expertise in translating metal chemistry solutions into auto applications



- Ability to scale up
- Efficient manufacturing
- Well positioned in supply chain

- Deep relationships with OEMs
- Strong reputation
- Understand future needs

JM well placed to capture value from evolving powertrain

In Summary…

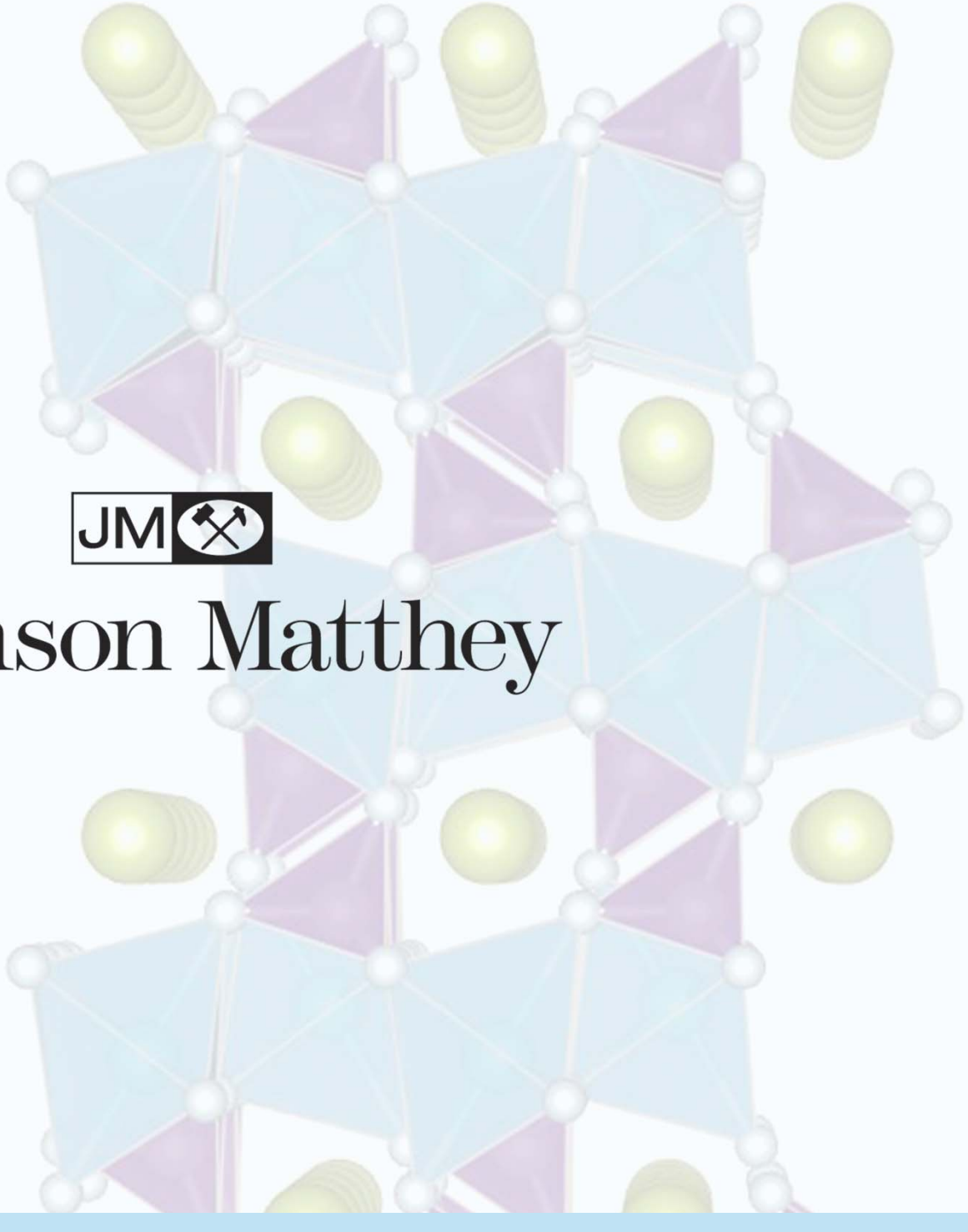
JM has robust strategy and strong market drivers

Evolution of the powertrain requires high technology solutions

Clear technology roadmap supports strong growth for ECT over next decade

Good growth from Battery Technologies in medium term; investing for 2020 and beyond

JM remains well placed for sustained long term growth



JM

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JM Executive Board

Robert MacLeod
Chief Executive

Den Jones
Group Finance Director

Larry Pentz
Executive Director

John Walker
Executive Director
Emission Control Technologies

Presentation Team

Robert MacLeod
Chief Executive

Nick Garner
Division Director
New Businesses and
Corporate Development

John Walker
Executive Director
Emission Control
Technologies

Dr Chris Morgan
European Technology
Director
Emission Control
Technologies

Dr Andy Walker
Divisional Technology
Director
Emission Control
Technologies

Martin Green
Director
Battery Technologies

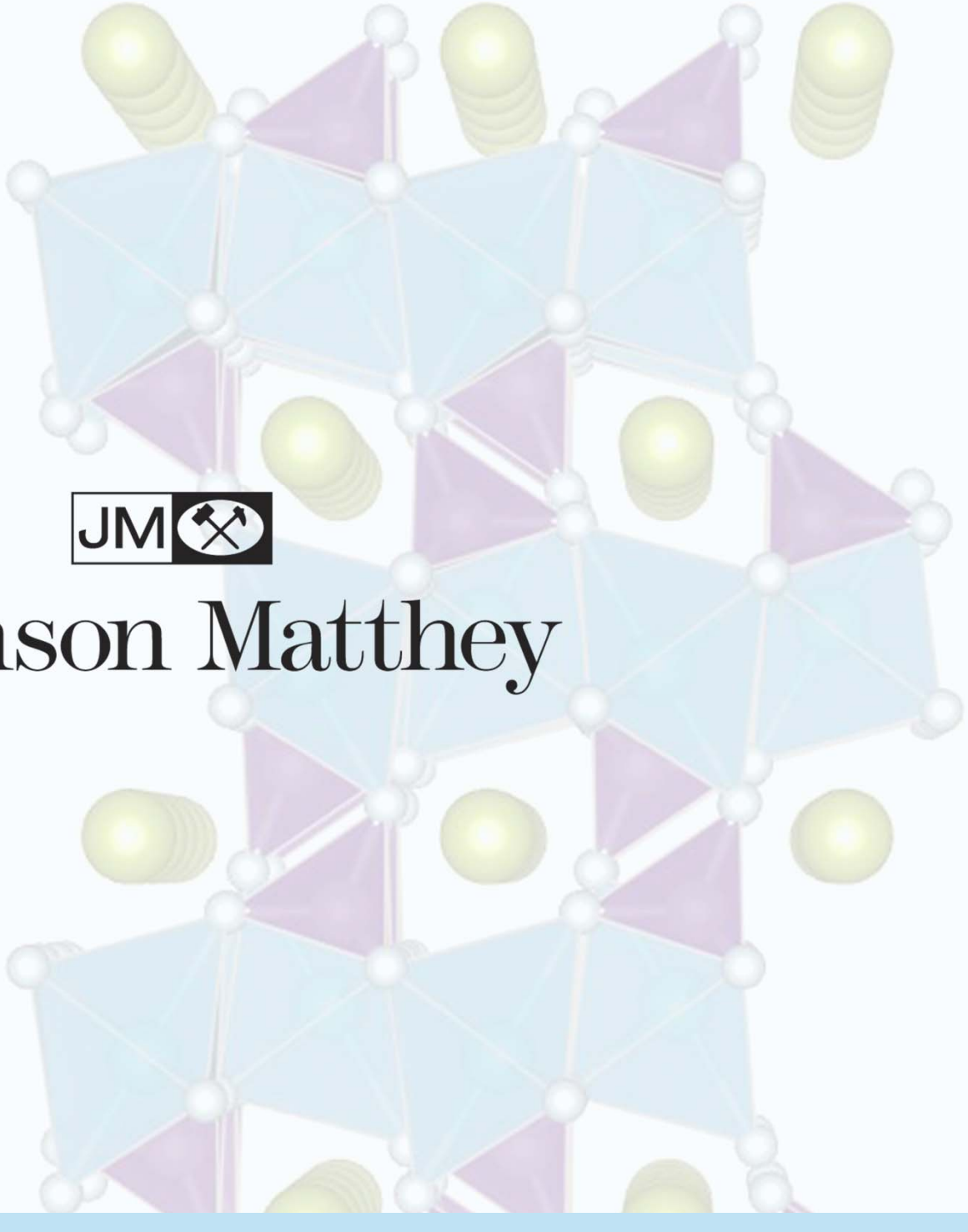
Dr Alan Nelson
Chief Technology
Officer

Glossary

ACT	Atmosphere Control Technologies
ALM	Application lifecycle management
ASC	Ammonia slip catalysts
bbl	Oil barrel, a unit of volume
BEV	Battery electric vehicle
CAGR	Compound annual growth rate
Capex	Capital expenditure
CARB	California Air Resources Board
CF	Conformity factors
cGPF	coated gasoline particulate filter
CH_4	Methane, natural gas
CNG	Compressed natural gas
CO_2	Carbon dioxide
CTC	Coal to chemicals
Cu	Copper
DOC	Diesel oxidation catalyst
dCSC	diesel Cold Start Concept
ebike	Electric bike
ECT	Emission Control Technologies
EGR	Exhaust gas recirculation
EPA	Environmental Protection Agency (US)
EREV	Extended range electric vehicle
EU	European Union
EV	Electric vehicle
FC	Fine Chemicals
FCEV	Fuel cell electric vehicle
GDI	Gasoline direct injection
GHG	Greenhouse gas
g/km	grams per kilometre
HDD	Heavy duty diesel
HEV	Hybrid electric vehicle
IC	Internal combustion
ICE	Internal combustion engine
IP	Intellectual property
JM	Johnson Matthey
JMTC	Johnson Matthey Technology Centre
kW	Kilowatt
kWh	Kilowatt hour
LCO	Lithium cobalt oxide
LDV	Light duty vehicle
LEV	Low emission vehicle
LFMnP	Lithium iron manganese phosphate
LFP	Lithium iron phosphate
Li-air	Lithium-air, a type of battery cell chemistry
Li-ion	Lithium-ion, a type of battery cell chemistry
Li-S	Lithium-sulfur, a type of battery cell chemistry
$LiCO_2$	Lithium cobalt oxide (chemical formula)

Glossary

$LiFePO_4$	Lithium iron phosphate (chemical formula)
$LiMn_2O_4$	Lithium manganese oxide (chemical formula)
LMO	Lithium manganese oxide
LPG	Liquefied petroleum gas
LiB	Lithium-ion battery
MEA	Membrane electrode assembly
mpg	Miles per gallon
Mwh	Megawatt hour
N_2O	Nitrous oxide
NAC	NOx adsorber catalyst
NB	New Businesses
NCA	Lithium nickel cobalt aluminium oxide
NEDC	New European driving cycle
NEV	New energy vehicles
NMC	Lithium nickel manganese cobalt oxide
NMOG	Non-methane organic gas
NPV	Net present value
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides
OEM	Original equipment manufacturer
OpEx	Operating expenditure
Oz	Troy ounces
p.a.	Per annum
Pgm	Platinum group metal
PHEV	Plug in hybrid electric vehicle
PM	Particulate matter
PMP	Precious Metal Products
Pms	Precious metals
PN	Particulate number
PT	Process Technologies
Pd	Palladium
Pt	Platinum
R&D	Research and development
RDE	Real world driving emissions standards
ROIC	Return on invested capital
SCR	Selective catalytic reduction
SNG	Substitute natural gas
SULEV	Super ultra low emission vehicle
SUV	Sports utility vehicle
TCO	Total cost of ownership
TWC	Three way catalyst
TWF	Three way filter
ULEV	Ultra low emission vehicle
VCM	Vinyl chloride monomer
xEV	Electric vehicles (of all types)
ZEV	Zero emission vehicle



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