



Presentation to Analysts / Investors  
**Johnson Matthey Strategy Update – Building Our 3rd Century**

29th January 2015



Johnson Matthey



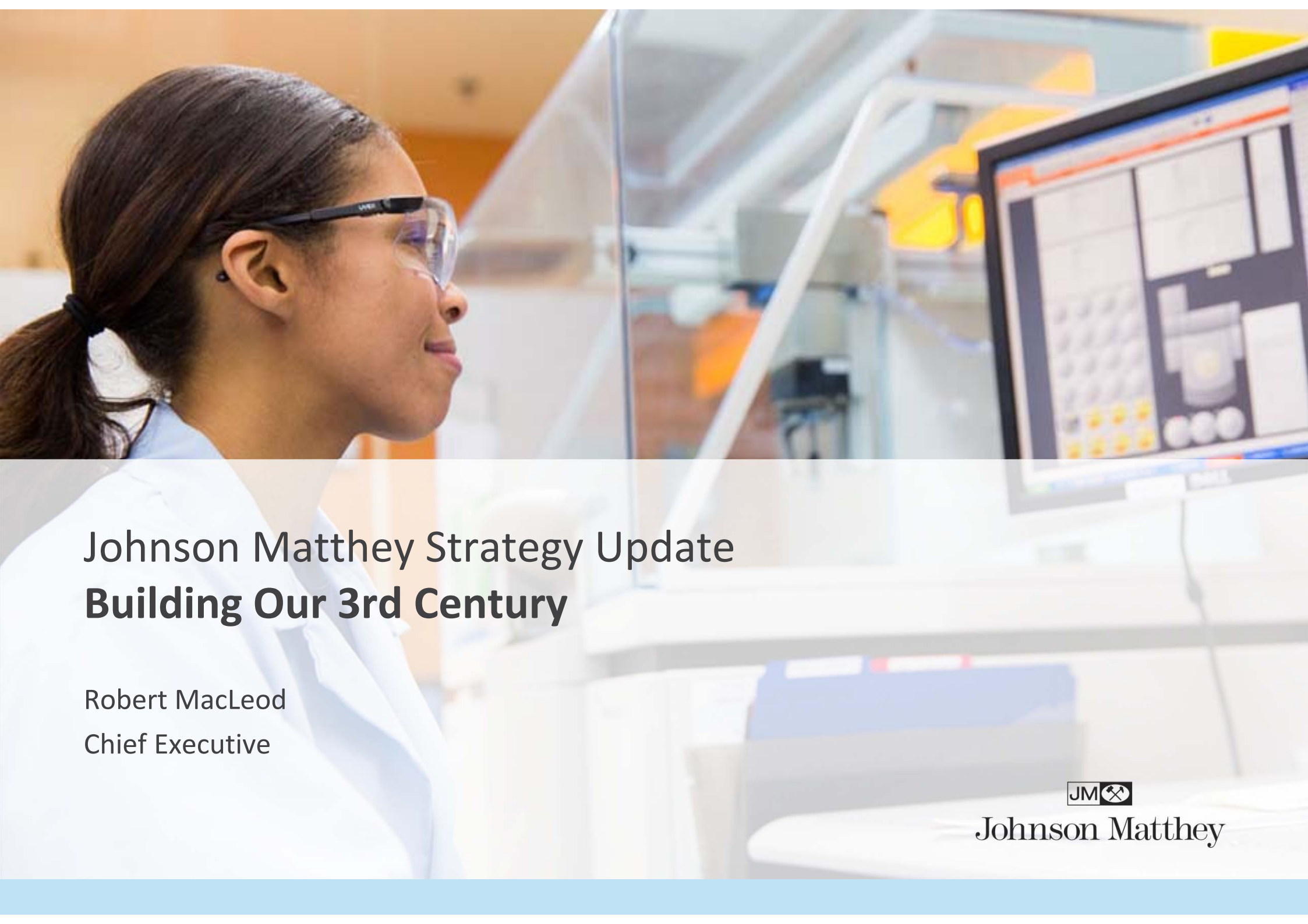
## Cautionary Statement

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.



Johnson Matthey





# Johnson Matthey Strategy Update **Building Our 3rd Century**

Robert MacLeod  
Chief Executive



Johnson Matthey

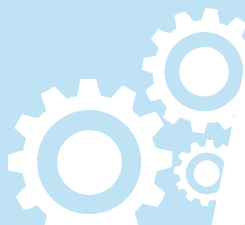
# Programme

<b>10.30</b>	Introduction and Strategy Update <i>Q&amp;A after this session</i>	<b>Robert MacLeod</b>
<b>11.20</b>	Fine Chemicals	<b>John Fowler</b>
<b>11.40</b>	Precious Metal Products <i>Q&amp;A after this session</i>	<b>Alan Myers</b>
<b>12.15</b>	Lunch	
<b>13.00</b>	New Businesses	<b>Nick Garner</b>
<b>13.25</b>	Process Technologies	<b>Geoff Otterman</b>
<b>13.40</b>	Emission Control Technologies <i>Q&amp;A and coffee break after this session</i>	<b>John Walker</b>
<b>14.40</b>	Technology	<b>Liz Rowsell</b>
<b>15.00</b>	Summary and final Q&A	<b>Robert MacLeod</b>
<b>15.30</b>	Coaches depart – Tour of Sonning Technology Centre	
<b>17.45</b>	Closing remarks	<b>Robert MacLeod</b>
<b>18.00</b>	Coach departs for Reading station / drinks reception and dinner	

# Purpose of the Day

## Update

on the group's long term strategy and priorities



## Outline

key developments since January 2011



## Explain

Divisional strategies and the fundamental role of technology in creating value



## Highlight

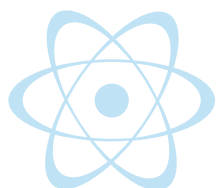
how Johnson Matthey is positioned for superior long term growth



## 2011 – Our Strategy to Deliver Growth in Value



Continued core focus on leading edge catalysis



Maintain differentiation through technology



Strong position in pgms remains an intrinsic part of group



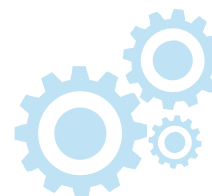
Primary focus is organic growth



Developing new opportunities underpinned by our core chemistry expertise



JM attributes



Manufacturing excellence



People and culture

# JM has Delivered Strong, Consistent Performance

## What we said in 2011



Growth at double digit rates with ROIC >20%



Some growth in EBITDA margins (ex substrates)



Increased R&D spend



Invest in new businesses



Target net debt (incl. post tax pension deficit) / EBITDA 1.5 to 2.0 times



Bolt-on M&A to accelerate organic growth



Average capex 1.2 to 1.3 times depreciation

## What we've done



## Comment

12.8% CAGR in uEPS, ROIC on track

Benefiting from manufacturing excellence and despite change in Anglo contracts

Up 39%, maintained at 5% of sales

New Businesses division established

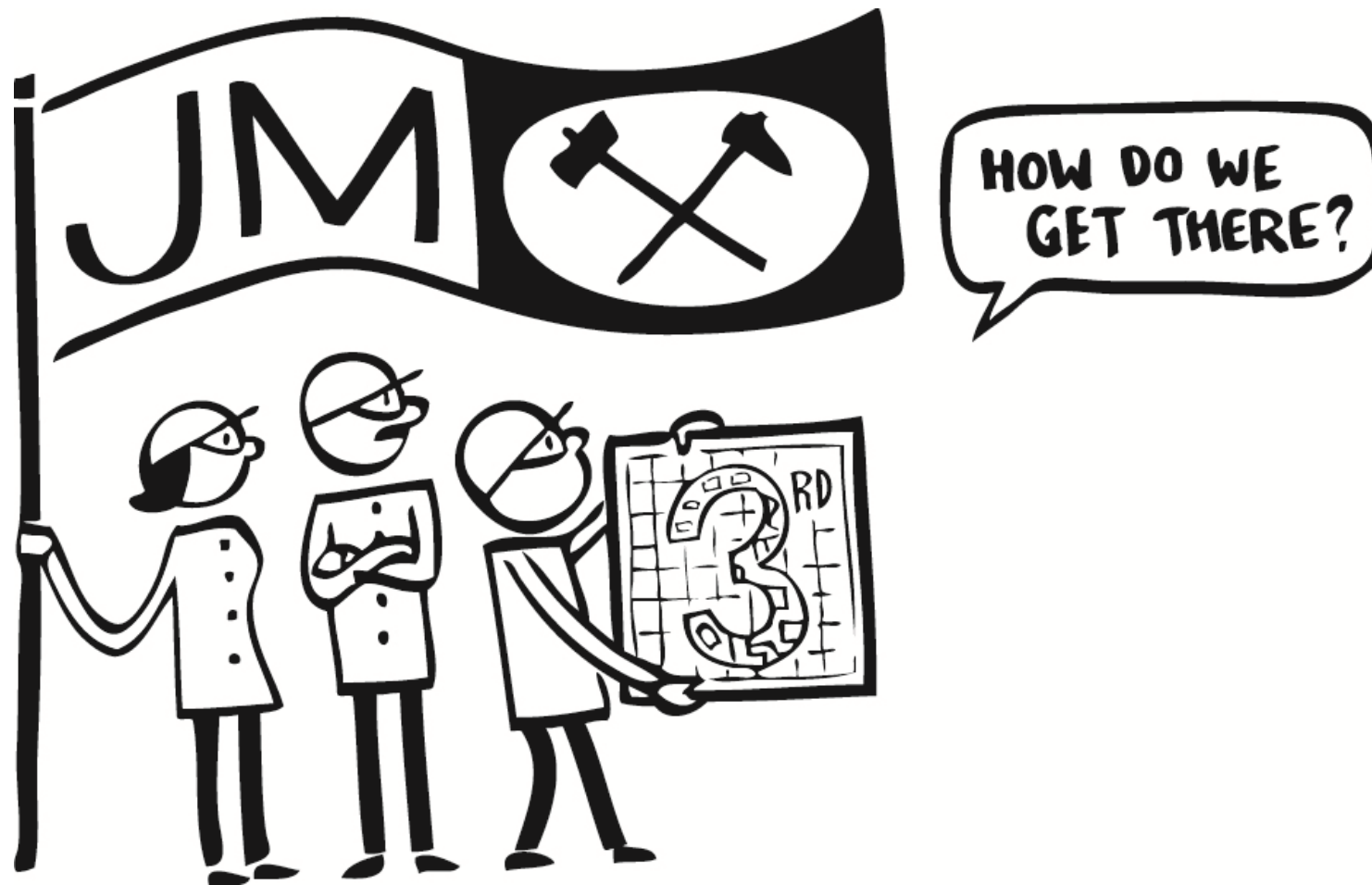
100p per share special dividend in August 2012

Key acquisitions in PT and NB

Slightly higher (~1.4 times) – more investment required to support growth, especially ECT

**In line with our expectations**

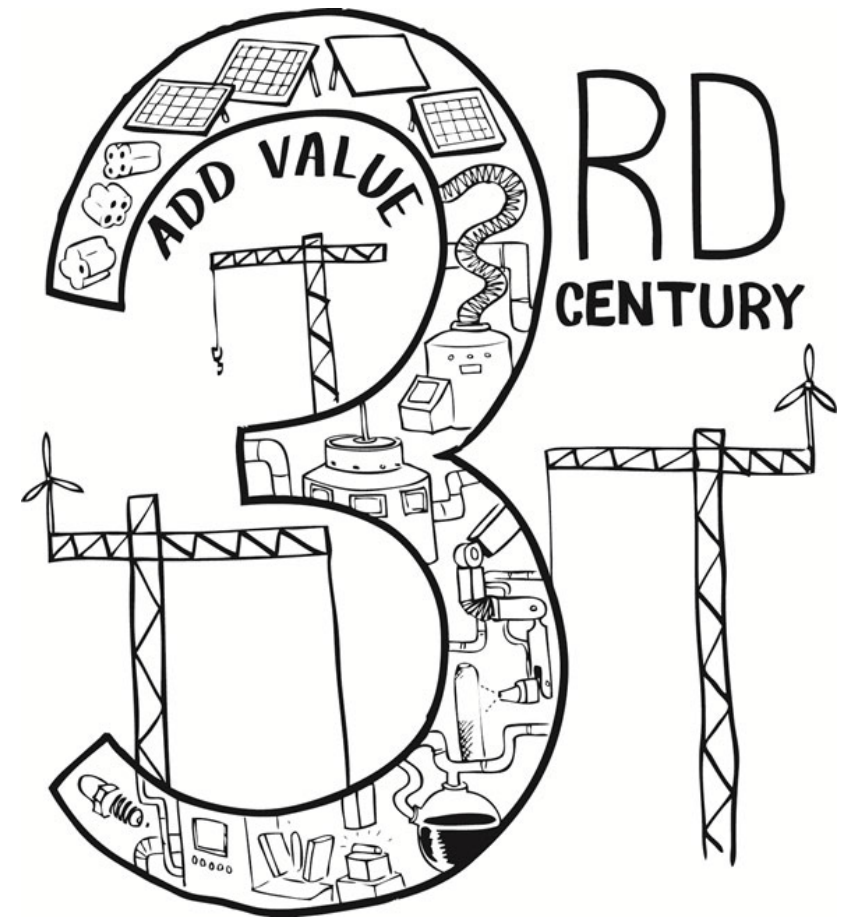
## Our 3C Strategy





## JM Today – A Global Leader in Sustainable Technologies

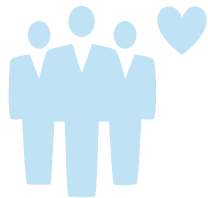
Our **Vision** is to  
build our 3rd Century  
through value adding  
**sustainable technologies**



## Our Purpose – What We Do

As a business we always aim to deliver what we promise.

We work together, applying our expertise in **advanced materials and technology** to **innovate and improve** solutions that:



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are valued by  
our customers



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optimise the use of  
natural resources



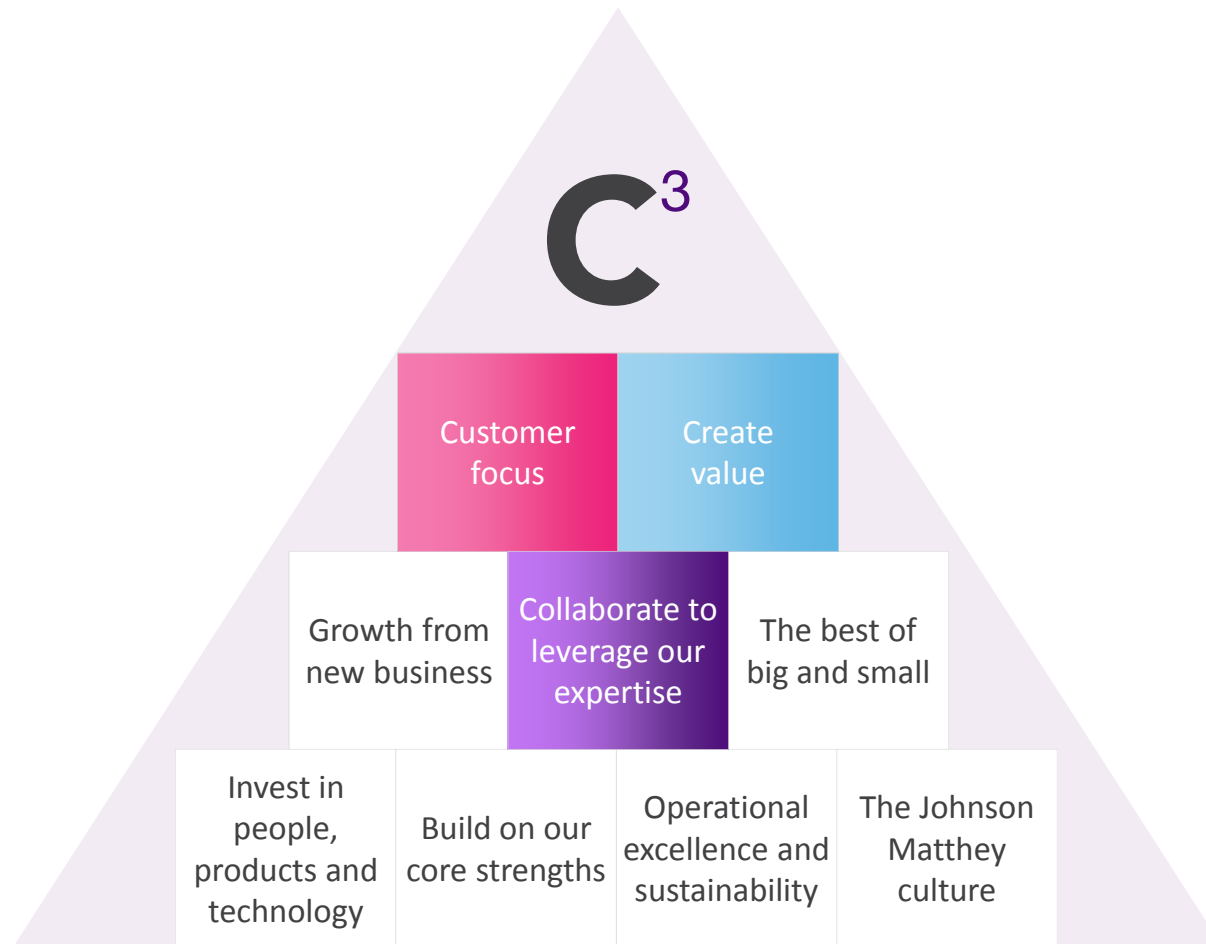
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and enhance the quality of  
life for the people of the  
world, both for today and  
for the future

# Sustainability Drivers Provide Superior Growth for JM

Global Drivers	Short to medium term	Longer term
Population Growth Urbanisation Increasing Wealth	JM well positioned in emerging markets <ul style="list-style-type: none"> <li>• China represents 11% of sales</li> </ul>	Growth from South America and other emerging markets
Natural Resource Constraints	Energy security – coal in China, gas in US Recycling of pgms – a strategic service	Alternative energy – biorenewables
Environmental Factors Climate Change Regulation	Continued tightening of emissions legislation <ul style="list-style-type: none"> <li>• Vehicles</li> <li>• Industrial emissions</li> <li>• Fuel quality requirements</li> </ul>	Electrification of powertrain Tighter regulation on pollutants in other industries (new business opportunities)
Health & Nutrition Ageing Population	Ongoing pressure on healthcare costs <ul style="list-style-type: none"> <li>• Increased use of generics</li> </ul>	Enzymatic catalysis / more sustainable chemistry in pharma industry

# Our Strategy for Superior Growth



# Invest in Technology – How We Differentiate

- Strong set of technology skills
- Complex, ‘difficult to do’
- Creates high barriers to entry
- Generates continuous stream of new products

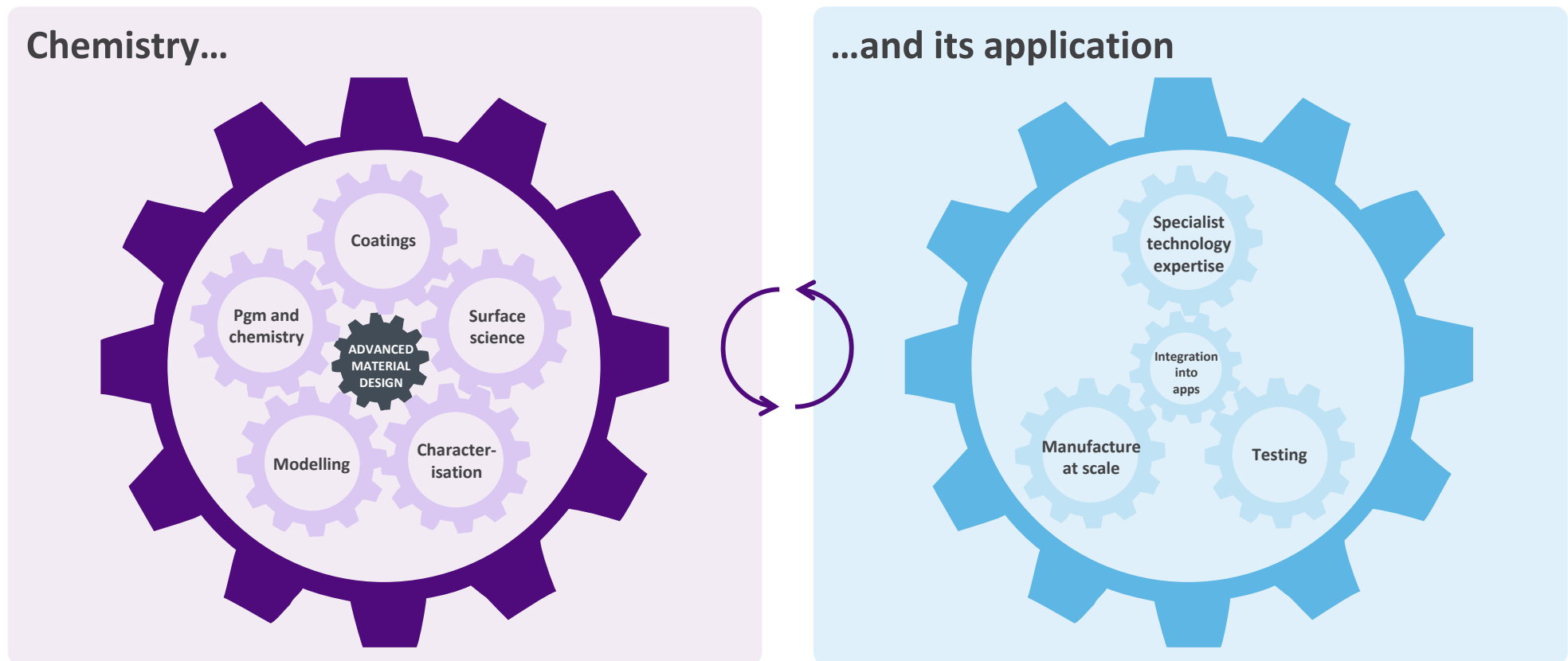
**But, what is most important is  
how you use them.....**





# Differentiation Through Technology

JM's skill lies in understanding both the chemistry and the applications



Chemistry has to be cutting edge

But we are more interested in, and good at, understanding how it can be used

That enables us to build multi million pound product businesses

# Differentiation Through Technology - Complexity Matters

Operating at the frontiers of science enables lower risk, higher margin business models

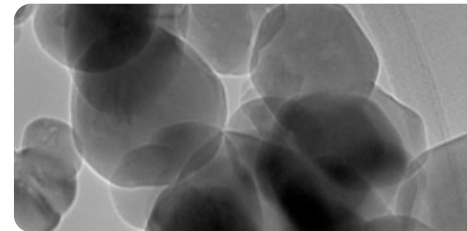


We sell Tier 2 products in B2B environments

- JM has IP



Technical, reputational and legislative barriers to entry



Complex products that are difficult to emulate and are constantly improved

- Sustains pricing / margins

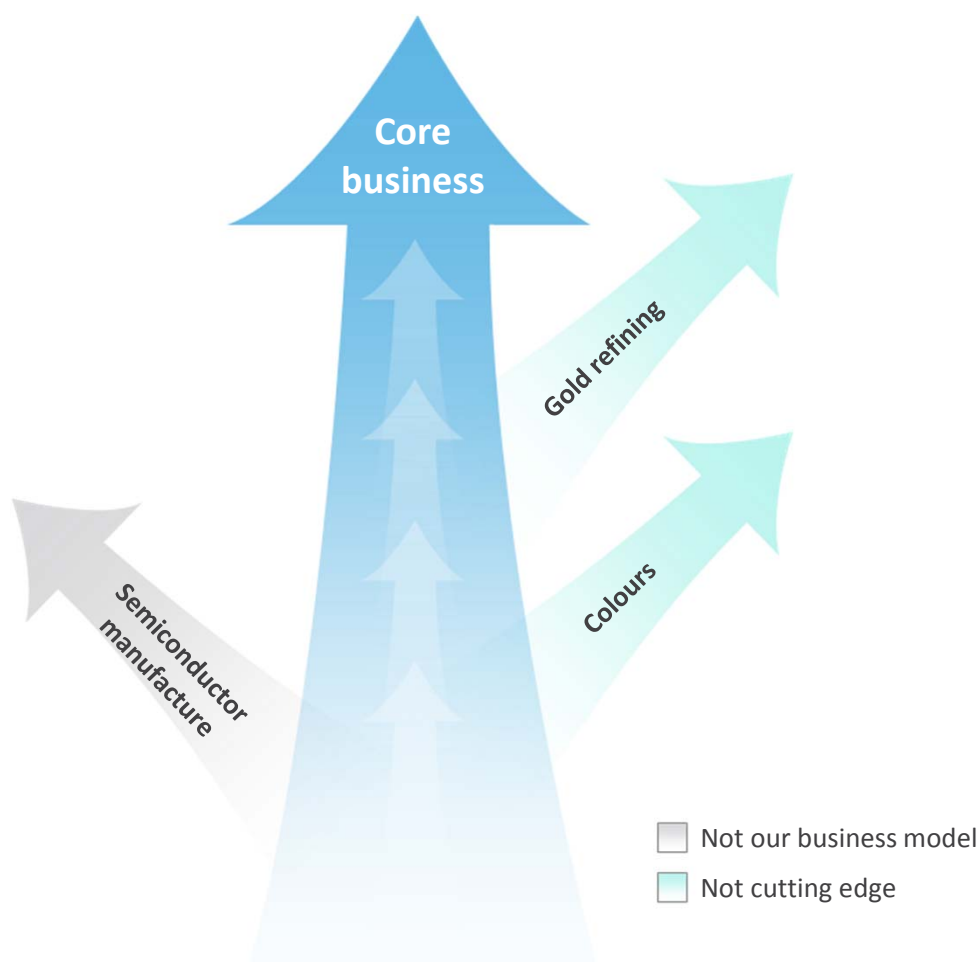


Maximise value of technology through strong customer focus and reputation

**We will continue to invest ~5% of sales p.a. in R&D to extend technology advantage**

# Build on Our Core Strengths

**We will actively manage our portfolio to maintain focus**



- Stay focused on markets which command high margins
- Exit areas that cease to benefit from our cutting edge expertise:
  - Gold and Silver refining
- ...or that do not fit with our business model
- Build and develop product offering in areas where synergies exist

# Positioning for Growth

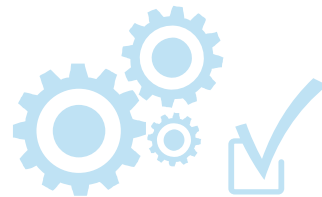
**Improve efficiencies, maintain margins, grow sales**



## Health and Safety

Internal programmes to engage employees

Aspiration – zero accidents



## Manufacturing Excellence

Drive for world class

Increase operational efficiencies

Maintain / grow margins



## Sustainability

Sweet spot for JM

Resource efficiencies targeted to date

Future - develop new sustainable products



## Best of Big and Small

Investment in core functions / systems

Upgrade business information systems

Enhance HR processes and talent management

## Medium Term Targets and Priorities

	Targets	Priorities
	High single digit CAGR in sales	<ul style="list-style-type: none"> <li>Continued development of service and products to maintain market position</li> <li>Drive operational efficiencies</li> </ul>
	Mid to high single digit CAGR in sales	<ul style="list-style-type: none"> <li>Broaden offering</li> <li>Access strong share of opportunity from US shale gas and China coal</li> </ul>
	Mid single digit CAGR in sales	<ul style="list-style-type: none"> <li>Provides key services – further enhance reliability / efficiency of refineries</li> <li>Drive Manufacturing businesses for higher growth</li> </ul>
	Mid to high single digit CAGR in sales	<ul style="list-style-type: none"> <li>Invest in new products for medium term growth</li> <li>Enhance offering in Europe</li> </ul>
	Invest £5m to £7m p.a. in organic growth £30m OP in Year 5	<ul style="list-style-type: none"> <li>Accelerate delivery of operating profit growth</li> <li>Develop new business pipeline</li> </ul>

**At stable margins**



# Investment and Capital Efficiency



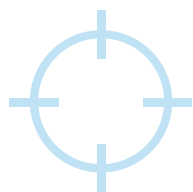
## Investment

- Average capital expenditure around 1.6 to 1.8 times depreciation
- Capital expenditure shifts from ECT to other divisions
- Investment in business systems

## Capital efficiency remains embedded

- ROIC target >20%
- Net debt (incl. pension) / EBITDA between 1.5 to 2.0 times

## Key Takeaways



**Robust strategy in place**  
Strong market drivers



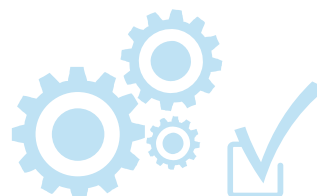
**Focus on sustainable technologies**  
Using our expertise in advanced materials and technology



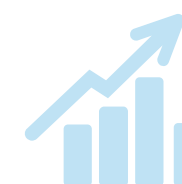
**Build and develop new product offerings**  
R&D at 5% of sales p.a. to maintain competitive advantage



**Invest in new businesses to accelerate growth**  
Ongoing £5-7m p.a.  
>£100m p.a. OP by 2025



**Operational Excellence**  
Drive operational efficiencies and invest in internal systems to maintain margins



**Double digit growth in uEPS at >20% ROIC**



Q&A



Johnson Matthey





# Fine Chemicals Focus on Pharma for Future Growth

John Fowler

Division Director, Fine Chemicals



# Fine Chemicals

## Global supplier of APIs and other speciality chemical products and services for the pharmaceutical market

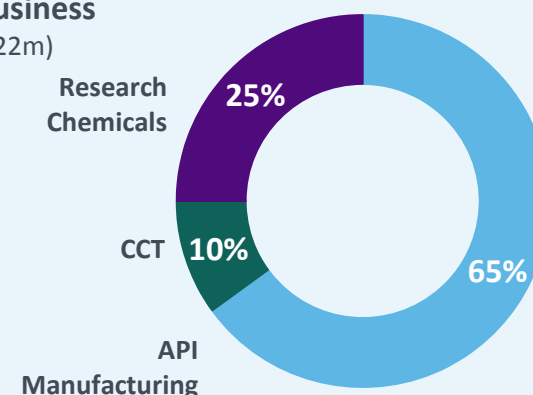
### Fine Chemicals Today

- Leading positions for APIs in specific therapeutic areas
- Provider of development and manufacturing services to innovator pharmaceutical segment
- Expertise in catalysis and complex chemistry
- Strong return on sales

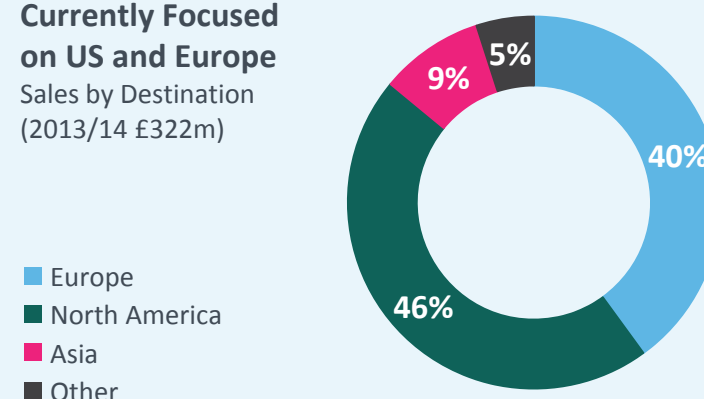
### Positioning for the Future

- Geographic expansion
- Further expand position in high value niche drug segments and formulated products
- Investments in next generation drug development / manufacturing capability

**Sales by Business**  
(2013/14 £322m)



**Currently Focused on US and Europe**  
Sales by Destination  
(2013/14 £322m)

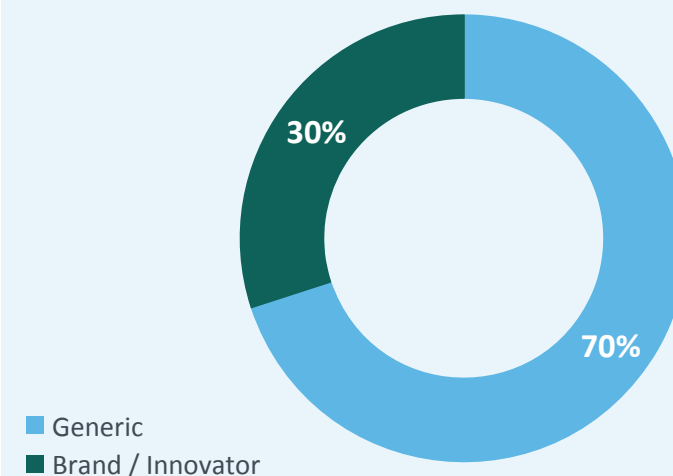




# Fine Chemicals – Business Background

Supply of API	Customers	Competitors
<ul style="list-style-type: none"> <li>Market size ~\$1.5bn – niche segment of ‘small’ molecules API market</li> <li>#1 or #2 in majority of our markets including APIs for ADHD and palliative care</li> </ul>	<ul style="list-style-type: none"> <li>Teva</li> <li>Actavis</li> <li>Mundipharma</li> </ul>	<ul style="list-style-type: none"> <li>Mallinckrodt</li> <li>Francopia</li> </ul>
Custom Services	Customers	Competitors
<ul style="list-style-type: none"> <li>Market size ~\$30bn</li> <li>#3 provider of US development services</li> </ul>	<ul style="list-style-type: none"> <li>Biogen Idec</li> <li>Nektar</li> </ul>	<ul style="list-style-type: none"> <li>AMRI</li> <li>Cambridge Major</li> </ul>
Supply of Catalysts	Customers	Competitors
<ul style="list-style-type: none"> <li>Market Size ~\$0.5bn</li> <li>#2 position</li> </ul>	<ul style="list-style-type: none"> <li>Syngenta</li> </ul>	<ul style="list-style-type: none"> <li>Evonik</li> <li>BASF</li> </ul>

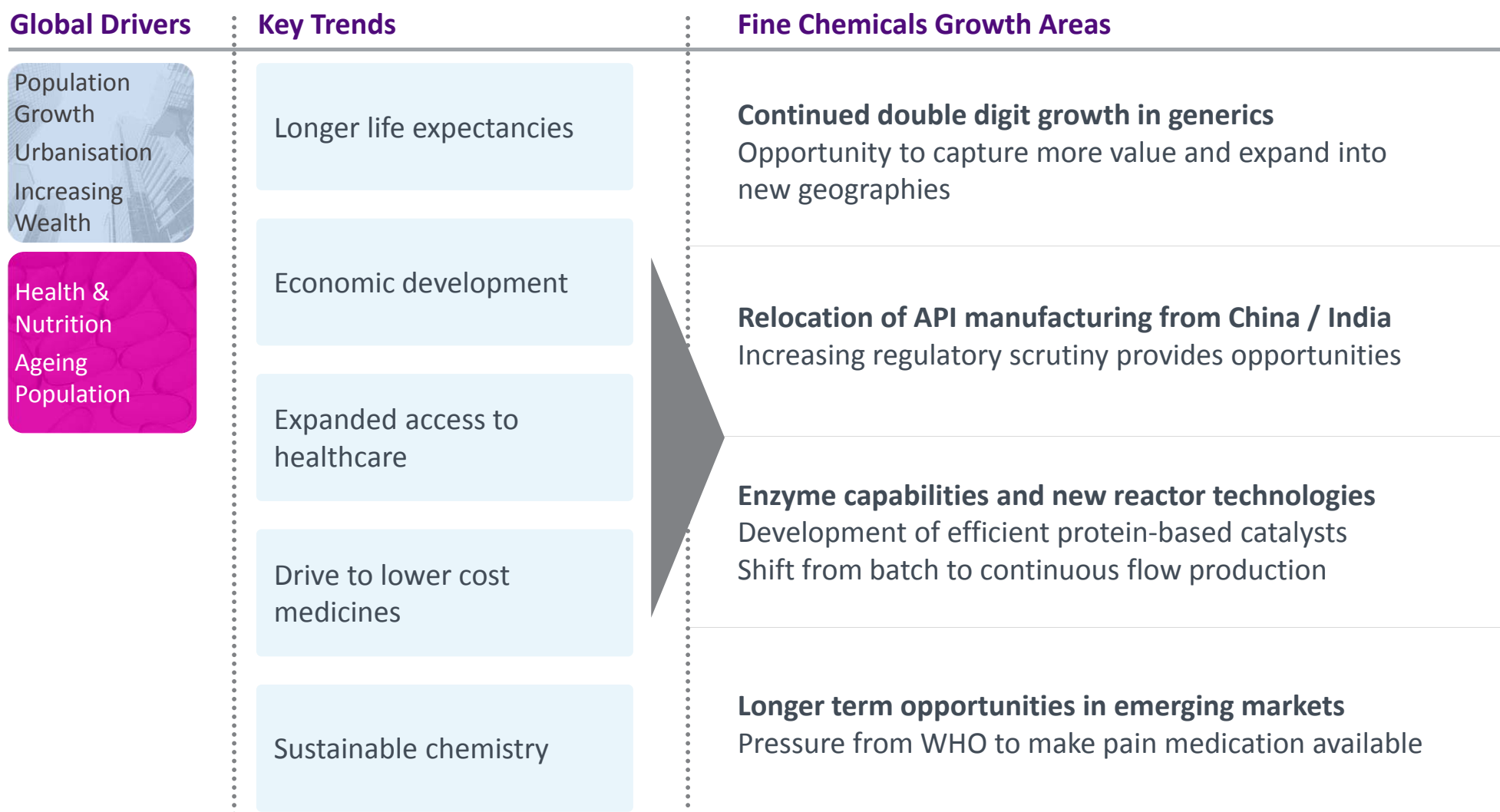
Sales Split by Customer Type



## Income Streams

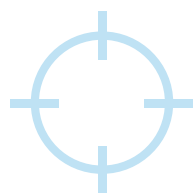
- Generic** – API supply and profit sharing deals, catalysts
- Brand / Innovator** – API custom synthesis, catalyst service and sales
- Opportunistic licensing of novel API chemistry**

# Global Drivers Impacting Fine Chemicals



# Fine Chemicals – A Pharma Focused Strategy

## Growth ahead of the market



Increased penetration of niche  
**generic APIs** market



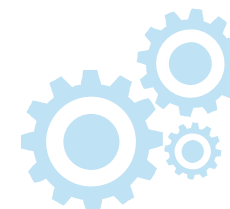
Accelerate **move up value chain**  
to formulated drug products



**M&A** to accelerate growth in  
product / services offering

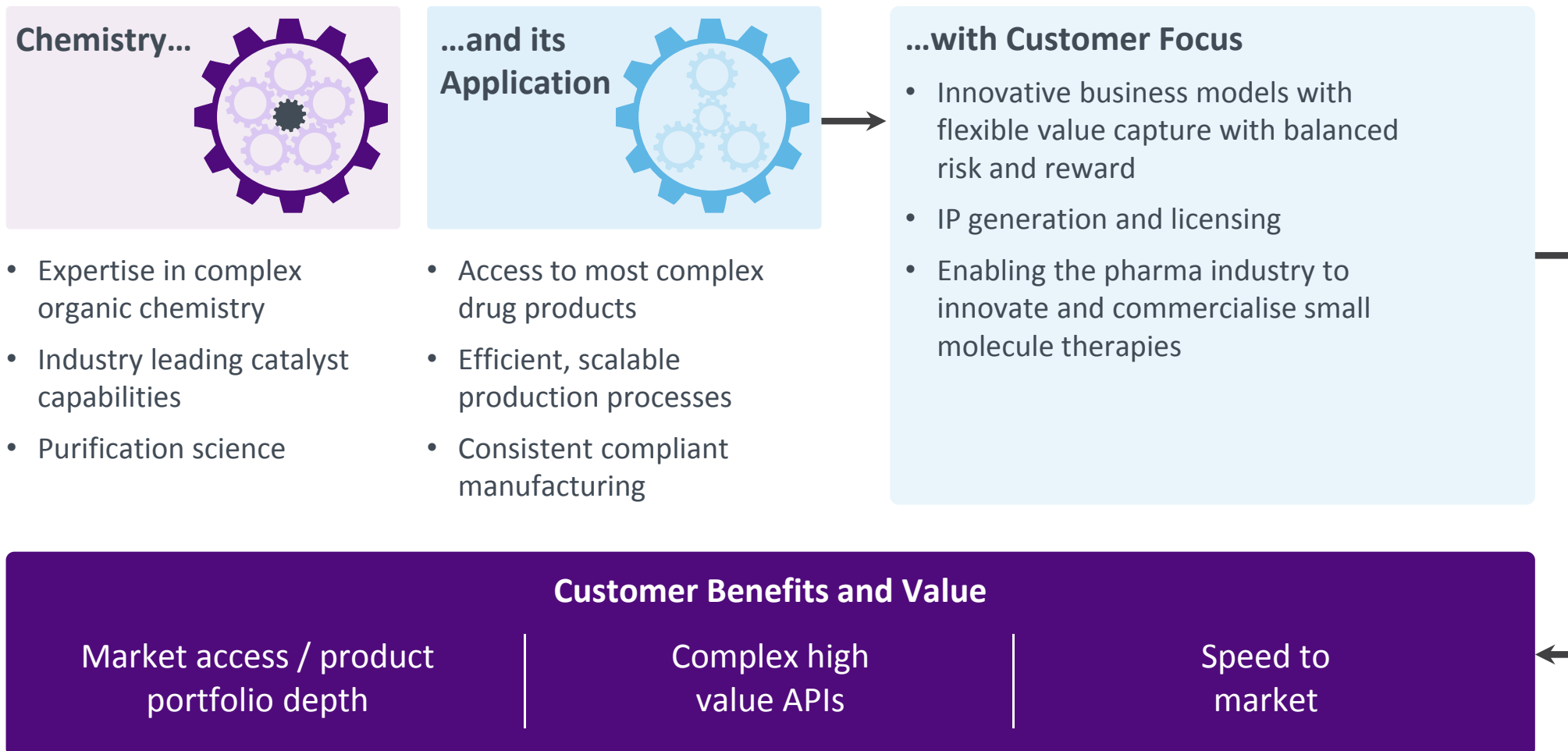


Expand **custom services**  
capabilities in Europe and Asia



Increased **technology**  
**differentiation**

# Sustained Differentiation Through Technology



# Vertical Integration – Moving Up the Value Chain

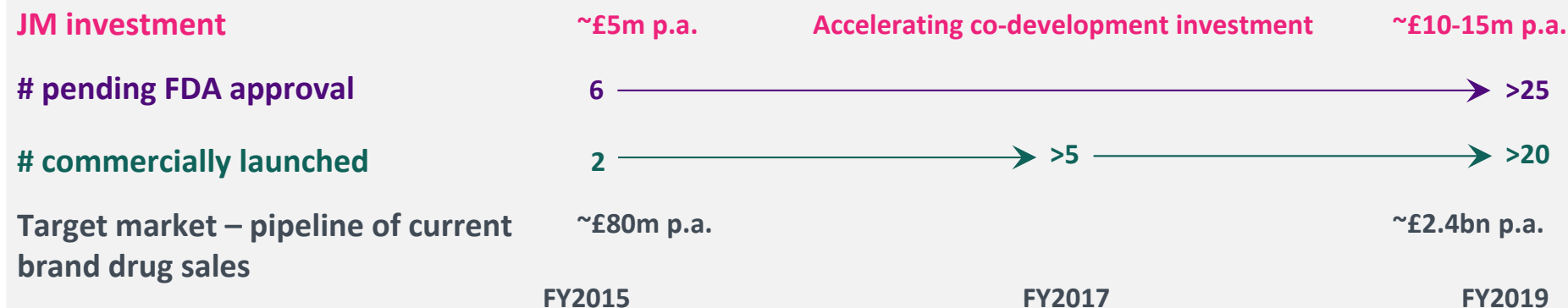
## Key Divisional Growth Initiative

- Continue to expand beyond supply of controlled APIs
- Partner on drug product formulation, manufacturing and marketing
  - Enables shift from 'API sale' commercial model to higher value 'drug product profit share'
- Addressable JM market value increases significantly, ~5 times

### Example: Dofetilide

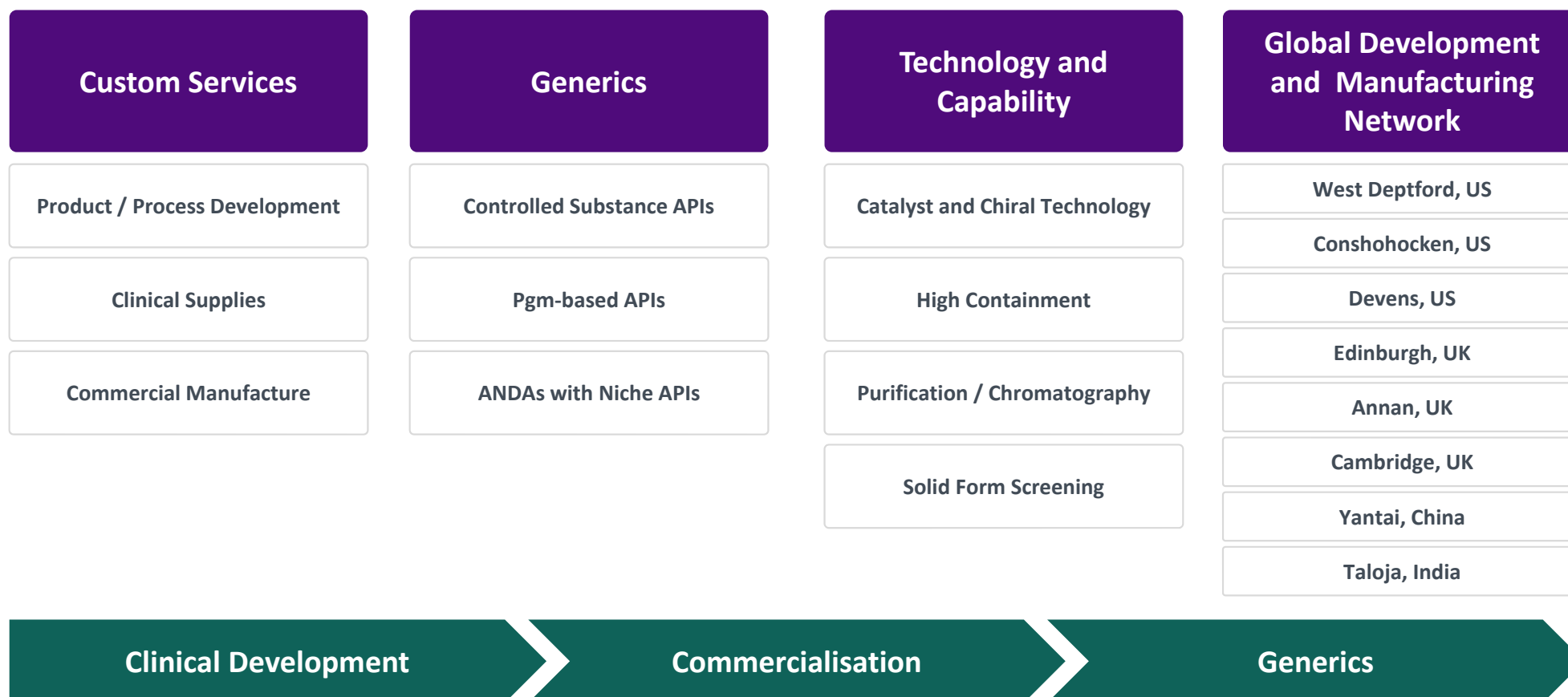
- Generic to Tikosyn®, antiarrhythmic agent, ~\$150m US brand
- Developed API using innovative chemistry for freedom to operate
- Partnered drug product manufacturing and marketing
- US FDA granted expedited review for the ANDA
- Potential 180 days of generic market exclusivity as 'first to file'

## JM's ANDA Product Pipeline Evolution



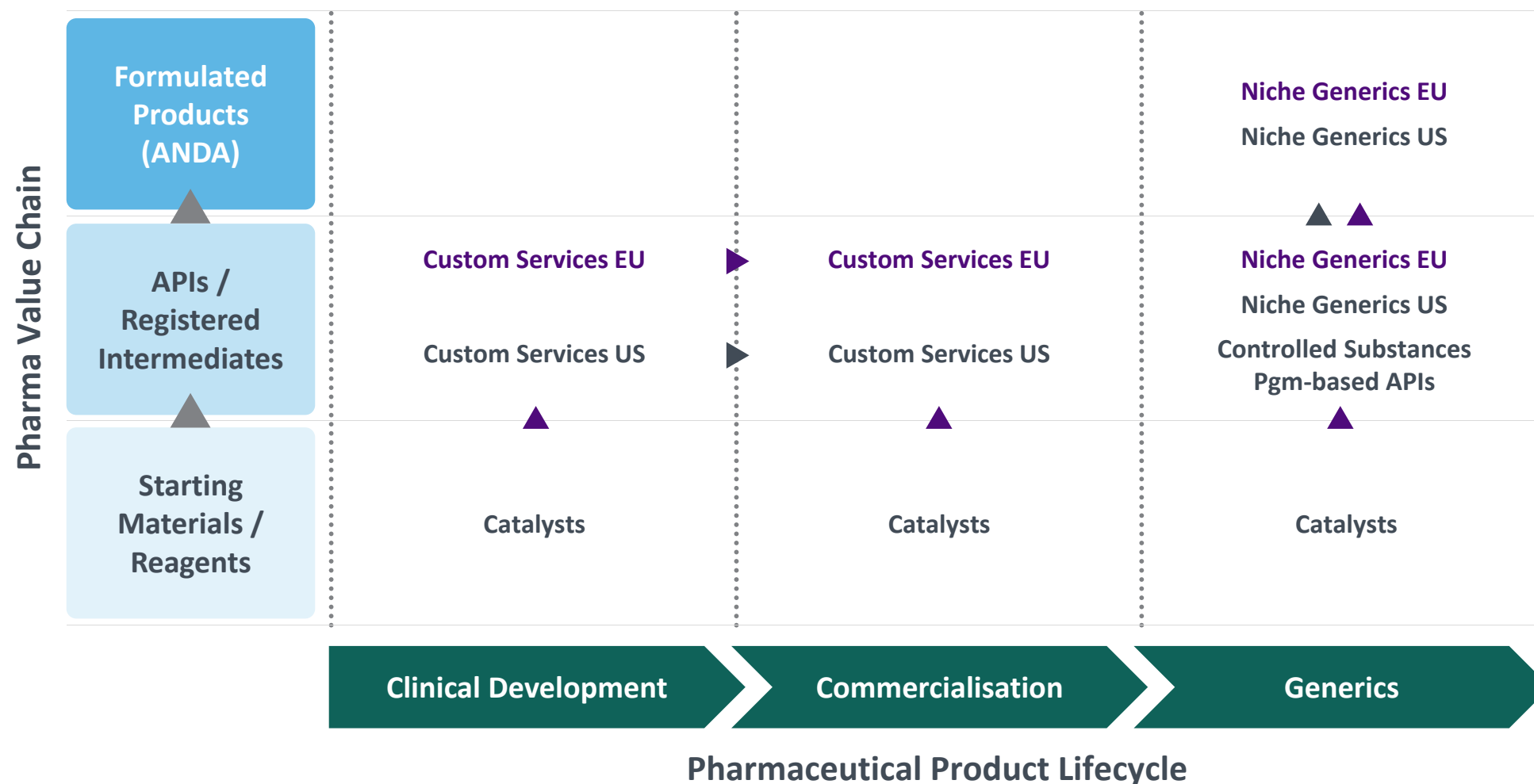
# Pharma Market Alignment Enhances Customer Focus and Growth

## Johnson Matthey – Pharma Solutions





# Strategic Growth through Expanded Product-Service Offer Across Pharma Product Lifecycle and up the Value chain

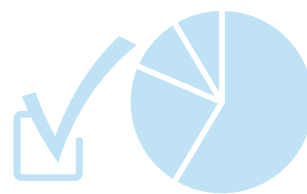


# Fine Chemicals – Key Takeaways

## Opportunities for double digit growth longer term



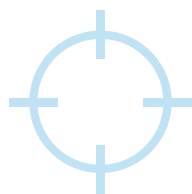
**Strong market drivers** and large potential opportunity



**Leading API positions** in existing markets



**Growth** from geographic expansion, migration across life cycle and up the value chain




Strategic focus on **complex chemistry solutions** for pharma industry



**M&A** could accelerate growth



**Mid to high single digit growth medium term** with stable margins



# Precious Metal Products Investing for Growth

Alan Myers  
Division Director, Precious Metal Products



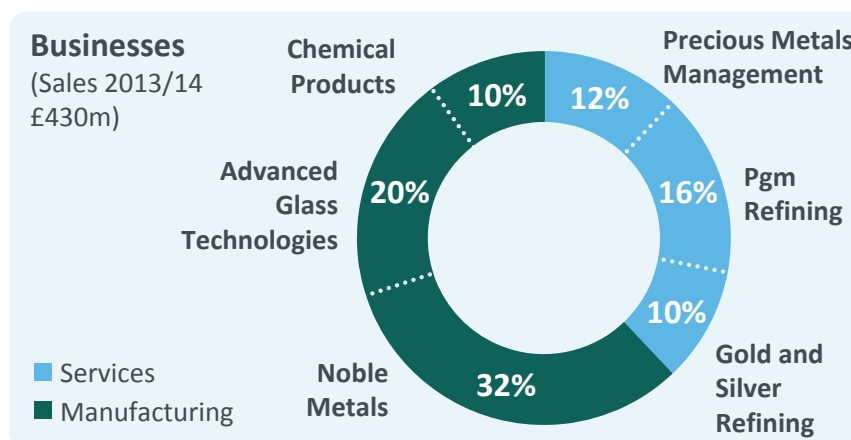
Johnson Matthey

# Precious Metal Products (PMP)

High performance products for a range of industries; world leading pgm recycler

## PMP Today

- Leading positions in key markets
- Some more mature businesses
- Strong return on sales and ROIC
- Key developments
  - Change in the Anglo contracts
  - Disposal of gold and silver
  - Lower metal price sensitivity



**Major Markets in Europe and US, Expanding in ROW**  
Sales by Destination  
(2013/14 £430m)



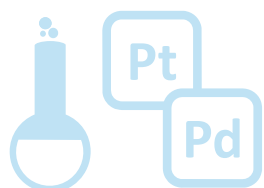
# Precious Metal Products – Drivers

## Continued strong fundamentals for pgms

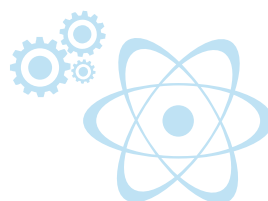




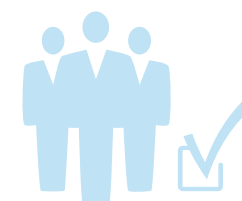
# Precious Metal Products Strategy



Develop new products with more complex chemicals and lower pgm content



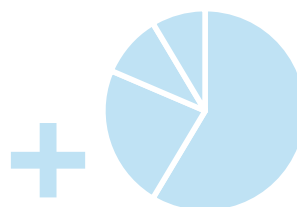
Leverage core strengths in precious metals and materials chemistry



Ensure pgm supply to JM and customers



Drive continued efficiencies in pgm refineries and refining stream



Bolt on acquisitions to expand capabilities

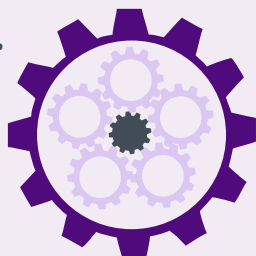


Drive growth in China



# Differentiation Through Technology

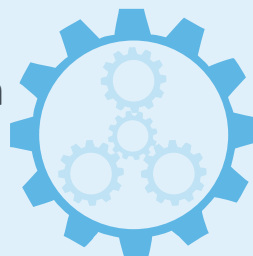
Chemistry...



**Expertise in precious metal chemistry and its applications**

- Alloy development
- Complex pgm chemicals
- Refinery process
- Silver paste

...and its Application



**Example: Ignition Alloys**

- Used in spark plugs – market growth ~6% p.a.
- Expertise in chemistry of minor pgms and hot metal working
- Next generation alloys provide higher performance at lower cost
- Double digit growth for JM through value adding technology



Technology expertise  
+ Precious metal management  
+ Market insight  
= **Unique offering**

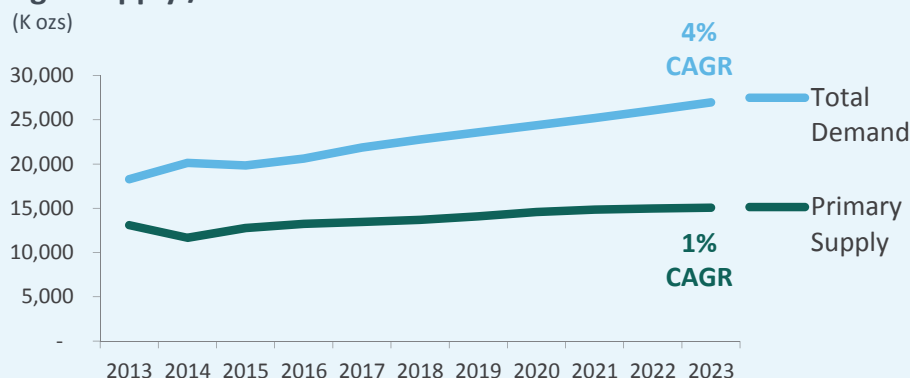
# Pgm Refining

## Strategic service and growing demand

### Market / business environment

- JM is #1 secondary refiner of pgm globally
  - Sales of £67m in 2013/14
- Long term partnerships with customers and suppliers
- Competitive market – differentiated technology key to success
- Pgm demand increasing faster than primary supply – secondary supply will bridge the gap

### Pgm Supply / Demand



### Future Growth Opportunities

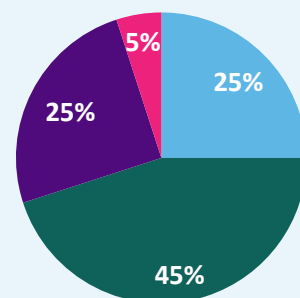
- End of life autocatalysts
- Enhancements to refining process
- Plans to construct refinery in China



**Aim – Mid single digit growth in sales**

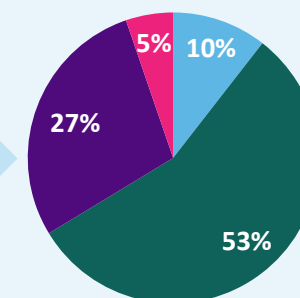
### JM Total Pgm Refining Throughputs

2014



2023

5% CAGR



Primary and Secondary Refiners  
Autocatalyst Recycling  
JM Product Customers  
Other

# Noble Metals - Industrial

## Steady performer, opportunities to accelerate growth

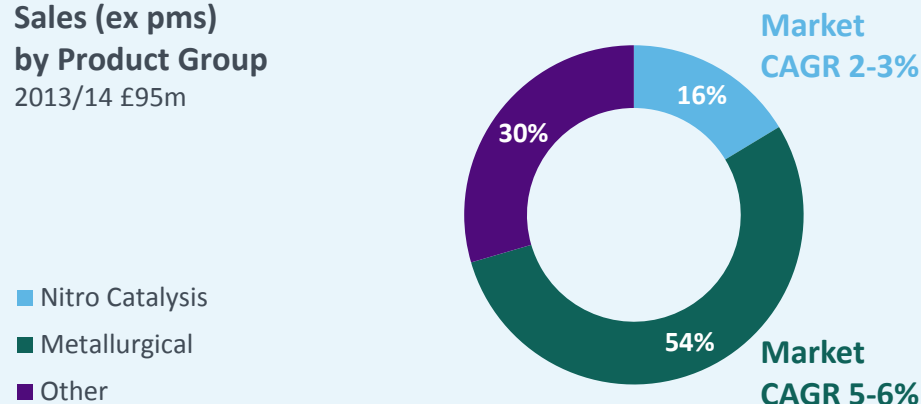
### Market

- Wide range of end markets
- Key product areas
  - Nitric acid gauzes (#1 position)
  - Metallurgical including ignition products (#1 position)

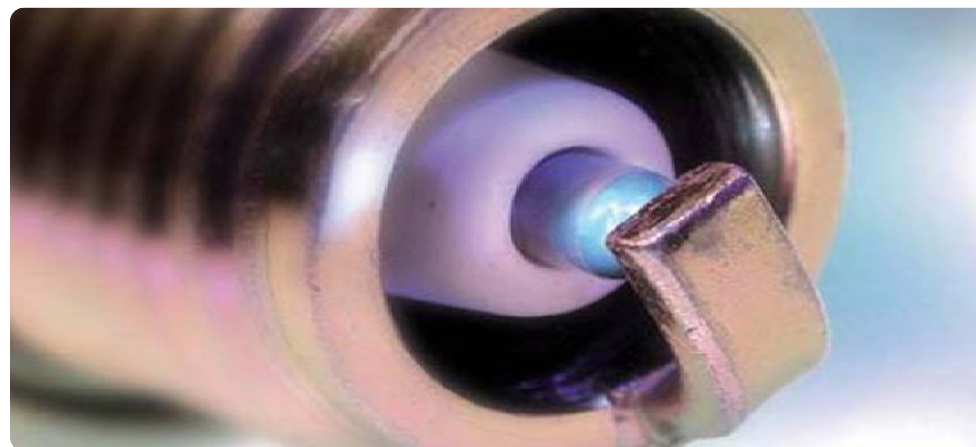
### Future Growth Opportunities

- Leverage technology and manufacturing expertise
  - Thrifted and lower cost alloys
  - More efficient production, new technology
  - New product development

Sales (ex pms)  
by Product Group  
2013/14 £95m



**Aim – Mid single digit growth in sales;  
opportunities for higher growth**



# Noble Metals – Medical Components

## Strong position in a growing market

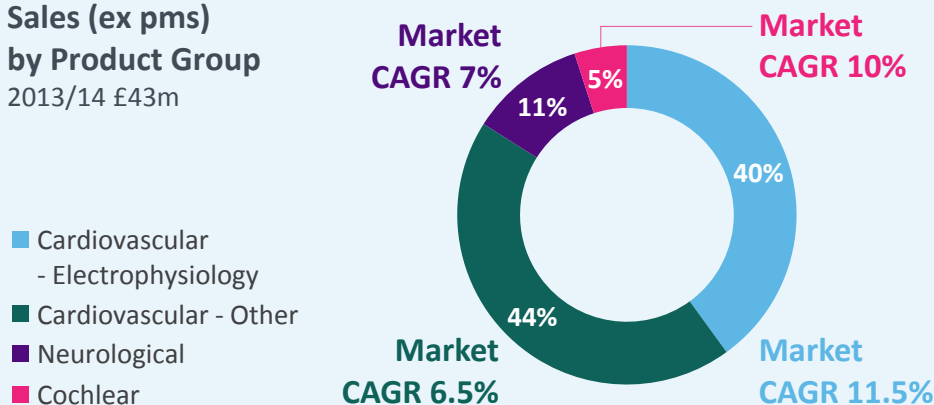
### Market

- Pgm medical components
- Key products areas:
  - Cardiovascular – electrophysiology
  - Other cardiovascular
  - Neurological
  - Cochlear
- JM growth in line with the market

### Future Growth Opportunities

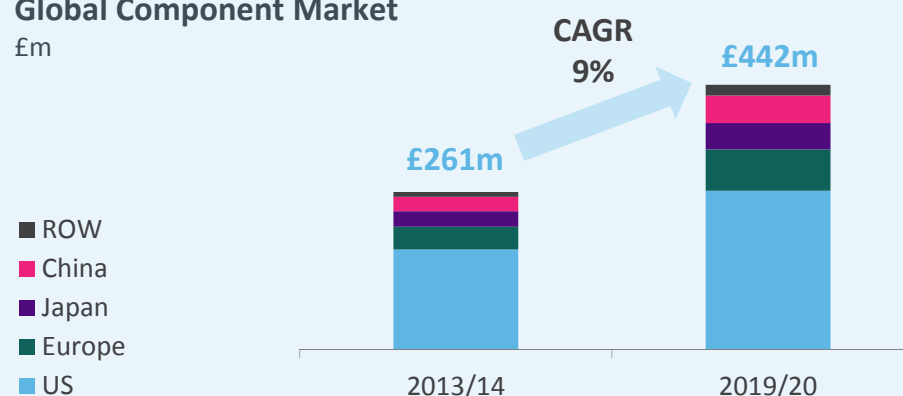
- Geographic expansion into Europe and Asia
  - Add dedicated development cells
- Bolt-on M&A

Sales (ex pms)  
by Product Group  
2013/14 £43m



**Aim – High single digit growth in sales**

Global Component Market  
£m



# Advanced Glass Technologies

## Opportunities for new products and new markets

### Market

- Functional coatings for automotive glass market
  - Black obscuration enamels (market ~£100m)
  - Silver paste (market ~£60m)
- JM sales in 2013/14 £86m
- Strong market position
- Growth in line with light duty car market

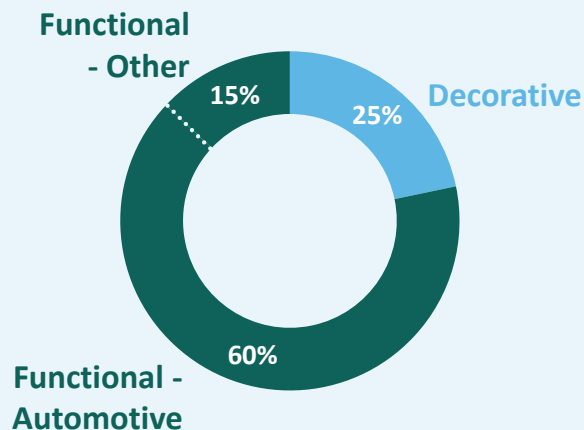
### Future Growth Opportunities

- Opportunities for growth in China
- Apply current expertise to expand portfolio in technical glass materials
  - Medical applications – glass market ~\$250m
  - Electronic applications – glass market ~\$300m



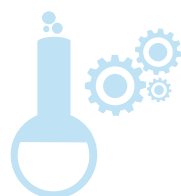
**Aim – High single digit growth in sales**

Sales (ex pms)  
by Product Group  
2013/14 £86m



# Precious Metal Products – Key Takeaways

## Investing for future growth



**Leverage core chemistry strengths** and leading market positions



**Accelerate growth** through market expansion, new products and bolt-on acquisitions



**Drive further efficiencies** in pgm refining



**Investment in pgm refining in China**

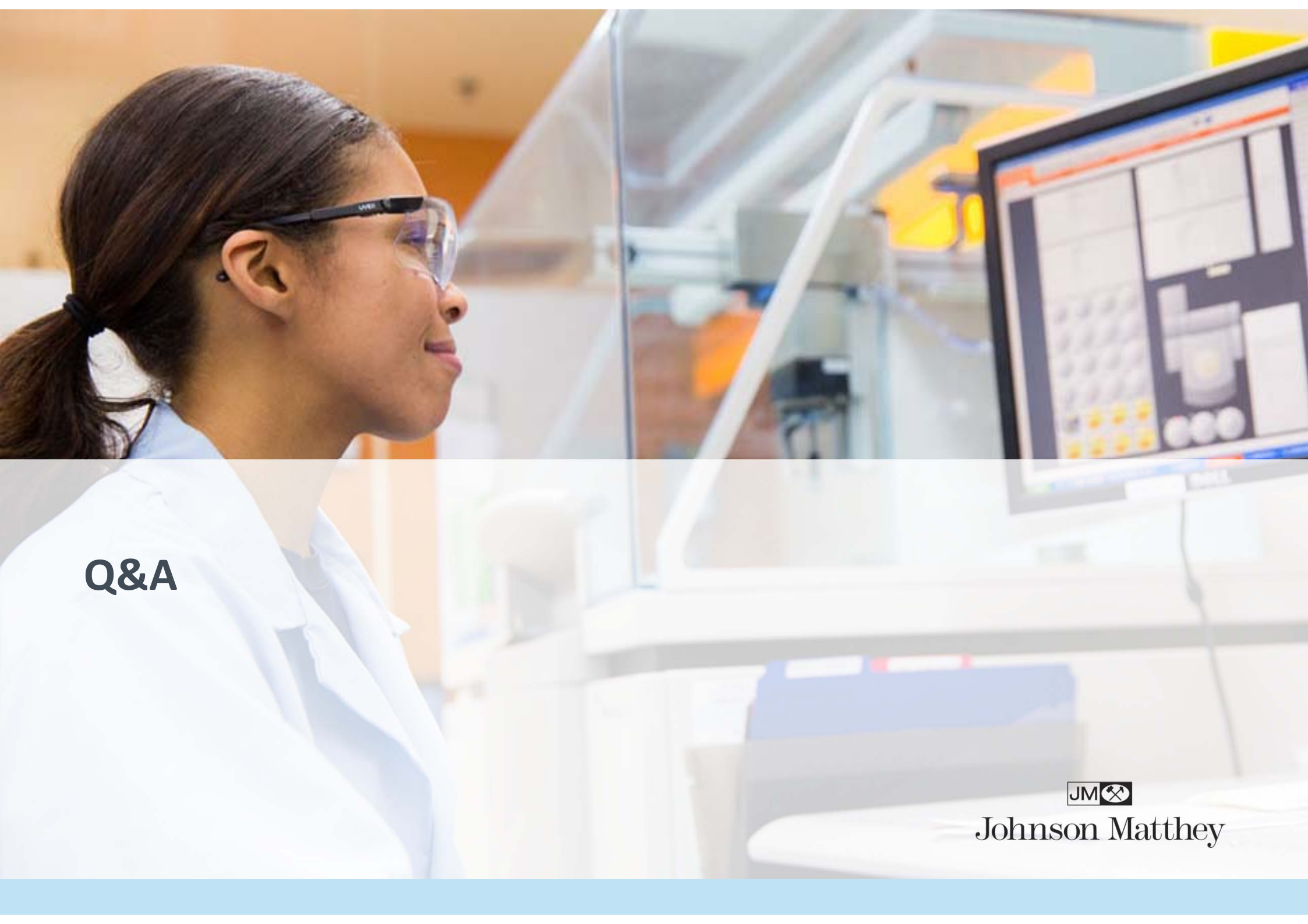


**Maintain strong ROIC** while growing sales with at least stable margins



**High single digit sales growth in Manufacturing businesses from 2016/17**





**Q&A**



**Johnson Matthey**

A 3D CAD model of a car chassis, showing the internal structure and components. A large green battery pack is mounted in the center, with various mechanical parts, suspension components, and wiring visible. The car's body panels are shown in a semi-transparent grey, revealing the underlying structure. The background is white.

# New Businesses Generating the Next Growth Engines

Nick Garner

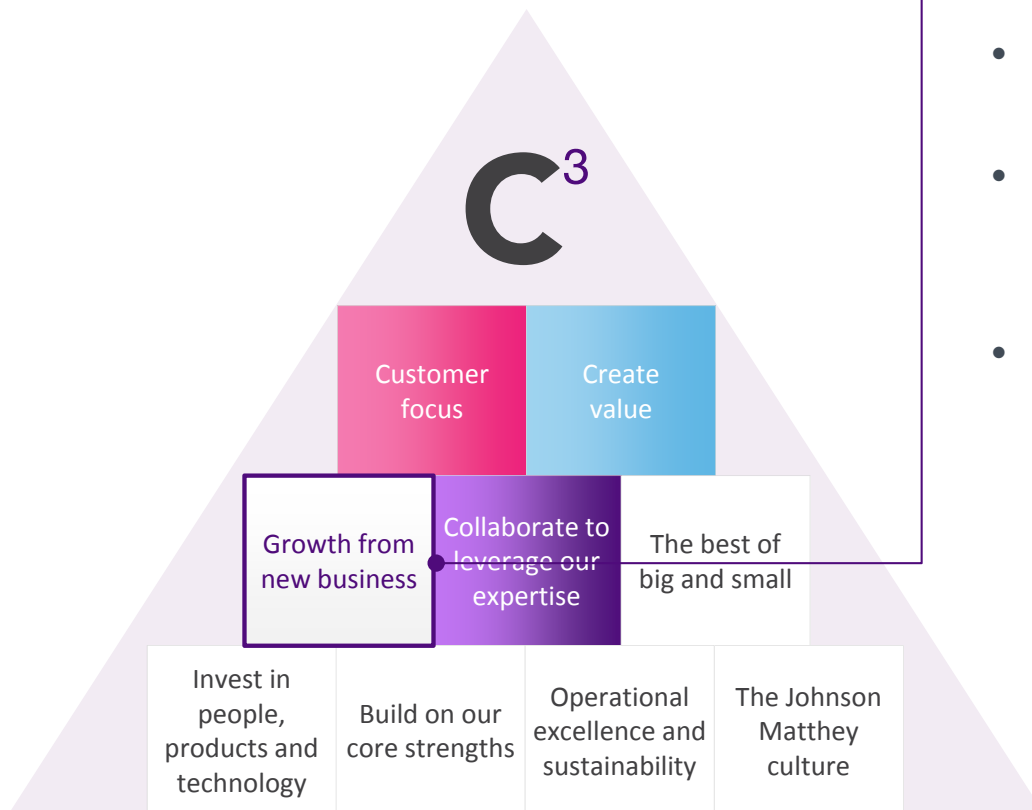
Division Director, New Businesses and Corporate Development



Johnson Matthey

# New Businesses

## Creating growth engines of the future



### • New Businesses Strategy:

- Create new divisions with sales >£200m in ten years
- Look at areas adjacent to main operating business focus
- Build on core competences of JM but will involve development / acquisition of some key elements
- Further improve the generation and commercialisation of new products in JM

- **High tech, high margin with JM fit**
- **Target developing markets with strong drivers**
- **Portfolio of opportunities**
- **M&A key to delivery**

# Developing a Portfolio of Opportunities

Ongoing investment of £5-7m p.a. in concept stage businesses

## Concept stage



Indoor Air  
Purification



Cabin Air  
Purification



Low Carbon  
Vehicles

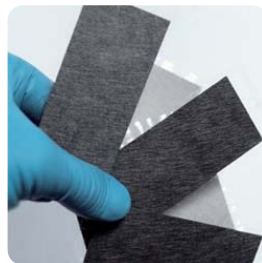


Atmosphere Control  
Technology

## Commercialisation stage



Battery  
Technologies



Fuel Cells



Water  
Purification



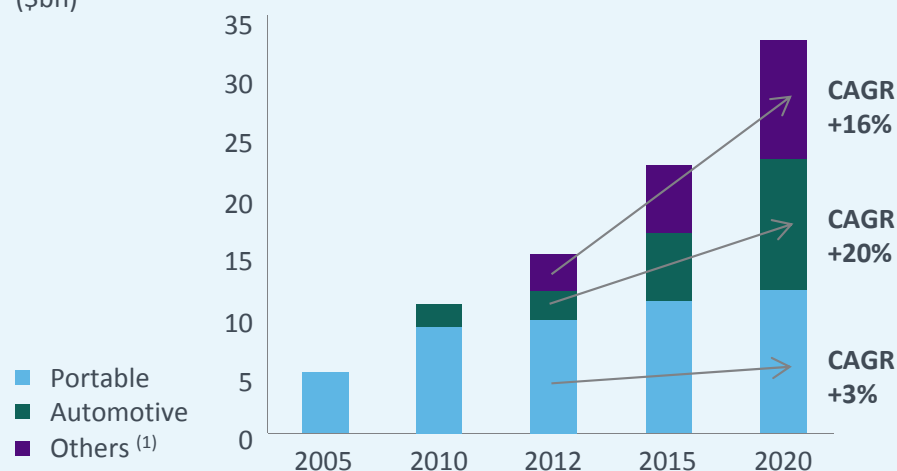
- **Rigorous investment appraisal**
- **Assessed against key milestones**
- **Must have capacity to deliver typical JM returns**



# Battery Technologies – The Opportunity

- Broad consensus that powertrain will diversify – volumes and timing uncertain
- Li-ion batteries for automotive applications expected to grow strongly
- Li-ion battery performance holding back mainstream commercialisation of fully electric vehicles

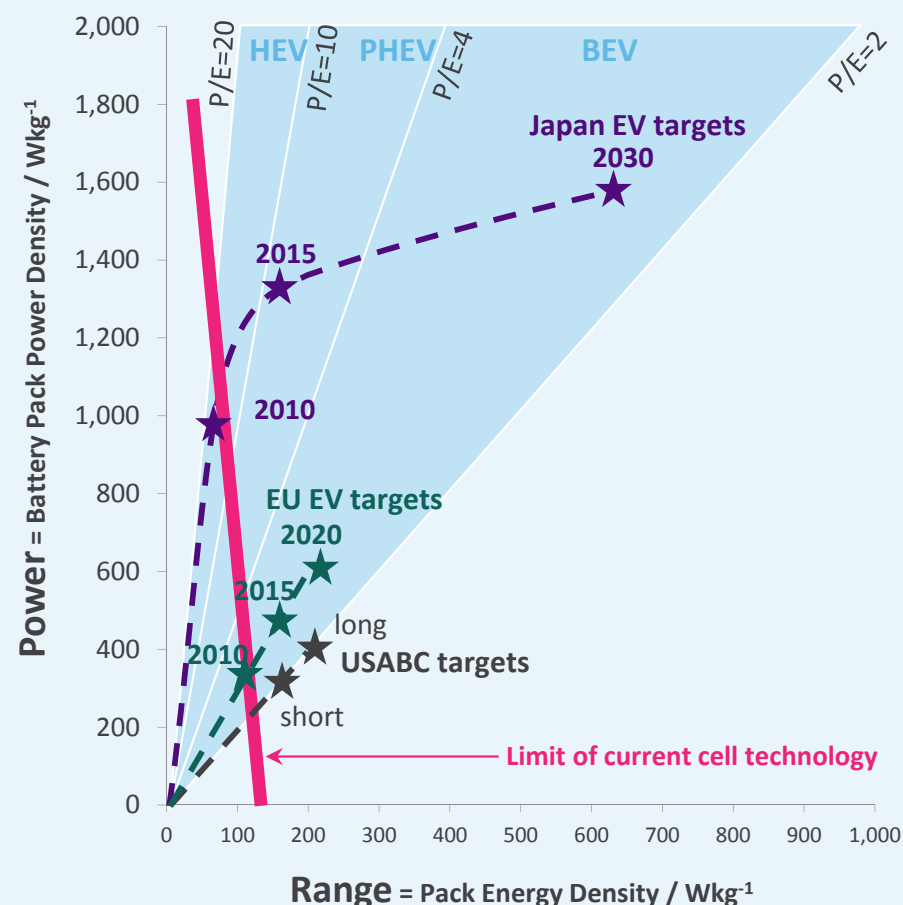
**Total Li-Ion Battery Market (Battery Pack Level)**  
(\$bn)



Source: Avicenne Energy, 2014

Note (1): Others is principally e-bikes, industrial and medical

**Electric Vehicle Battery Requirements <sup>(2)</sup>**



(2) Adapted from Peter Lamp, BMW, AABC 2010

# Battery Technologies – The Opportunity

- Li-ion materials market will be dominated by five major classes of chemistries over next ten years
- Market for cathode materials to grow strongly to 2025
- Next generation enhanced materials under development

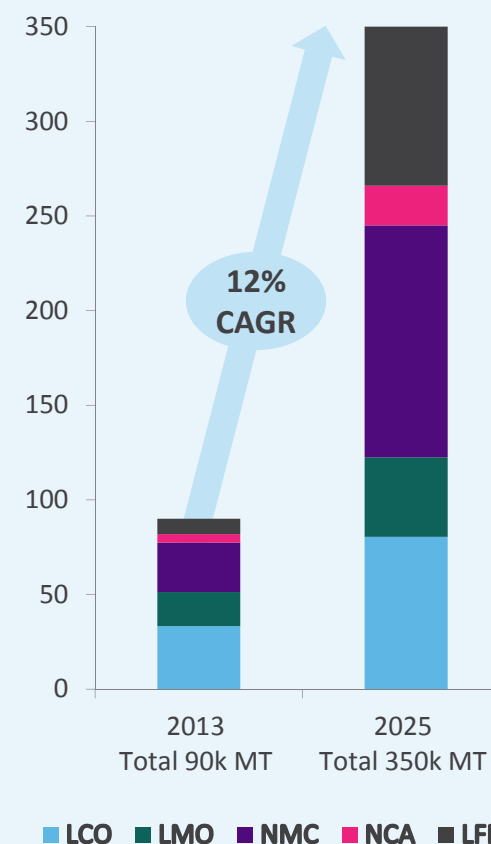
Material	LCO Lithium cobalt oxide	LMO Lithium manganese oxide	NMC Lithium Ni Mn Co oxide	NCA Lithium Ni Co Al oxide	LFP Lithium iron phosphate
Energy density	Green	Yellow	Green	Green	Yellow
Power density	Yellow	Yellow	Yellow	Yellow	Green
Safety	Red	Yellow	Yellow	Yellow	Green
Cycle life	Red	Yellow	Yellow	Green	Green
Intrinsic cost	Red	Green	Red	Red	Green
Main applications	Electronics	Early EV	PHEV and EV. Some electronics	High energy EV	Mild hybrids, heavy duty vehicles

Automotive Applications					
	None	Nissan Leaf	BMW i3	Tesla Model S	Volvo Bus

Images copyright of relevant manufacturer

Cathode Material Volumes, by Chemistry



Source: Avicenne Energy, 2014



# Battery Technologies – Why JM?

## Strong fit with JM technology competences

### Chemistry

- Focus on advanced, functional battery materials (initially Li-ion)
- Draw on JM strengths in functional materials
  - Promoters and dopants
  - Particle shape, morphology control
  - Surface coatings and treatments
  - Stabilisation and durability

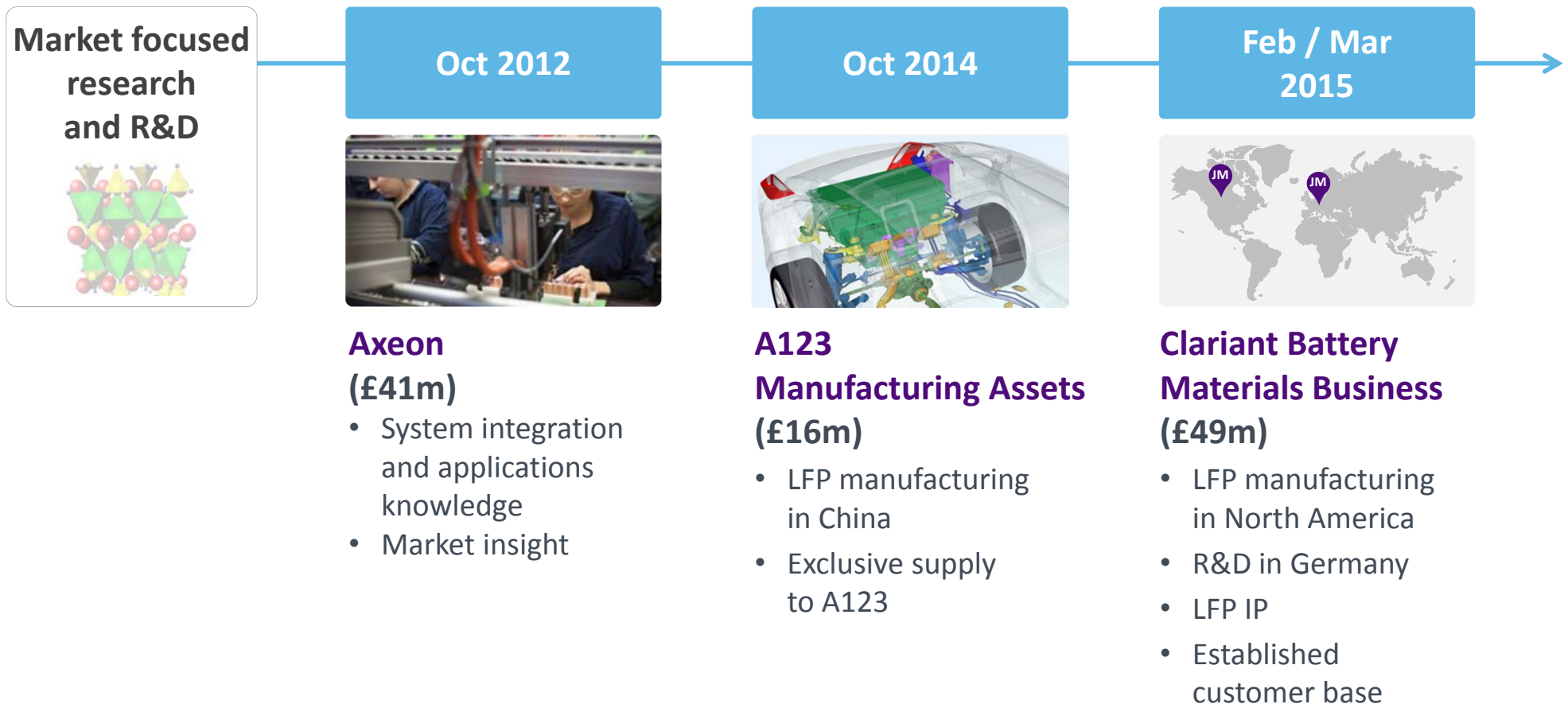
### Applications

- Expertise in high performance systems integration
- Understanding of current and future market requirements
  - Automotive and non-automotive
- Relationships with cell suppliers, OEMs, Tier 1s

Understanding of applications engineering = better product development

# Battery Technologies – Strategy

## Building a competitive position...



# Battery Technologies – Strategy

## Building a competitive position... with a broad product portfolio

### Battery Technologies today



- Credible supplier of cathode materials to cell industry
- Developing broader portfolio of cathode materials
  - In-license to accelerate in-house development
- Continued investment in R&D programmes
  - Next generation Li-ion and beyond



### Battery Technologies roadmap



Scope to accelerate growth through delivery of new products and chemistry

# Fuel Cells

## Key element of vehicle powertrains

### Opportunity

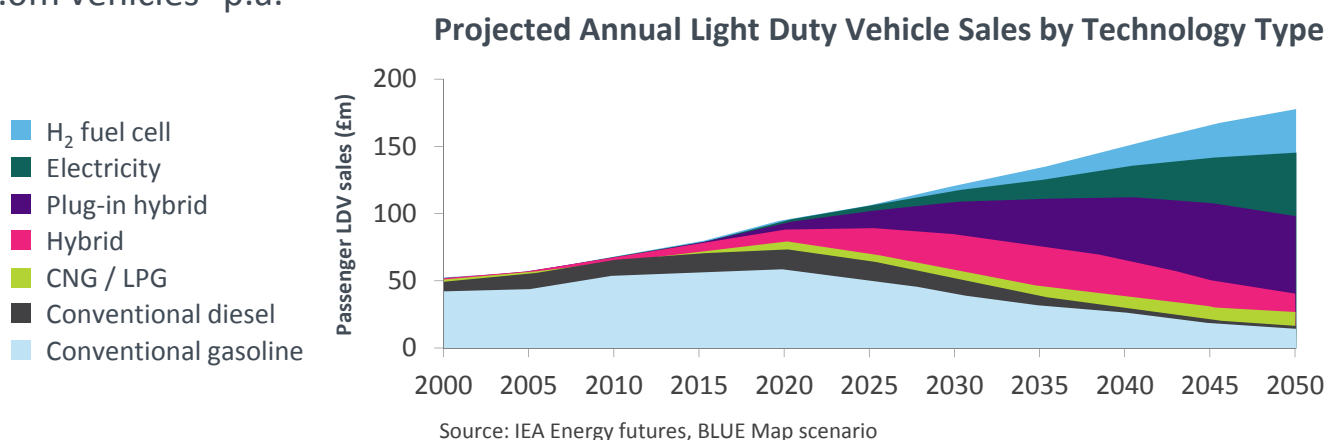
- Automotive market has started
  - CARB ZEV mandate
  - Japan Basic Energy Plan 2014 specifies move to hydrogen for fuel cell cars
- 2020: 10k-20k vehicles<sup>1</sup> p.a.
- 2025: 0.3-5.0m vehicles<sup>2</sup> p.a.

### Why JM?

- Strong technology, good understanding of market
- Supported by JM's position as an automotive supplier

### Strategy

- Convert existing OEM relationships into volume supply in next 2 to 3 years
- Position business for strong growth in automotive after 2020
- Continue R&D to meet 2025 MEA cost and performance targets



**Market now more certain, supply chain still developing**

<sup>1</sup>OEM projections <sup>2</sup> Jeffries "Fuel Cell Electric Vehicles: Benefits Without Compromise" 2014, Roland Berger Strategy Consultant "Fuel cells : A realistic alternative for zero emissions?" 2014

# Water Purification

## Opportunity

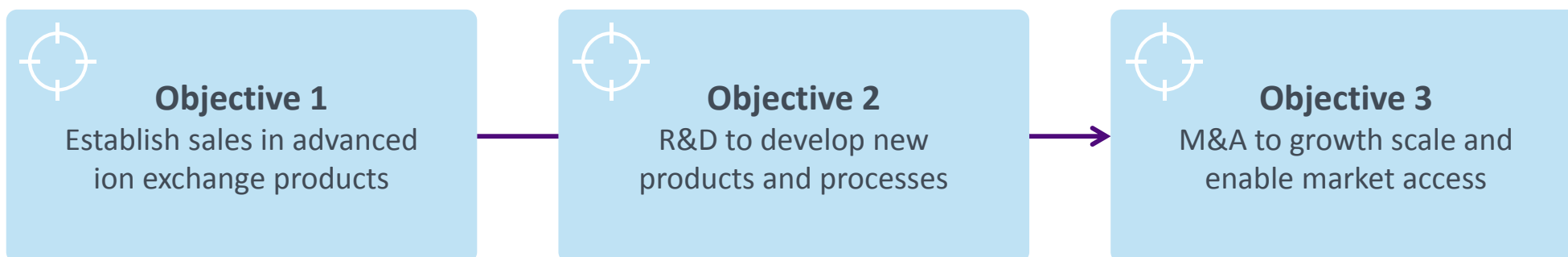
- Strong legislative drivers
  - Reduce contaminant levels
  - Increased water recycling
- Current existing markets >£500m in familiar areas – mining, oil and gas, chemicals

## Why JM?

- Good fit with JM's chemistry and applications know how
- Advanced materials and processes
  - Adsorbents and catalysts
  - Tailored functionality
- Targets selective contaminants

## Strategy

- Provide high technology, high margin products to treat challenging contaminants in niche markets
- Initial focus on Europe, Americas and China



**Strong opportunities confirmed, significant progress dependent on M&A**

# Atmosphere Control Technologies (ACT)

## Opportunity

- Strong global drivers
  - Efforts to minimise food waste and prolong produce life
  - Consumer demand to reduce use of chemical preservatives
  - Demand for convenience packaging
- \$1bn addressable market

## Why JM?

- Complex ecosystem control
- Application of core competences
  - Coatings
  - Surface chemistry
  - Managing gases at ambient temperature

## Strategy

- Develop atmosphere control technologies based on advanced functional materials
- Enhance conventional packaging and extend shelf life



### Objective 1

Develop novel scavenging technologies through investment in R&D



### Objective 2

Small scale M&A (up to £100m) to add technology and provide market access



### Objective 3

Develop an extensive portfolio of solutions with global presence

**Target – sales of £200m by 2025**

## New Businesses – Roadmap to 2025

TODAY

- Sales ~£80m
- Operating loss ~£20m
- £150m investment in new business areas

YEAR  
3

- Division breakeven
- Battery Technologies profitable
- Fuel Cells breakeven
- ACT profitable after moderate M&A
- Water Purification – modest M&A delivers profit; potential for more significant M&A

YEAR  
5

- £30m OP
- Total investment £250m
- ROIC > cost of capital

YEAR  
10

- >£100m OP – no significant further investment
- Opportunity for higher OP with right M&A



# New Businesses – Key Takeaways

On track with long term ambitions



## Investing for long term

To sustain superior growth for the group



## Target £200m sales p.a. businesses

Capable of meeting group returns



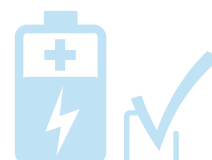
## M&A key to delivery

Rigorous financial criteria



## Ongoing investment £5-7m p.a.

Maintain portfolio of opportunities

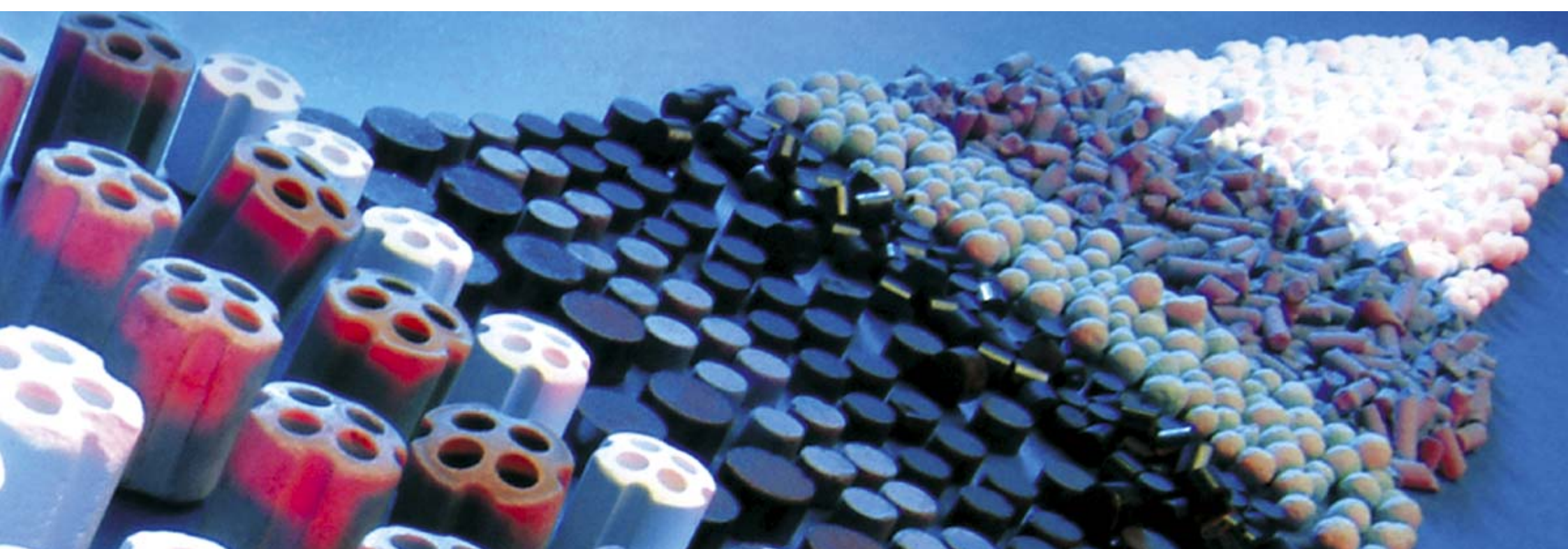


## Expect breakeven for division in Year 3

Well positioned in battery technologies



Target >£100m p.a. operating profit from new businesses by 2025



# Process Technologies **Strategy for Growth**

Geoff Otterman

Division Director, Process Technologies



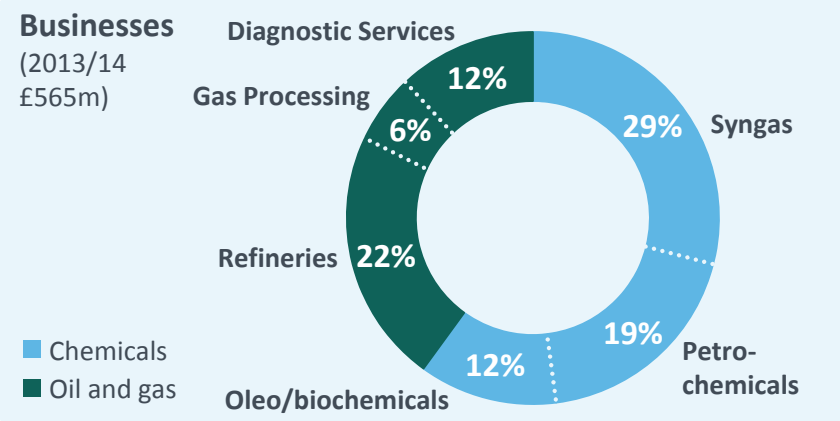
Johnson Matthey

# Process Technologies (PT)

**Manufactures speciality catalysts, licenses technology and provides services to the chemicals and oil and gas markets**

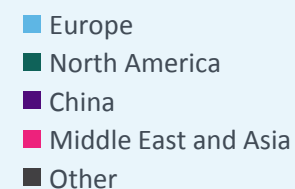
## PT Today

- Leading positions in targeted markets
- Strong growth opportunities supported by global drivers
- Creating value from combined strengths in catalyst and process technology
- Some short term headwinds...
  - Lower oil price – limited direct impact on PT but creates uncertainty
  - Slow down in new projects and licences in China – now expected to continue into 2015/16
- ...but long term fundamentals still in place
- Strategy to expand and broaden portfolio on track

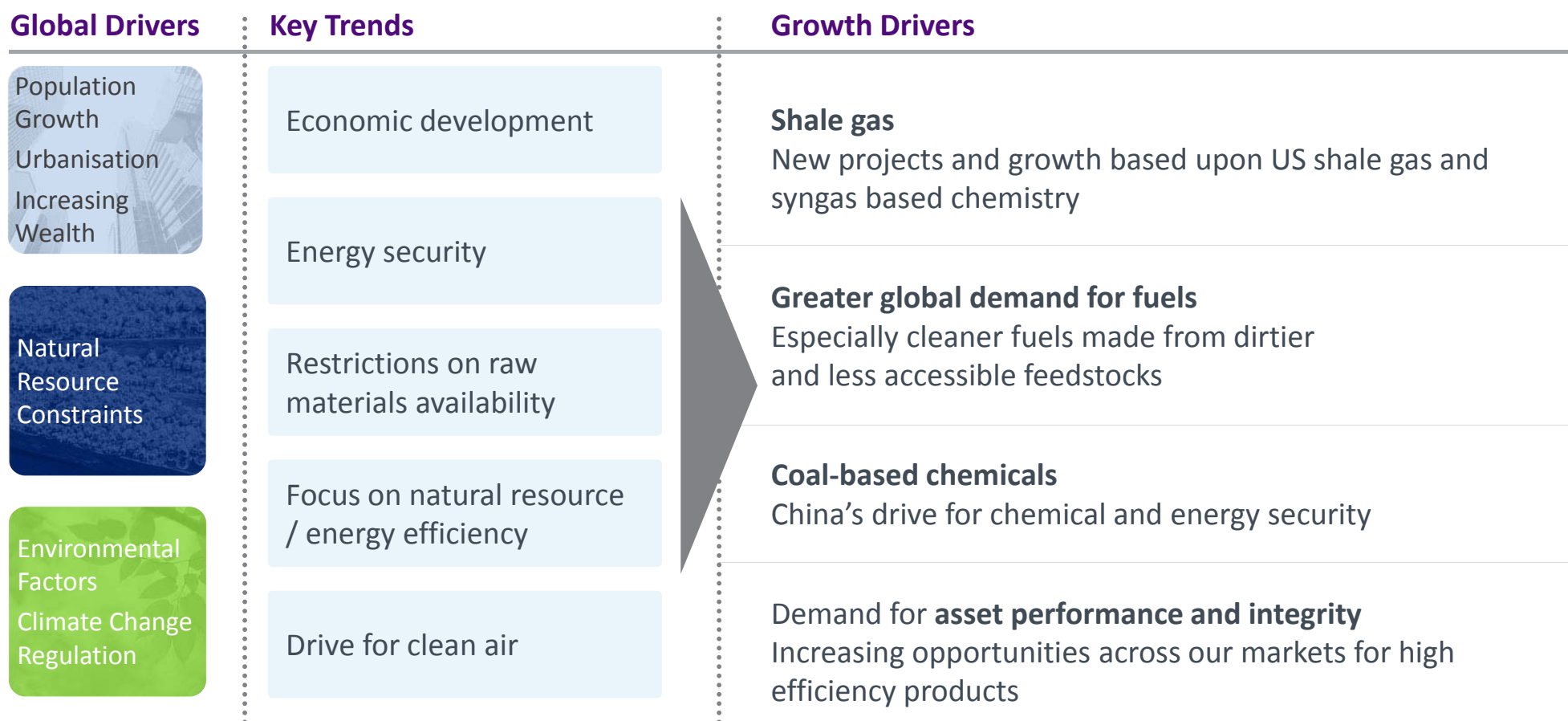


## Broad Geographical Spread

Sales by Destination  
(2013/14 £565m)



# Process Technologies - Drivers





## Shale Gas

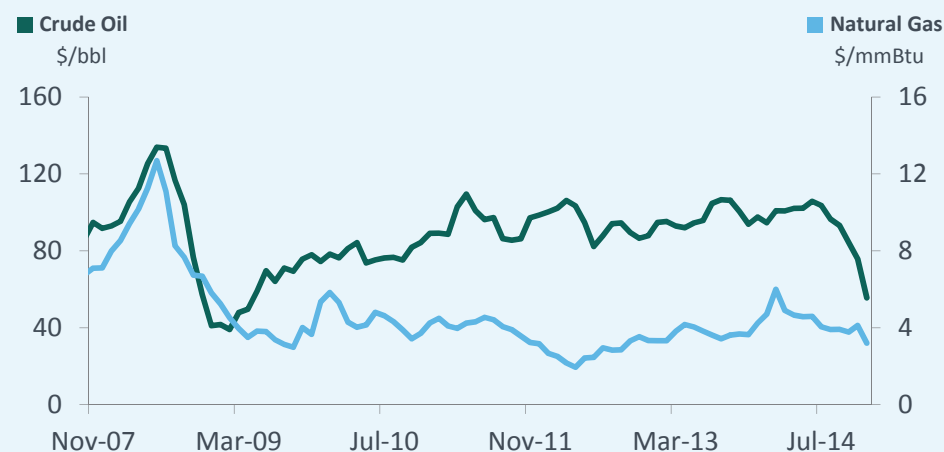
### Market Dynamics

- Low cost gas underpins new gas to chemicals investments
- Prospects for increased new plant activity
  - Progress on new ammonia plants
  - New methanol plants for China export market
- Gas to liquids (GTL) to monetise gas

### Key Opportunities

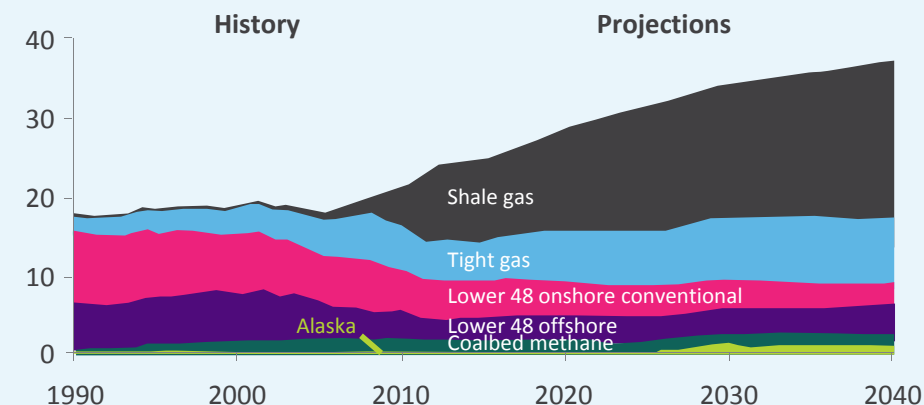
- Strong growth from licensing and catalysts
  - Pipeline of new methanol and ammonia plants
- New GTL capacity in longer term
- JM has leading position in key syngas technologies
- Remains robust long term opportunity

US Oil vs. Natural Gas Prices



Source: EIA

US Natural Gas Production by Source  
trillion cubic feet







## Global Demand for Fuels

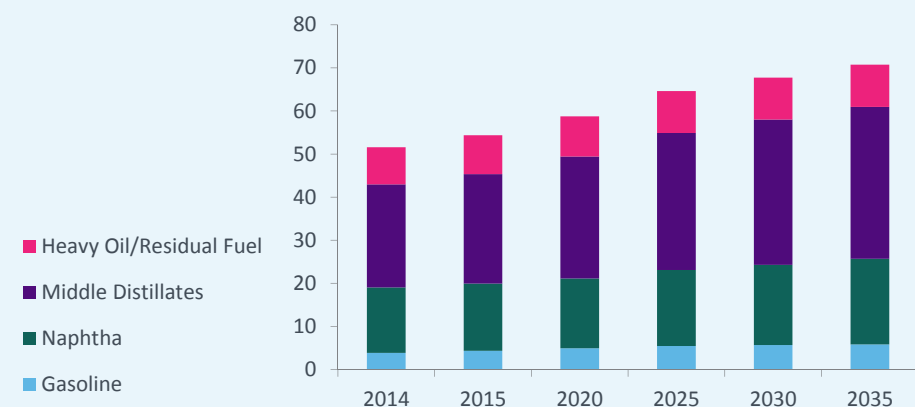
### Market Dynamics

- Clean fuels and trend to heavier sourer crudes underpins long term growth
- Growing demand for additives
- FCC capacity growth in Asia (fuels) and Middle East (chemicals) drives demand for additives
- New hydroprocessing capacity creates demand for new hydrogen plants

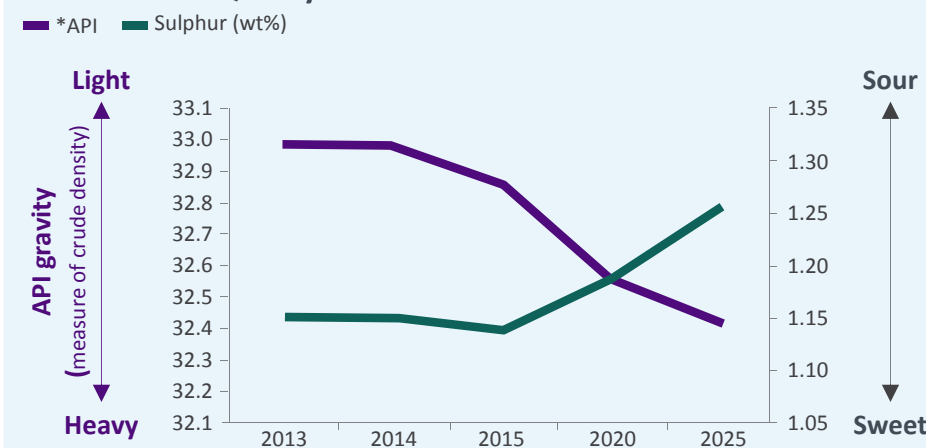
### Key Opportunities

- Expect market fundamentals and business growth to remain strong
- Robust growth in key JM markets
  - Hydrogen catalysts 6% p.a.
  - Refinery additives 5-7% p.a.
- Opportunities to expand JM portfolio

**Global Hydroprocessing Capacity Requirements**  
(million b/d)



**Global Crude Quality Trends**



Source: Hart Energy Research & Consulting



## Coal-based Chemicals

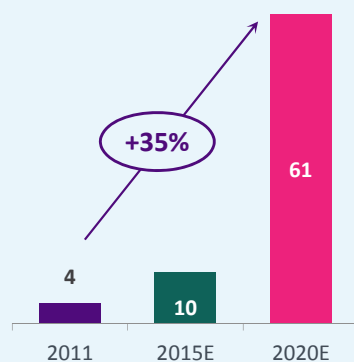
### Market Dynamics

- Energy demand / security drivers in China to meet needs of growing population
- Growing demand for key petrochemicals in China
- Coal to chemicals and SNG (substitute natural gas) technologies offer economic alternative to imports
- Balance between air quality issues and environmental concerns

### Key Opportunities

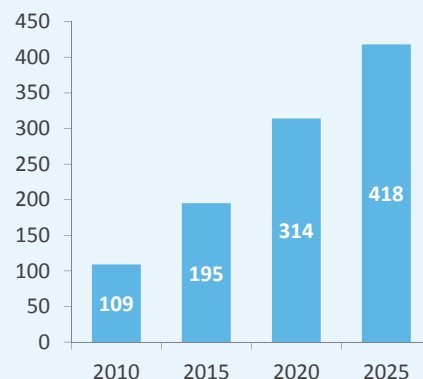
- Investment in new capacity for China requiring catalysts and processes
- JM portfolio of coal, gas and oil based technologies
- JM #1 position in SNG sector with nine projects licensed
- Portfolio strengthened with addition of new VCM and MEG technologies
- Long term view remains positive

**Coal to SNG Capacity**  
billion m<sup>3</sup>



Source: China Petroleum and Chemical Association and JM estimates

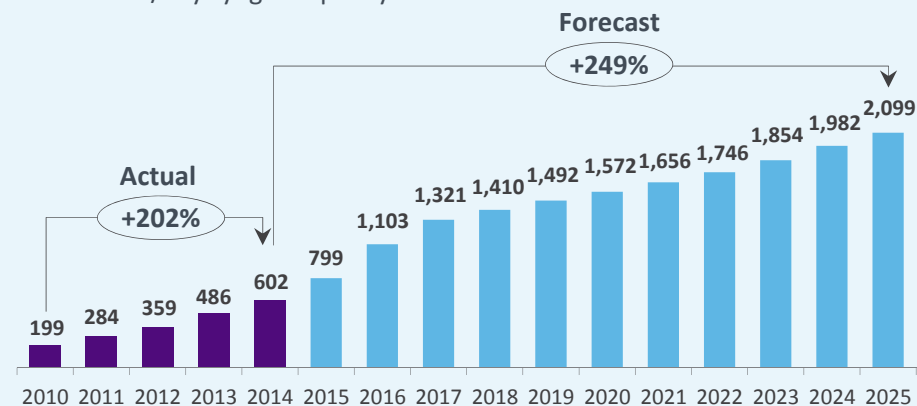
**China Natural Gas Demand**  
billion m<sup>3</sup>



Source: Arthur D. Little

**China CTC: Syngas capacity build by end product**

Unit: MMm<sup>3</sup>/day syngas capacity



Source: Arthur D. Little





# Asset Performance and Integrity

## Market Dynamics

- Capex pressures require
  - Greater value from more efficient processes and better catalyst technology
  - Use or reuse of older assets
- Financial and reputational risks of poor asset assurance

## Key Opportunities

- Growth from innovative new products and services across PT's Chemicals and Oil and Gas businesses
  - High efficiency catalysts and reactors
  - Process changes and revamps
  - Smart technology for flow control, asset inspection and product assurance
- Good progress with introduction of new products and services



# Process Technologies Strategy

## Progress since January 2014



**Maintain leading positions in catalysts and process technologies for chemicals markets**

- Leveraging catalysts / process technology edge in existing technologies
- Commercialisation of new technologies



**Develop larger presence in oil and gas markets**

- On track – extending capabilities in catalysis
- Current market conditions may create M&A opportunities



**Invest for growth**

- R&D spend maintained at 5% of sales
- Short term capex revised in view of current conditions



**Expand capabilities**

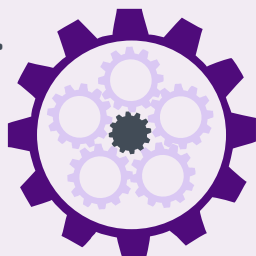
- Working with key partners on new opportunities
- Exploring M&A in adjacent technologies

**Broaden offering to deliver superior growth**

# Differentiation Through Technology

## Unique combination of catalysts, know how and process technology

### Chemistry...

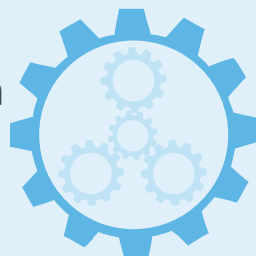


Catalysis and process understanding underpin technology leadership

Ability to integrate catalyst and process technology

- Creates value for JM and customer
- Develop technology for new markets
- Competitive edge

### ...and its Application



Deep understanding of customer operations adds value

Effective and safe technology transfer

- Customers integral to R&D process
- Partnerships accelerate commercialisation
- High project win rates

### Example: Vinyl Chloride Monomer (VCM) in China

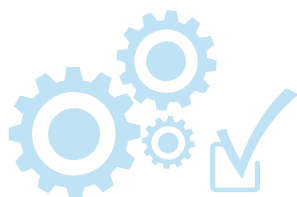
- New gold catalyst and process technology package
- Research done at JMTC
- Process IP developed with partner and acquired
- Replaces toxic mercury catalyst
- Expect new licences over next two years



**R&D investment drives strong technology pipeline and new product delivery**

# Process Technologies – Key Takeaways

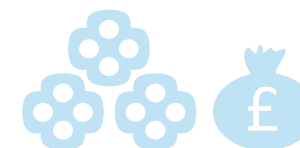
## Well placed for long term growth



**Fundamental drivers**  
still firmly in place



**Expect short term slow down**  
in some markets



**Uniquely placed to create value**  
through integrating catalyst and  
process technology



Continue to **invest to broaden portfolio** for  
longer term growth



Medium term **mid to high single digit sales growth** on  
average

A man in a dark sweater and collared shirt is working on a complex robotic engine in a laboratory. The engine is suspended by chains and has various wires and hoses attached to it. The background is a bright blue wall.

# Emission Control Technologies **Motoring On and Driving Forward**

John Walker

Executive Director, Emission Control Technologies



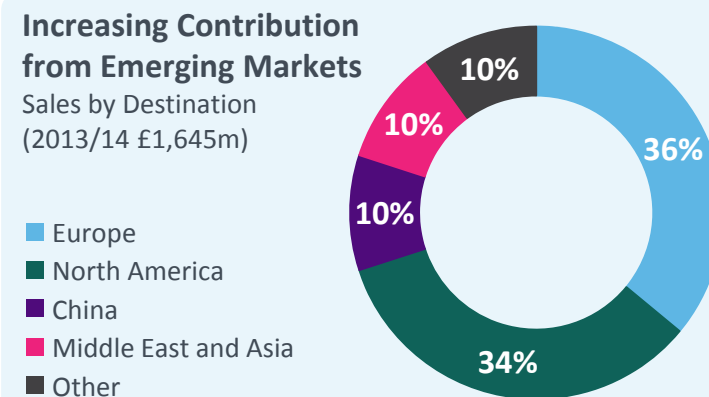
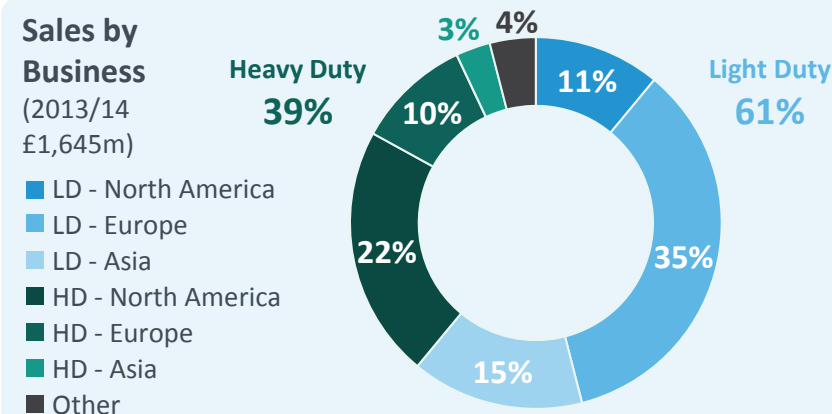
Johnson Matthey

# Emission Control Technologies (ECT)

## Global leader in catalysts and technologies for light and heavy duty vehicles

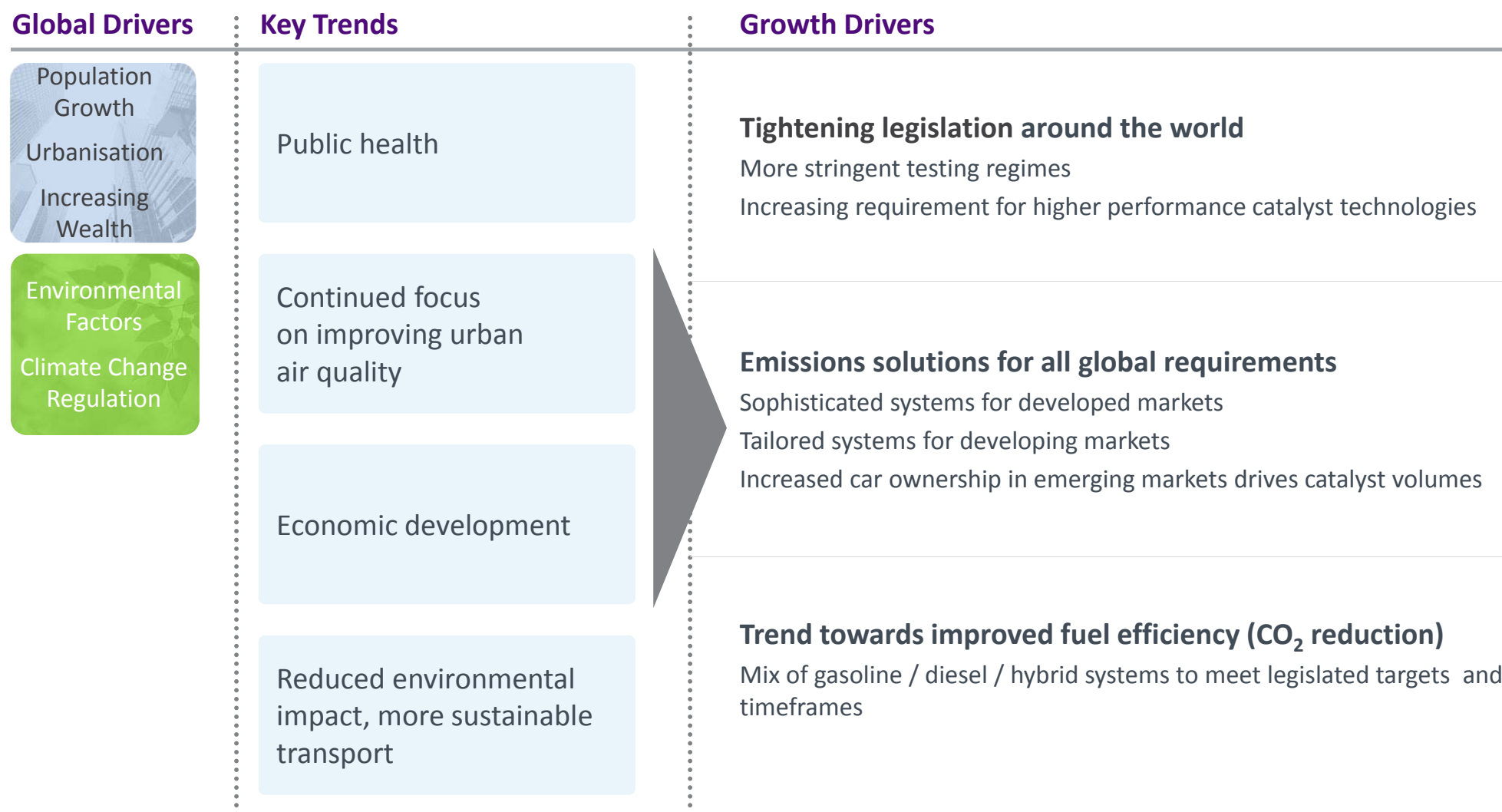
### ECT Today

- Performing strongly on the back of long term investment in R&D and facilities
- Benefiting from:
  - Growth in vehicle markets
  - Tightening legislation – requires new technology
  - Focus on operational excellence
  - Increasing capacity utilisation
- Stable positions in light and heavy duty sectors
- Air quality impact on public health remains major global focus

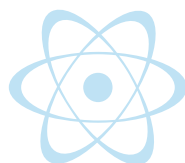




# Global Drivers Support Growth in ECT

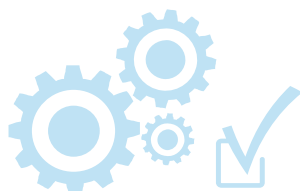


# Emission Control Technologies' Strategy



## Invest in our people, products and technology

- R&D investment to maintain differentiation through technology
- High performance catalysts matched to local needs
- Materials science and manufacturing



## Operational Excellence and Sustainability

- Optimum efficiency
- High quality products
- Supply chain



## Customer focus

- A deep understanding of our markets and customers

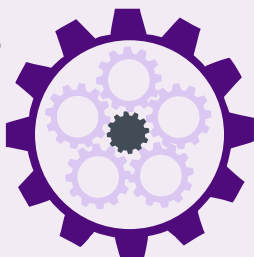


## Create value

- Deliver superior growth
- Markets driven by global trends and regulation
- Rates above industry baselines

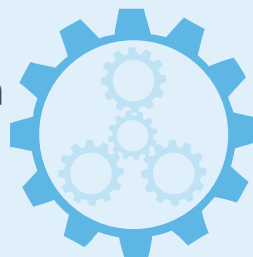
# Technology – Accelerating Innovation, Maintaining Edge

## Chemistry...

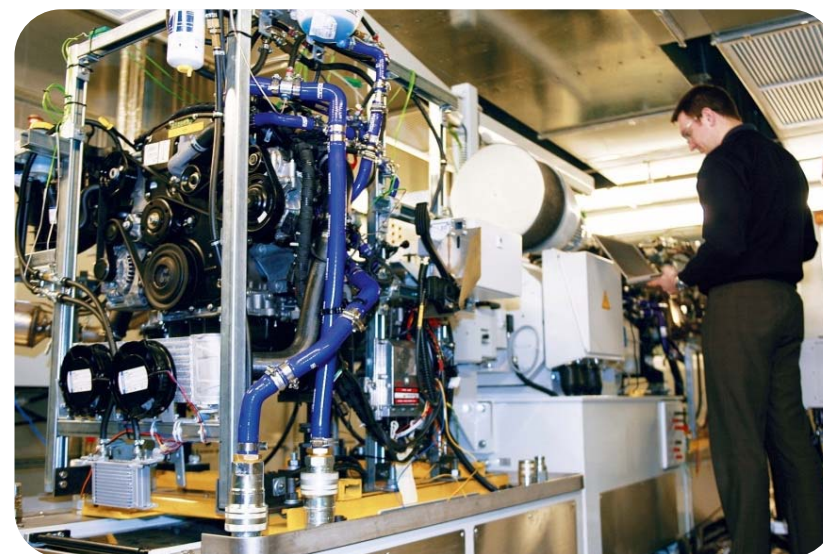


- Full suite of products for global market requirements

## ...and its Application



- Global capabilities to support customer development and testing
- 
- Increasing portfolio of tailored technology types
  - Trend towards multifunctional catalysts
    - Customer demands, restricted space
  - Design for manufacturing excellence
  - Technologies for potential additional regulated emissions



**Customer collaboration  
critical to successful  
innovation**

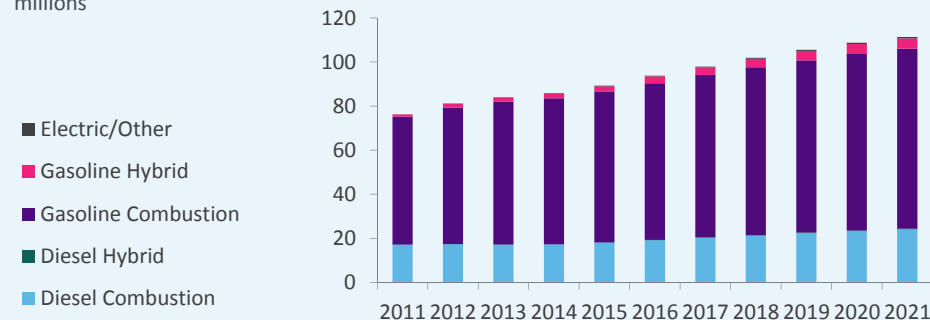
# Light Duty – Key Trends

## Market Trends

- Strong volume growth in Asia, especially China
- European market below 2007 levels – latent demand
- Engine size – some reduction but very slow pace
- Powertrain developments
  - Diesel – Europe remains main market, share expected to trend down only slightly
  - Low penetration for hybrids (5% by 2020)
    - Hybrids still need a catalyst
    - Catalyst value comparable to IC equivalent

### Global LDV Production: Fuel Type and Hybridisation

millions



Source: LMC Automotive

## Legislative Trends

### Europe

- Euro 6b for diesel now coming in – adds ~20% in catalyst sales value for JM
- Euro 6c for some gasoline from 2017/18 – doubles catalyst sales value for JM
  - Expect ~25% of gasoline vehicles initially and ~50% by 2021
- Real world driving emissions from 2017 – will influence system selection

### Asia

- China 5 nationwide in 2018 – diesel filters
- Beijing 6
- India regulations delayed post 2017

### North America

- Tier 3 on track for 2017 implementation
- GHG / fuel efficiency targets tightening to 2025
- PM standard may phase in by 2025 – gasoline filters

# Diesel – Key to Meeting CO<sub>2</sub> Targets

## Diesel essential to the mix to meet tighter CO<sub>2</sub> targets

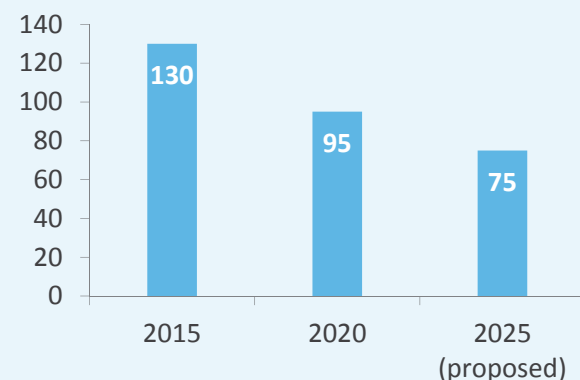
- Penalties for OEMs that miss fleet average targets
- UK today – for cars meeting 2020 CO<sub>2</sub> standards, over 50% are diesel
- Difficult to radically change mix in current timeframe

## Diesel continues to get cleaner

- Real world driving standards (anticipated 2017) – expect to have a major impact on emissions
  - System architecture likely to change – more higher value components in mix for JM
- Technology exists today to meet even tighter standards
  - Similar emissions for diesel and gasoline

### European CO<sub>2</sub> Fleet Average Targets

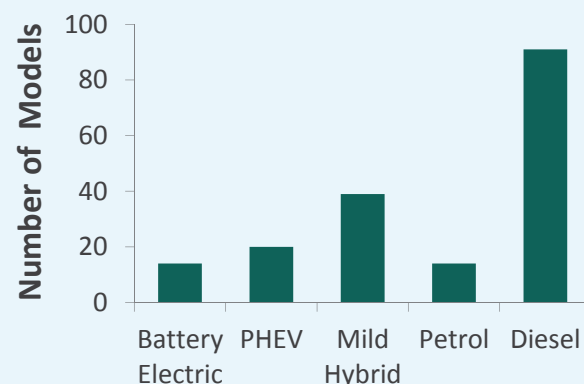
CO<sub>2</sub> emissions g/km



Source: European Commission data

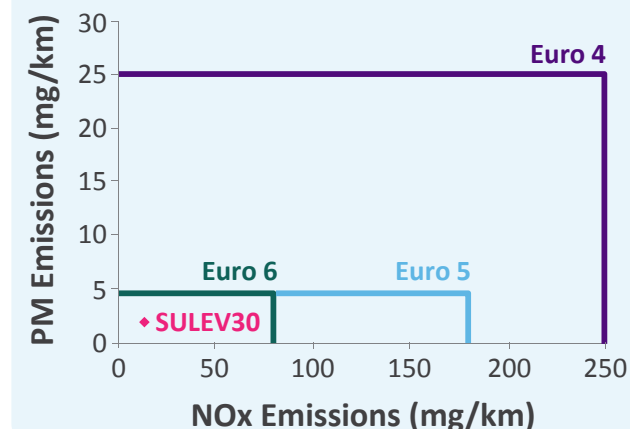
### UK Available Car Types

Vehicles meeting 2020 (95 g/km) CO<sub>2</sub> target



Source: Vehicle Certification Agency website

### Progression of Diesel Emissions Standards



# Strong Sales Growth Continues in Light Duty

## Update since January 2013

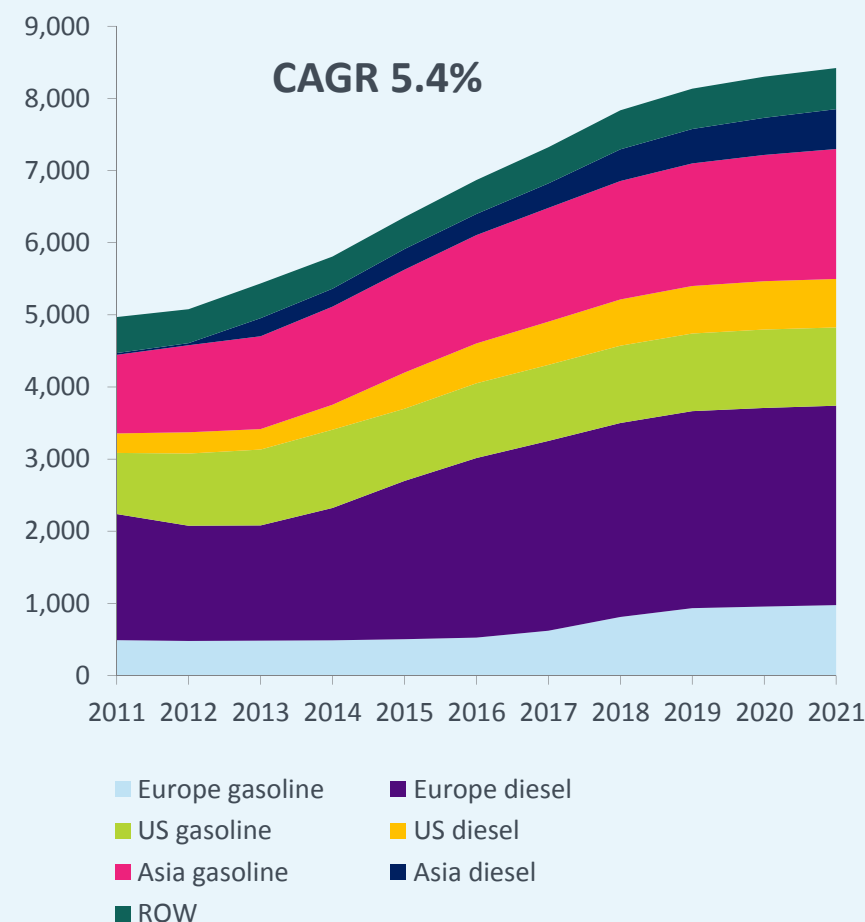
- Market size forecast unchanged
  - \$6bn by 2015 and \$8bn by 2020
- European diesel remains the main value driver
- Asian car sales growth still adds further opportunity
- Higher value diesel market in Asia and US
- Still expect stable sector position



Light duty market continues to offer good growth potential

JM sales growth expected at 2 to 3% ahead of growth in global vehicle production

Sales ex pms \$m



Source: LMC Automotive and JM estimates



# Heavy Duty Diesel – Key Trends

## Market Trends

- Current strong growth in Class 8 US truck sales expected to continue through 2015
- European truck production forecast to improve
  - Pent up demand following weak sales, ageing fleet
- Natural gas penetration in US slower than expected

## Legislative Trends

### Europe

- Euro VI now implemented
- Advanced discussions re. US GHG type legislation
- Non-road – Stage V expected from 2019/20 will add value for JM

### Asia

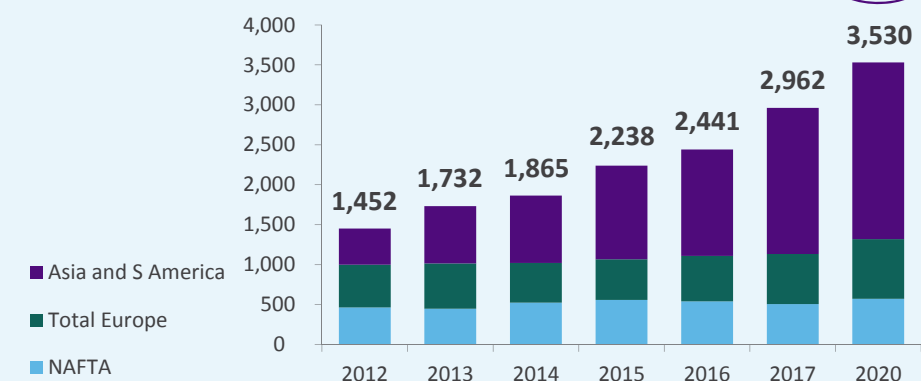
- China Euro IV nationwide from Jan 2015 drives volumes
- Beijing VI expected from 2018 – Euro VI equivalent, adds filters
  - Potential for nationwide roll out post 2020
- India regulations delayed post 2017

### North America

- GHG regulations tightening to 2020
- Discussions in California re. tighter NOx standards

## HDD Vehicle Production Outlook (Regulated Engines)

thousand



Source: LMC Automotive; Johnson Matthey estimates for proportion regulated

# HDD – A \$1.8bn Market by 2015, Growing to \$3.0bn by 2020

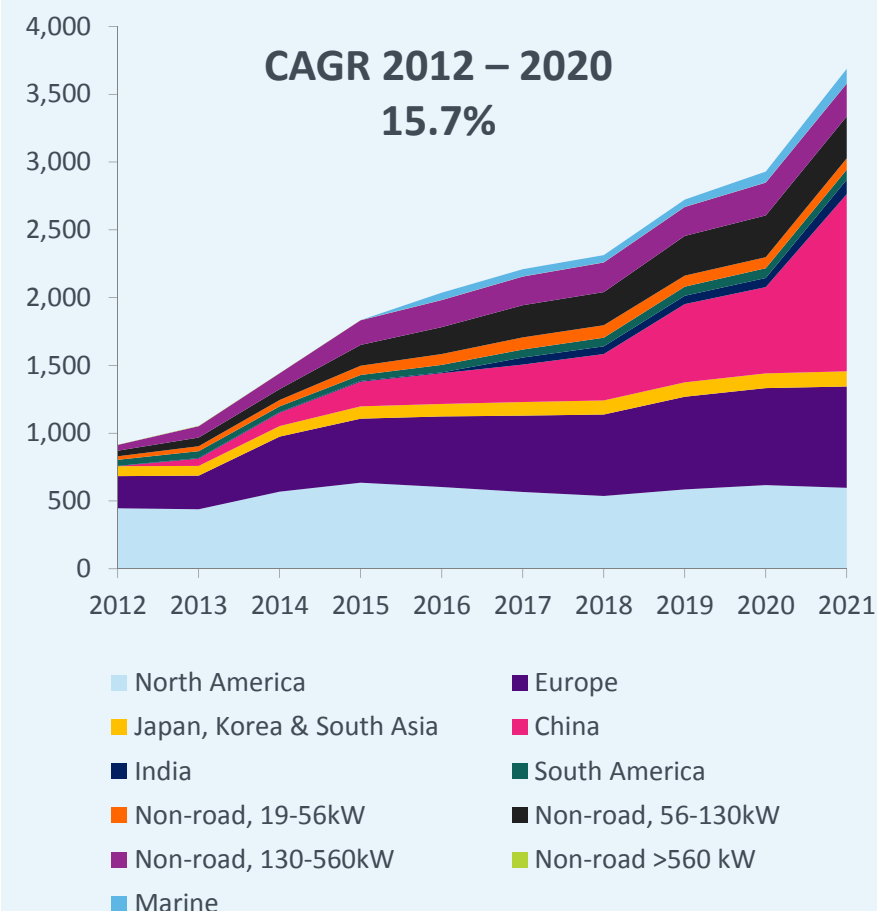
## Update since January 2013

- 2015 market size estimate revised due to timing of non-road market
  - Stage V in Europe adds value from 2019
- Continued growth in China as legislation tightens
- Geographic expansion of tighter emissions standards



**Heavy duty market continues to offer significant growth potential**

Sales ex pms \$m



Source: LMC Automotive and JM estimates

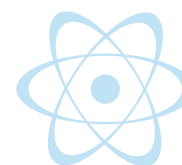
## Emission Control Technologies – Key Takeaways



**Growth in all  
our markets**



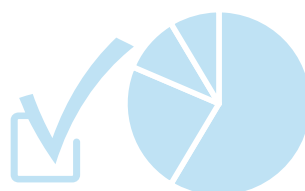
**Legislative tightening**  
continues to  
deliver value



**Create value** from  
catalysts and  
manufacturing  
technology



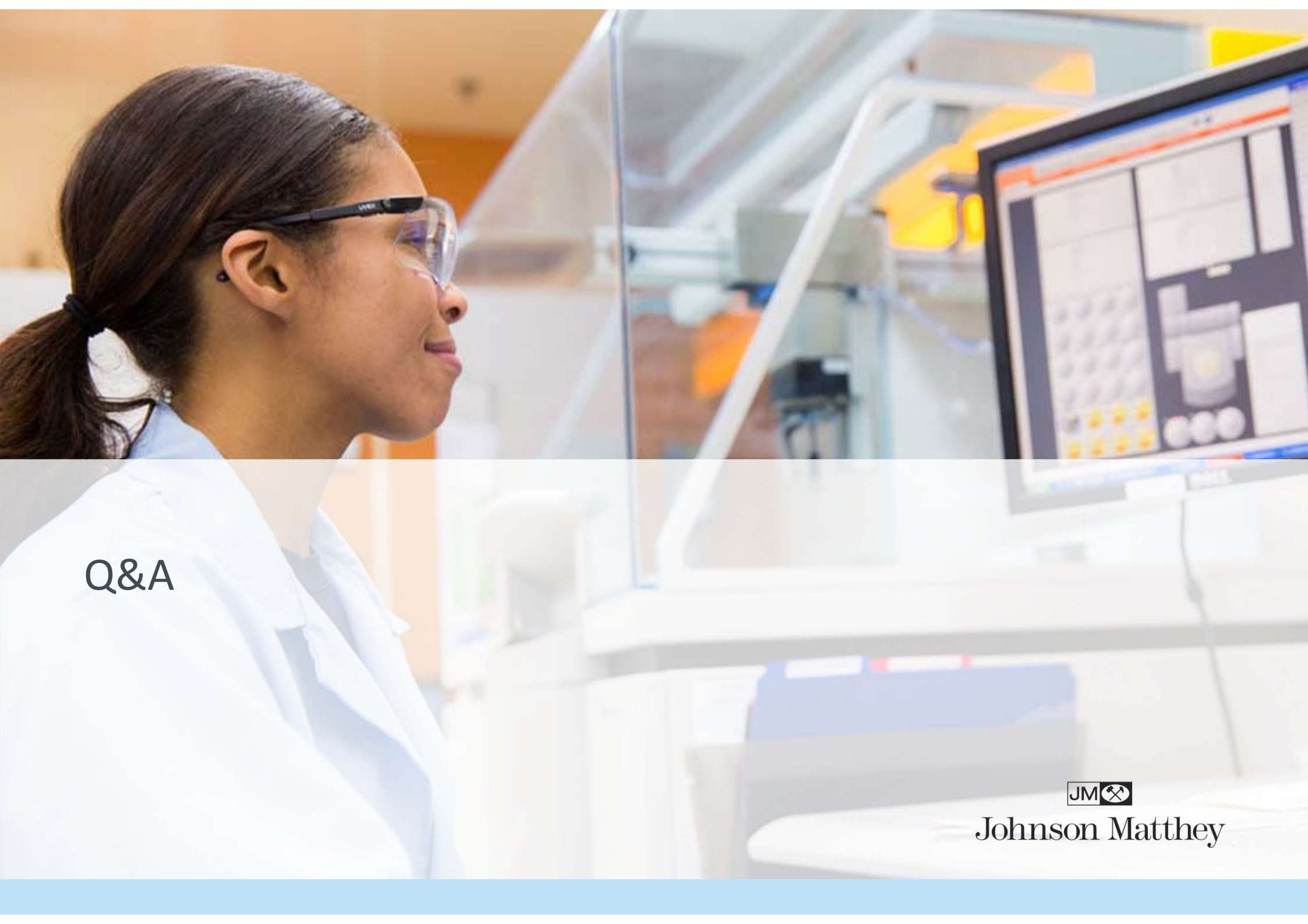
**JM continues to invest**  
ahead of growth  
opportunities.



**Strong positions** in  
light duty and HDD  
to be maintained



**High single digit sales  
growth on average**



Q&A



Johnson Matthey





# Johnson Matthey R&D

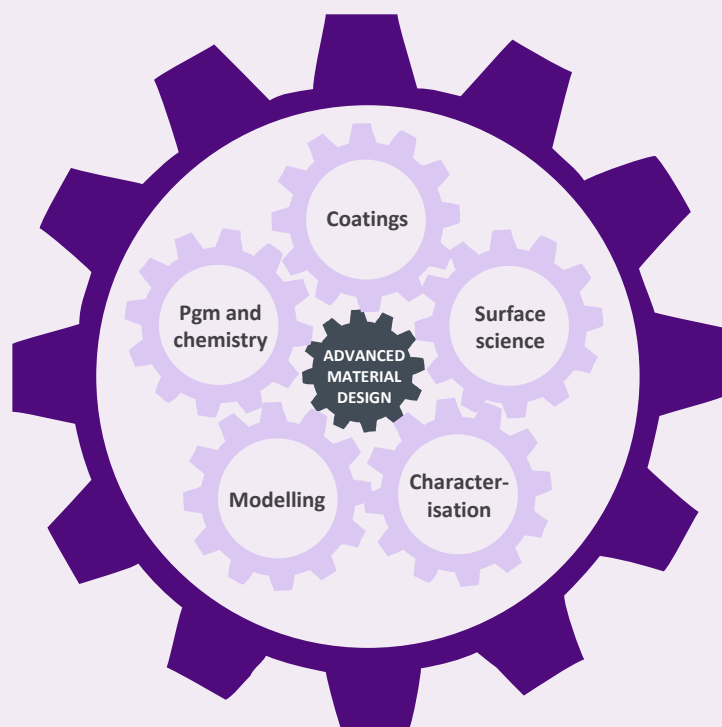
Dr Liz Rowsell  
R&D Director, Johnson Matthey Technology Centre



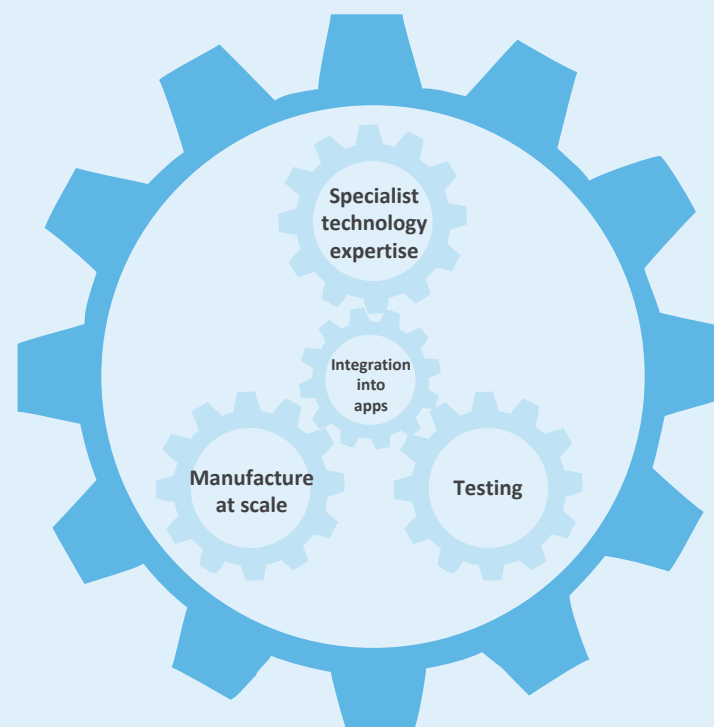
Johnson Matthey

# Differentiation Through Technology

## Chemistry...

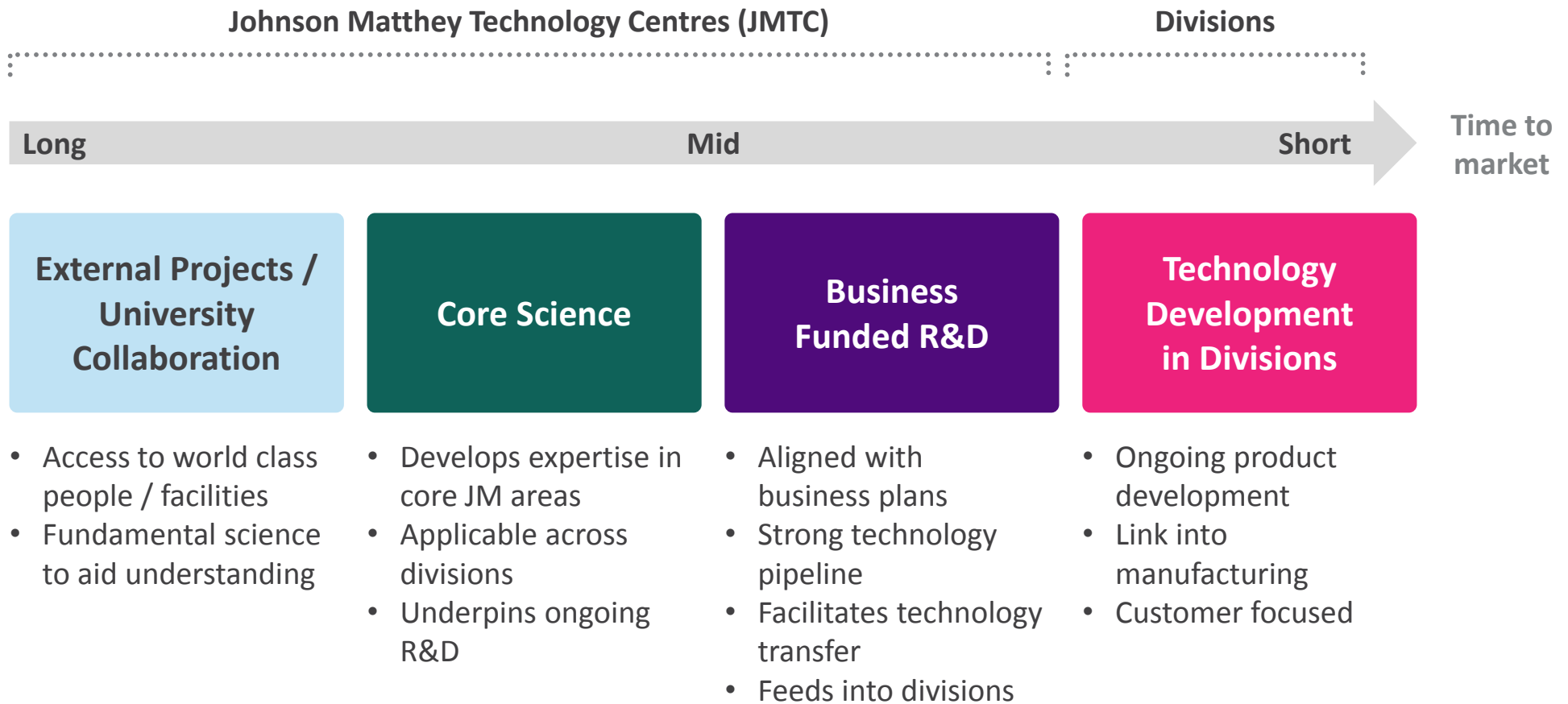


## ...and its application





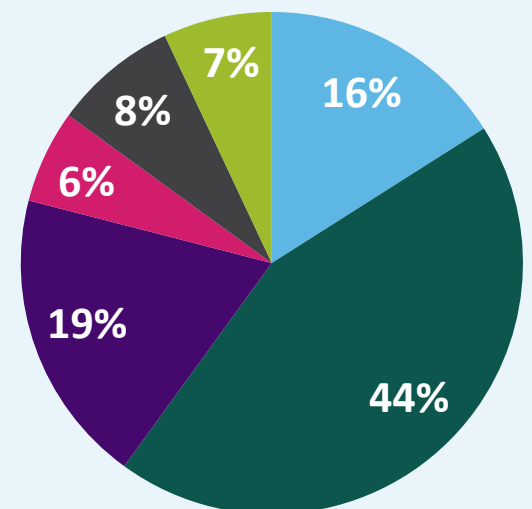
# R&D to Deliver Future Growth



## R&D Statistics

- Continued investment – maintain at ~5% sales
- 1,400 employees – 21% in JMTC
- JMTC sponsors work at over 30 universities in 9 countries
- A diverse community of nationalities, disciplines and age
- Highly collaborative approach
  - Strong links with customers and businesses
- Robust review processes
- High degree of know how, supported by strong IP portfolio

Distribution of Research and Development Expenditure  
Group R&D spend 2013/14 £152.3m



■ JMTC  
■ Emission Control Technologies  
■ Process Technologies  
■ Precious Metal Products  
■ Fine Chemicals  
■ New Businesses

# A Growing Network of Technology Centres



## Savannah

- 4 employees
- Microporous materials



## Billingham

- ~50 employees
- Process catalysis, engineering and scale up



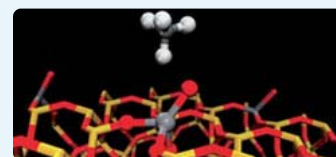
## Sonning Common

- ~250 employees
- Catalysis and materials, materials characterisation



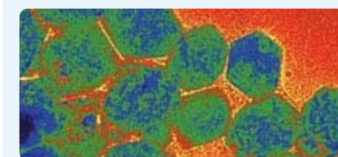
## Pretoria

- 6 employees
- Computer modelling



## Singapore

- 7 employees - 100 by 2020
- Functional materials



## New Ventures



### JMTC Singapore

- Vibrant international research community
  - Academic and applied
  - Strong in materials R&D
  - Diverse / collaborative environment / language
- Established collaboration with NTU (March 2014)
- Lease signed on ~1,900 m<sup>2</sup> of space in CleanTech 2
- Ambition – 100 scientists and support staff by 2020



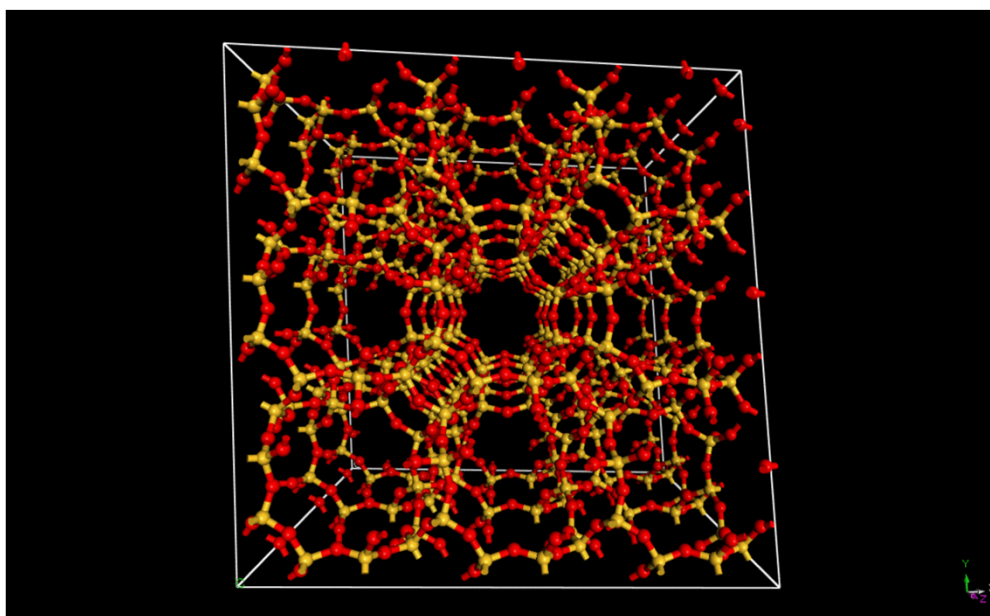
### JM / Oxford University / Diamond Light Source Collaboration

- Creation of a state of the art materials characterisation facility – Harwell, UK
- JM and Oxford University to contribute cutting edge electron microscopes to Harwell's nanoprobe beamline
- Nanoprobe will deliver world's highest spatial X-ray resolution
- Allows characterisation of materials across scales
  - From catalyst active sites (atomic scale) to their location in the end product (micron scale)
- Greater understanding across scales – to improve existing materials and design new ones

# Optimising SCR Catalysts

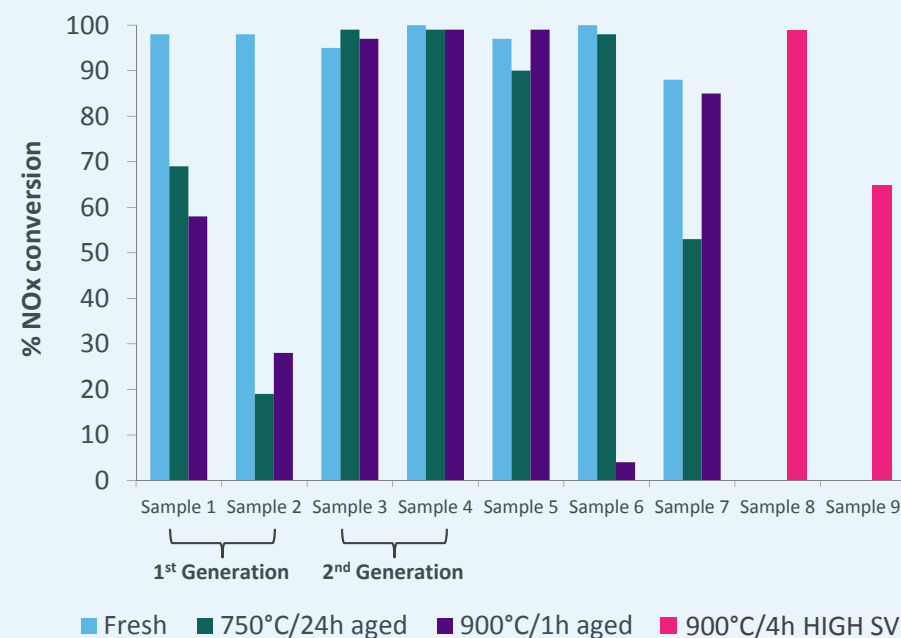
## Copper (Cu) zeolite NO<sub>x</sub> control catalysts for diesel engines

Zeolites – microporous crystalline solids with well defined pore architectures



Add Cu and zeolite materials become active for NO<sub>x</sub> reduction using ammonia (NH<sub>3</sub>) as a reductant

NH<sub>3</sub> SCR: NO<sub>x</sub> conversion at 250°C

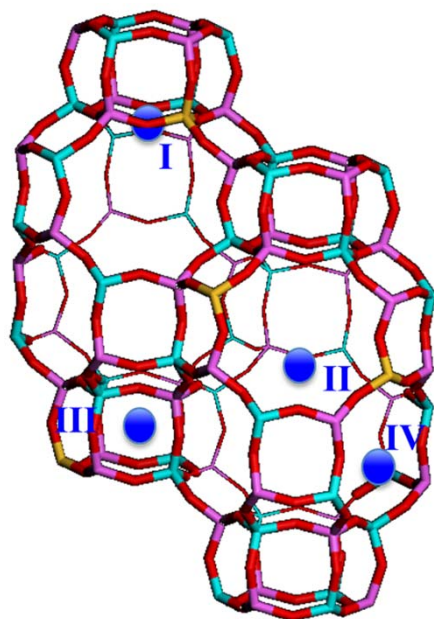


Designed small pore Cu zeolites

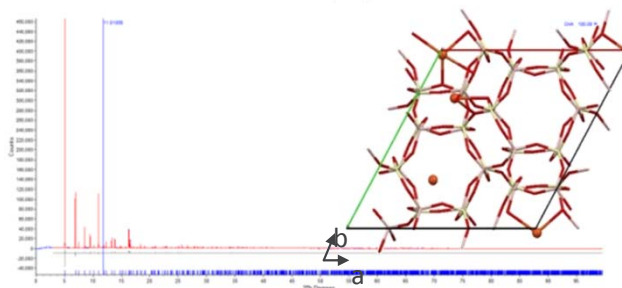
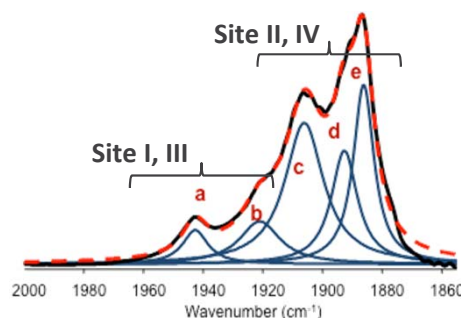
- More thermally durable and selective for NO<sub>x</sub> reduction

# Where is the Cu?

- Cu zeolites are examples of single site catalyst materials
  - Isolated Cu atoms represent the reaction site for the reaction of NO<sub>x</sub> and NH<sub>3</sub>
  - Locating the Cu within the structure is key to understanding the superiority of the latest generation of catalysts



Possible Cu sites from modelling



Use of probe molecules to bind to Cu and analyse using *in-situ* infra-red spectroscopy

Use of high resolution X-ray diffraction to identify Cu locations (at Diamond Light Source)

Cu in Site II and IV



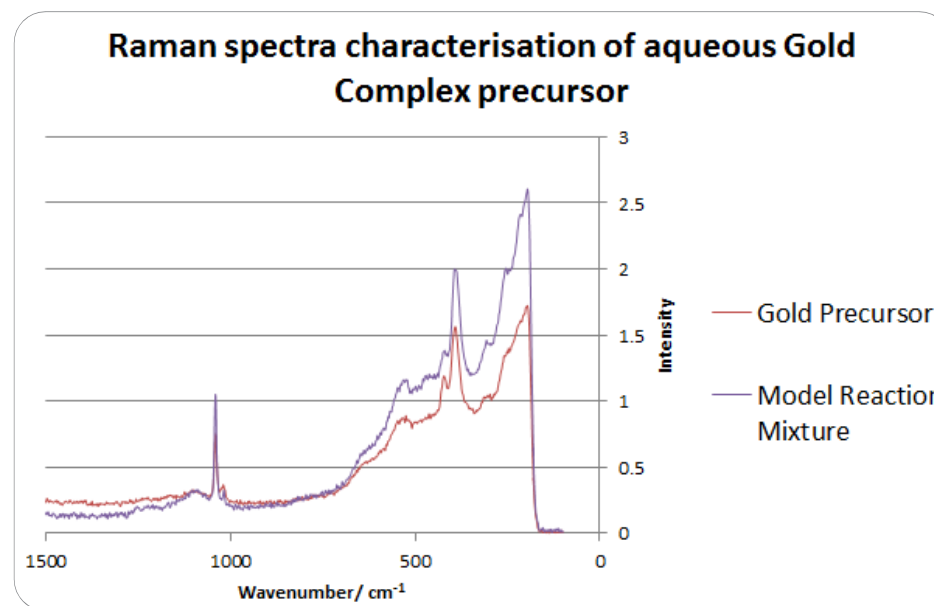
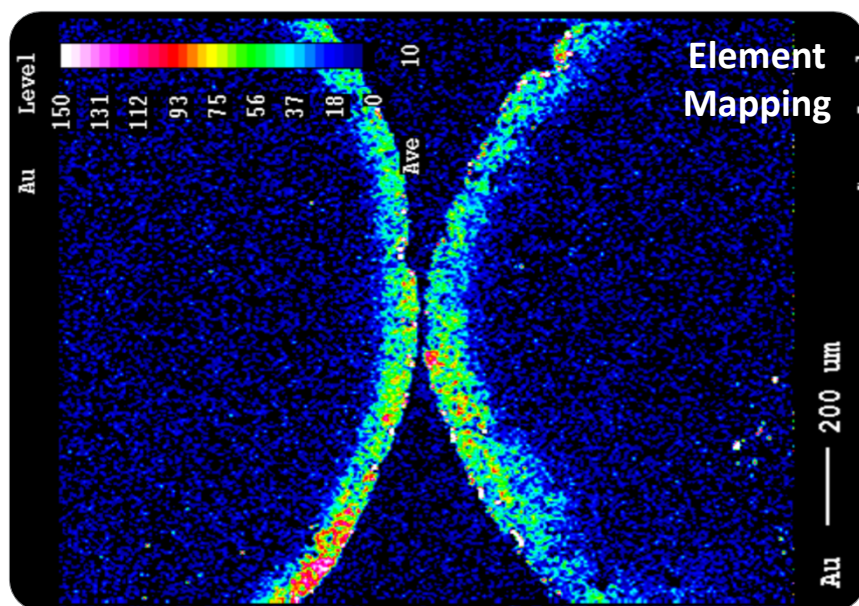
## Gold Based VCM Catalyst



- JM developed an economically viable gold catalyst
  - Direct drop in for current mercury system
- Catalyst designed to be stable in highly acidic environments
- Superior yield and lifetime
- Currently commissioning catalyst production plant in Shanghai

# The Application of Gold Chemistry

JM has long history of gold co-ordination chemistry in catalysis, inks, coatings and bio-materials



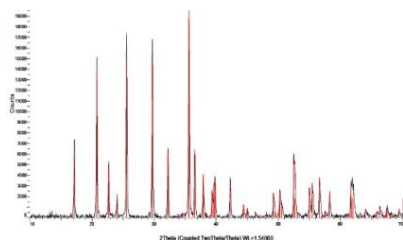
## EPMA – Eggshell of Au complex on carbon

- Benign process was invented to coat surface of carbon support with stable gold complex at scale
- Surface location ('eggshell' allows low loading and high activity in highly acidic environment)
- Raman spectroscopy confirms the correct gold species against model system

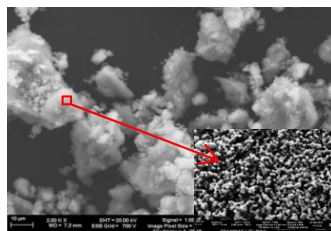
# Materials Characterisation

- JMTC Group Analytical provides world class characterisation of active materials
  - Provides insights into material properties
  - Combination of techniques
  - Enables improved performance and modification to prepare next generation materials

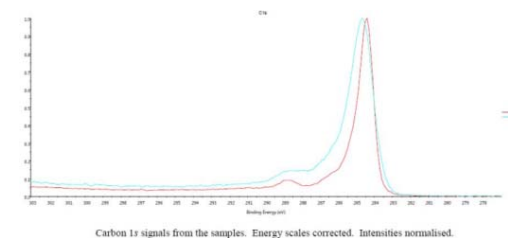
## XRD - Crystallinity



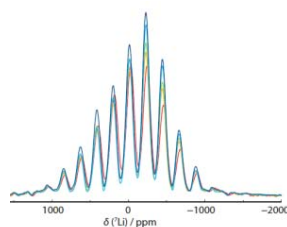
## SEM - Morphology



## XPS - Surface Chemistry

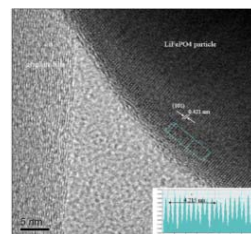


## SS-NMR - Environment

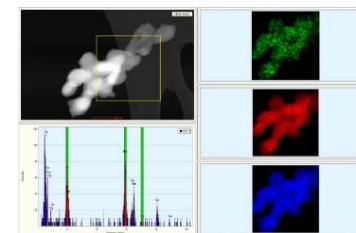


**Figure 1.** Normalised  $^7\text{Li}$  solid-state MAS NMR spectra

## HR-TEM - Atomic Arrangement

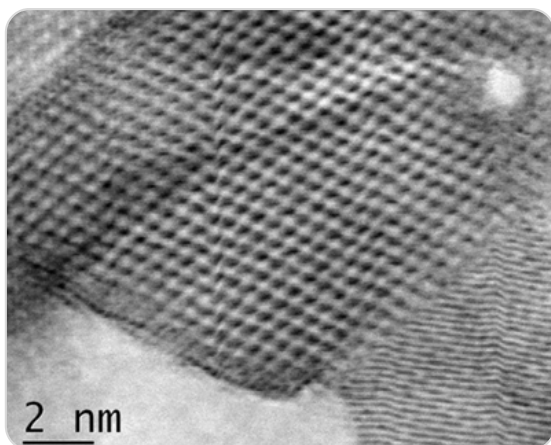


## EDX - Element Mapping



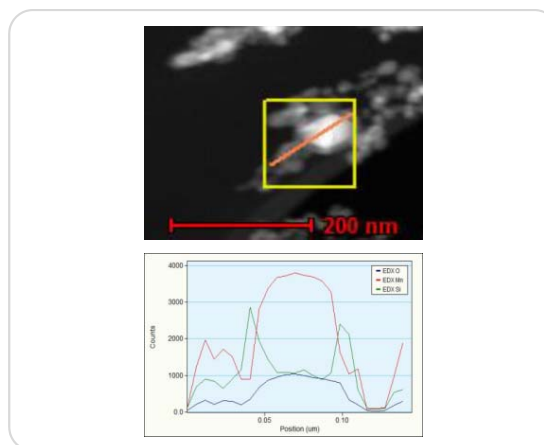
# Designing Improved Battery Materials

## Design of functional materials by careful control of synthesis and processes



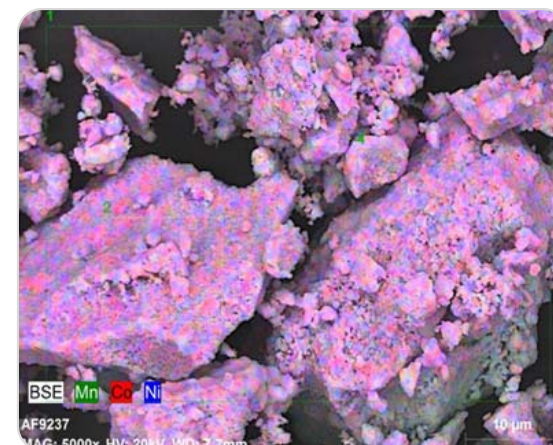
### Particle Size

- Highly crystalline nano lithium titanate anode material prepared by flame spray pyrolysis
- Small particle size aids lithium ion movement



### Coatings

- Coating lithium manganese oxide spinel with silica
- Stops metal leaching and prevents unwanted reactions



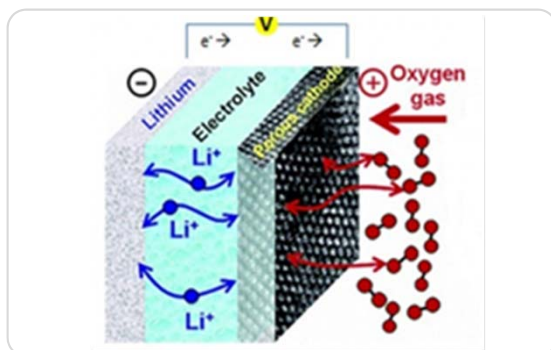
### Dispersion

- Catalyst synthesis expertise
- Produces uniformly distributed multi-metallic precursors for cathode materials

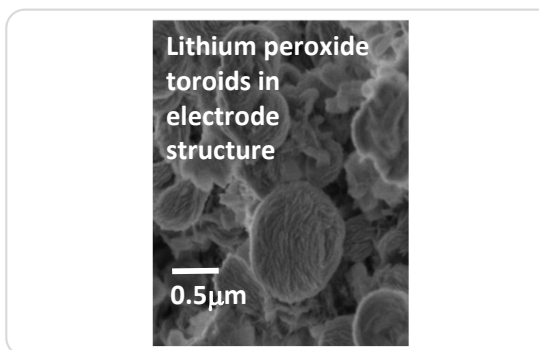


# Beyond Li-ion Chemistry

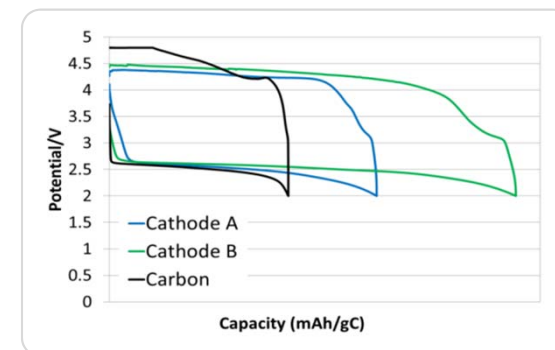
- Li-air and Li-S batteries have potential to deliver greater energy densities
- Will rely on improved materials and chemistries
- External collaborations with internationally renowned academics to solve the technical challenges



- Li-air battery has potential to increase amount of energy that can be stored for a given weight



- Electrodes can be blocked by lithium peroxide
  - Particle size and shape important for cell lifetime



- JM is making and testing cathodes doped with pgms
  - Promotes oxygen dissociation
  - Stops undesired side reactions

## Role of JMTC – Right Science at Right Time



### **Central expertise, innovation and knowledge**

Underpins JM's IP



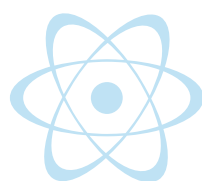
### **Deliver medium term R&D**

In close collaboration  
with divisional teams



### **New product development**

Supporting new business  
development activities



### **Core science programmes**

Extend and develop technologies  
central to JM and applicable  
across divisions



### **Collaboration with leading institutions**

Keeps JM science  
cutting edge



### **World class**

High skilled scientists,  
state of the art facilities



## Tour of JMTC Sonning

Refining Research – Dr Emma Schofield

.....

ECT – Dr Dave Thompsett

.....

Battery Materials – Dr Sarah Ball and Dr James Cookson

.....

Water Purification – Dr Alistair Kean and Dr Jonathan Sharman

.....

New Applications – Dr Alison Wagland

.....

Biomass Processing – Dr Mike Watson

.....

A woman with dark hair in a ponytail, wearing safety glasses and a white lab coat, is looking at a computer monitor. The monitor displays a software interface with various data points and graphs. The background is a blurred laboratory setting with equipment and bright lights.

## Closing Summary

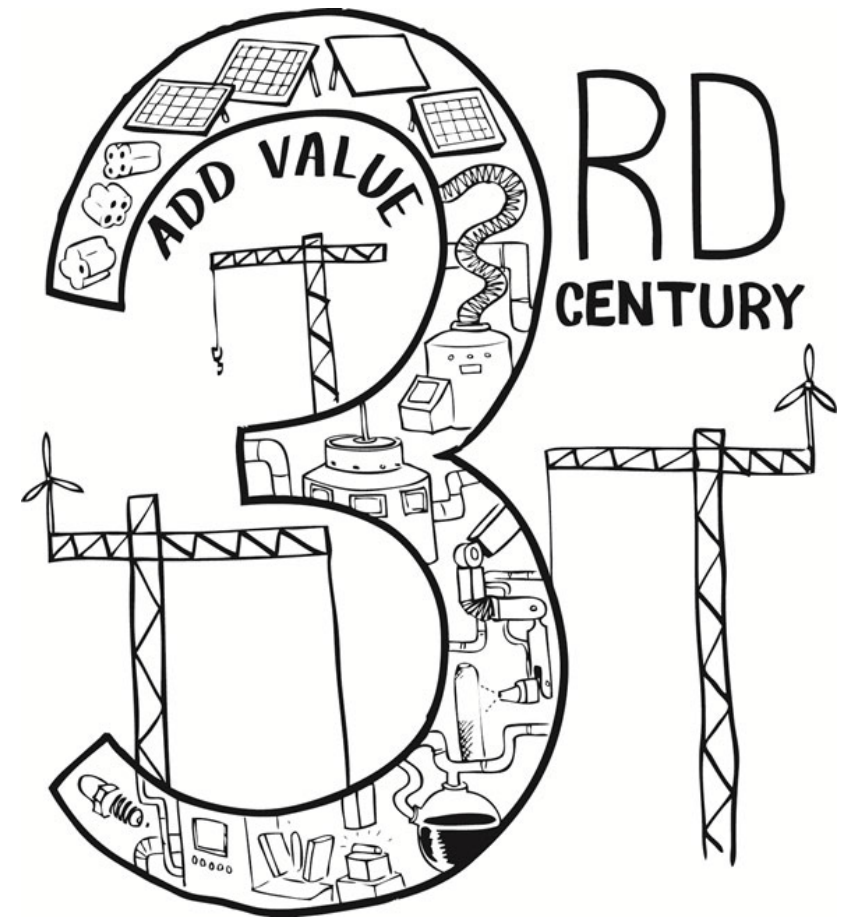
Robert MacLeod  
Chief Executive



Johnson Matthey

## JM Today – A Global Leader in Sustainable Technologies

Our **Vision** is to  
build our 3rd Century  
through value adding  
**sustainable technologies**

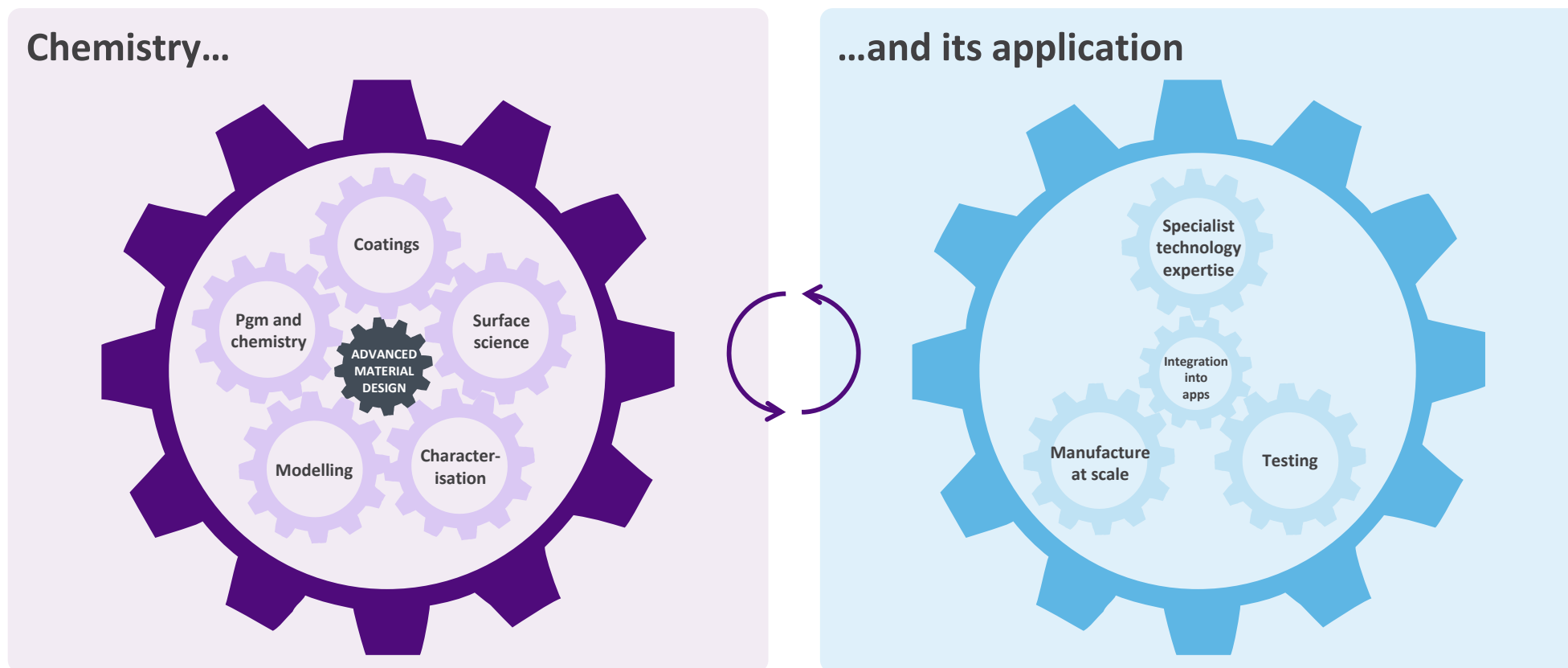


# Our Strategy for Superior Growth



# Differentiation Through Technology

JM's skill lies in understanding both the chemistry and the applications

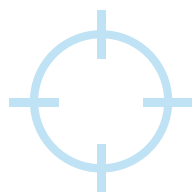


Chemistry has to be cutting edge

But we are more interested in, and good at, understanding how it can be used

That enables us to build multi million pound product businesses

## Key Takeaways



**Robust strategy in place**  
Strong market drivers



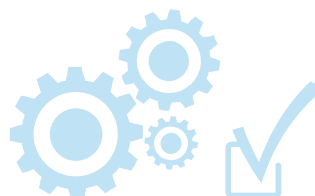
**Focus on sustainable technologies**  
Using our expertise in advanced materials and technology



**Build and develop new product offerings**  
R&D at 5% of sales p.a. to maintain competitive advantage



**Invest in new businesses to accelerate growth**  
Ongoing £5-7m p.a.  
>£100m p.a. OP by 2025



**Operational Excellence**  
Drive operational efficiencies and invest in internal systems to maintain margins



**Double digit growth in uEPS at >20% ROIC**





Johnson Matthey

## JM Executive Board

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**Robert MacLeod**

Chief Executive

**Den Jones**

Group Finance Director

**Larry Pentz**

Executive Director

**John Walker**

Executive Director  
Emission Control Technologies

## Presentation Team

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**Robert MacLeod**  
Chief Executive

**John Fowler**  
Division Director  
Fine Chemicals

**Alan Myers**  
Division Director  
Precious Metal Products

**Nick Garner**  
Division Director  
New Businesses and  
Corporate  
Development

**Geoff Otterman**  
Division Director  
Process Technologies

**John Walker**  
Executive Director  
Emission Control  
Technologies

**Dr Liz Rowsell**  
R&D Director  
Johnson Matthey  
Technology Centre

## Other Senior Management

### Emission Control Technologies

Chris Morgan  
David Prest

### Process Technologies

Iain Martin  
Joe Stevenson

### Precious Metal Products

Mark Bedford

### Fine Chemicals

Steve Barr  
Paul Evans

### New Businesses

Jack Frost  
Martin Green

### JMTC

Peter Bishop  
Mike Watson

### Investor Relations

Katharine Burrow  
Sally Jones

# Glossary

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ACT	Atmosphere Control Technologies	FC	Fine Chemicals
ADHD	Attention deficit and hyperactivity disorder	FCC	Fluid catalytic cracking
ANDA	Abbreviated New Drug Application	FCEV	Fuel cell electric vehicle
API	Active pharmaceutical ingredient	GHG	Greenhouse gas
API gravity	Measure of how heavy / light a petroleum liquid is compared to water	GTL	Gas to liquids
Au	Gold	HDD	Heavy duty diesel
bbl	Oil barrel, a unit of volume	HEV	Hybrid electric vehicle
BEV	Battery electric vehicle	HR-TEM	High resolution transmission electron microscopy
CAGR	Compound annual growth rate	IC	Internal combustion
CARB	California Air Resources Board	IP	Intellectual property
CCT	Catalysis and Chiral Technologies	JM	Johnson Matthey
CNG	Compressed natural gas	JMTC	Johnson Matthey Technology Centre
CO <sub>2</sub>	Carbon dioxide	ktpa	Kilo tonnes per annum
CTC	Coal to chemicals	LCO	Lithium cobalt oxide
Cu	Copper	LFP	Lithium iron phosphate
EBITDA	Earnings before interest, tax, depreciation and amortisation	Li-air	Lithium-air, a type of battery cell chemistry
ECT	Emission Control Technologies	Li-ion	Lithium-ion, a type of battery cell chemistry
EDX	Energy dispersive x-ray, a characterisation technique	Li-S	Lithium-sulfur, a type of battery cell chemistry
EU	European Union	LMO	Lithium manganese oxide
		LPG	Liquefied petroleum gas

# Glossary

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MEA	Membrane electrode assembly	R&D	Research and development
MEG	Mono ethylene glycol	ROIC	Return on invested capital
mmBtu	Million British Thermal Units	ROW	Rest of the world
mtpa	Million tonnes per annum	SEM	Scanning electron microscopy
NAFTA	North American Free Trade Agreement	SNG	Substitute natural gas
NB	New Businesses	SS-NMR	Solid state nuclear magnetic resonance spectroscopy
NCA	Lithium nickel cobalt aluminium oxide	Syngas	A mixture of hydrogen and carbon oxides
NMC	Lithium nickel manganese cobalt oxide	uEPS	Underlying earnings per share
Nm <sup>3</sup>	Normal cubic metre (volume of gas under standard conditions of 0°C and 1atm pressure)	VCM	Vinyl chloride monomer
NOx	Nitrogen oxides	WHO	World Health Organization
OEM	Original equipment manufacturer	XPS	X-ray photoelectron spectroscopy
OP	Operating profit	XRD	X-ray diffraction, a characterisation technique
p.a.	Per annum	Zeolite	Microporous crystalline solid with well defined pore architecture
Pgm	Platinum group metal		
PHEV	Plug in hybrid electric vehicle		
PM	Particulate matter		
PMP	Precious Metal Products		
Pms	Precious metals		
PT	Process Technologies		



# Glossary – Fine Chemicals

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**180 Day Exclusivity**

The period during which the first applicant to successfully file for a ANDA under Paragraph IV of the Wax-Hatchman Act is granted marketing exclusivity of a generic product.

**ADHD – Attention Deficit Hyperactivity Disorder**

A group of behavioural symptoms that include inattentiveness, hyperactivity and impulsiveness.

**ANDA – Abbreviated New Drug Application**

Is an application for a US generic drug approval for an existing licensed medication or approved drug. The generic drug product needs to be comparable to an innovator drug product in dosage form, strength, route of administration, quality, performance characteristics and intended use.

**Antiarrhythmic drugs**

Antiarrhythmic drugs are used to treat arrhythmia: a group of conditions used to describe abnormal heart rhythms.

**API – Active Pharmaceutical Ingredient**

A substance intended to have a pharmacological activity typically for the treatment, prevention or cure of a disease. Also known as Drug Substance.

**Bioequivalence**

Technical procedures and processes by which preparations of generics pharmaceuticals are tested and evaluated to ensure their performance will be equivalent to the original innovator product.

**Biopharmaceutical or Biologics**

Are medicinal products manufactured in or extracted from biological sources, for example vaccines, allergens, gene therapies, recombinant therapeutic proteins. See also Small Molecule.

# Glossary – Fine Chemicals

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**Chirality / Chiral Technologies**

The property of an organic chemical where it is different from its mirror image and cannot be superimposed upon it. This property is found throughout nature and is a critical aspect of pharmaceutical development. Derived from the Greek expression for 'handedness'.

**Clinical Trials / Development**

The formal process by which Investigation New Drugs are developed and tested, under the direction of regulatory authorities including the FDA and other regional organisations.

**Continuous Flow / Continuous Processing**

A manufacturing procedure by which reagents are continuously fed in to a flow reactor, forming products which are then discharged also on a continuous basis. Often resulting in higher yields, more profitable processes with lower costs for operation, equipment, and investment.

**Controlled Substances / Drugs**

A controlled substance is generally a drug or chemical whose manufacture, possession, or use is regulated by a government, typically because they have the potential for abuse or dependence.

**Crystalline Form**

Physical characteristics of crystalline Active Pharmaceutical Ingredients, which will determine aspects of its performance such as stability, compatibility, dissolutions rate etc.

**Dossier (Pharmaceutical)**

Formal documentation and submissions made to regulatory agencies required to be approved for marketing authorisation of pharmaceutical products.

# Glossary – Fine Chemicals

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**Drug Product**

A finished dosage form, for example, tablet, capsule, solution, etc., that contains one or more APIs. Also known as Formulated Product.

**Drug Substance**

A substance intended to have a pharmacological activity typically for the treatment, prevention or cure of a disease. Also known as API.

**EMA – European Medicines Agency**

European Union agency responsible for the protection of public and animal health through the scientific evaluation and supervision of medicines.

**Enzymes**

Enzymes are biological molecules (proteins) that act as catalysts and can be used to enable chemical reactions with high rates and levels of selectivity catalysts.

**FDA Approval**

Following the FDA's Drug Review Process which includes safety, efficacy, potential side effects and so forth, the Agency can approve drug products for sales and marketing.

**FDA - Food and Drug Administration**

The Food and Drug Administration (FDA or USFDA) is a federal agency of the United States Department of Health and Human Services.

**First to File**

Relates to the Wax-Hatchman Act (1984) regarding the process by which generics drug manufacturers submit ANDA filing for FDA approval. More specifically under Paragraph IV, the first company to successfully file an ANDA is granted a 180 days marketing exclusivity for the generic product.

# Glossary – Fine Chemicals

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**Formulated Product**

A finished dosage form, for example, tablet, capsule, solution, etc., that contains one or more APIs. Also known as Drug Product.

**Generic Drug**

A drug produced and marketed after a proprietary drug goes off patent. Note they must still meet the standards of GMP set out by pharmaceutical regulatory bodies.

**GMP – Good Manufacturing Practice**

Regulations and controlled set out by the FDA, EMEA and other regulatory bodies that set out the guidelines for pharmaceutical manufacture.

**High Containment**

A specific manufacturing requirement for specific types of API that have high potency (are active in extremely small quantities).

**IMS Health**

IMS Health is a leading provider of information and services to the healthcare industry.

**Innovator**

Pharmaceutical companies predominantly engaged in the research, development, clinical studies and commercialisation of novel materials to be used as therapeutic agents. See also Generic Drug.

**Palliative Care**

When there is no cure for an illness, palliative care tries to make the end of a person's life as comfortable as possible. This is done by attempting to relieve pain and other distressing symptoms.

# Glossary – Fine Chemicals

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**NDA – New Drug Application**

Is the vehicle in the United States through which drug sponsors formally propose that the Food and Drug Administration (FDA) approve a new pharmaceutical for sale and marketing.

**PGM-Based APIs**

Active Pharmaceutical ingredients which contain a platinum group metal as part of the chemical structure, commonly platinum.

**Registered Intermediates**

Registered Intermediates are isolated intermediates that are produced under GMP regulation from registered starting materials in the process to make APIs.

**Solid Form Screening**

Processes by which Crystalline Form and other physiochemical properties are studied and investigated to optimise the performance of Active Pharmaceutical Ingredients.

**Small Molecule**

Conventional therapeutic agents manufactured using conventional chemical synthesis, see also Biologics.

**Starting Materials**

Defined by the FDA and other regulatory agencies as the chemical starting point from which GMP regulations are introduced into the synthesis of APIs.



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