Catalyst Technologies Seminar
Driving growth in a net zero world

8th March 2022
Cautionary statement

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Introduction

01. Well positioned to target high growth, high return opportunities across decarbonisation, hydrogen technologies and circularity positioning JM at the forefront of the net zero transition.

02. Deep expertise in complex pgm chemistry underpins our leading market positions and competitive advantages across our world-class portfolio of technologies.

03. Clean Air has attractive positions in a durable market underpinned by continued legislation and is on track to deliver at least £4bn of cash over the next decade¹.

04. Focus on execution, efficiency, capital allocation and commercialising growth opportunities.

05. Strategic update from Liam Condon in May 2022.

¹. Driving at least £4bn of cash under our range of scenarios from 1st April 2021 to 31st March 2031. Cash target pre-tax and post-restructuring costs.
Today’s presenters

Jane Toogood
Sector Chief Executive, Efficient Natural Resources

Over 30 years’ experience in the chemicals industry, covering multiple industry sectors

Previous leadership positions at Borealis and current non-executive director at Victrex plc

Joined JM in 2016 as Divisional Director (Precious Metal Products) and became Sector Chief Executive, Efficient Natural Resources, in 2017

Alberto Giovananza
Managing Director, Catalyst Technologies

Over 25 years’ experience in the chemicals industry, covering multiple industry sectors, from plastics to nutrition and health

Previous leadership positions at BASF and Ciba in business management, technology and operations

Joined JM in 2021 as Managing Director, Catalyst Technologies
Introduction

Jane Toogood
CT is well positioned in a net zero world

Market leader with favourable exposure in core segments

Large new market opportunities driven by long-term megatrends

Recurring revenue model with many trusted 20+ year customer relationships

Proven technology deployed in pioneering projects supports growth

High single digit growth over the medium term
Catalyst Technologies overview
Alberto Giovananza
Catalyst Technologies is a global leader

**2020/21 sales**

- **JM** £3.9bn
- **CT** c.£450m

**End applications**

- **Sustainable fuels**
  - Transportation fuels, industrial heat

- **Industrial and consumer chemicals**
  - Industrial chemicals, fertilisers, food ingredients, wood products, paints and coatings, oleochemicals

- **Traditional fuels**
  - Transportation fuels
  - Natural gas (higher growth transition fuel)

Note: 2020/21 sales excluding precious metals. CT - Catalyst Technologies.
JM’s leading process technologies and catalysts enable customers to operate efficiently, profitably and sustainably.

### Process technologies
Licensing and engineering services to enable more efficient chemical processes
- Design and flowsheets of world-class plants and retrofits
- Optimised footprints enable minimum capex

### The combination maximises value to customers and supports long-term relationships

### High performance catalysts
Catalysts that enable chemical processes
- Increase plant efficiency and production, using less feedstock
- Small cost for customers, significantly lowering their OPEX
JM’s technologies and catalysts are critical to making day-to-day products and fuels.

Today
Traditional feedstocks
• Coal
• Natural gas
• Oil

Future
Sustainable feedstocks
• Renewable energy
• Biomass and waste
• Captured CO₂

Syngas building blocks are c.40% of major primary chemicals¹

1. Source IHS Markit. Capacity of methanol and ammonia as a proportion of total capacity for primary chemicals (methanol, ammonia, major olefins and aromatics).
Note: H₂ – hydrogen; CO – carbon monoxide; CO₂ – carbon dioxide
A leading provider of catalysts and technology

<table>
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<tr>
<th>Global segment position</th>
<th>Industrial and consumer</th>
<th>Traditional fuels</th>
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<td>End applications</td>
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<tr>
<td></td>
<td>Methanol</td>
<td>Hydrogen</td>
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<tr>
<td></td>
<td>Ammonia</td>
<td>Refining additives</td>
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<tr>
<td></td>
<td>Formaldehyde</td>
<td>Natural gas purification</td>
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<td></td>
<td>Top 3</td>
<td>Top 2</td>
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<tr>
<td></td>
<td>Paints, coatings, polymers</td>
<td>Fertilisers</td>
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<tr>
<td></td>
<td>Fertilisers</td>
<td>Wood products</td>
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<td>Transportation fuels</td>
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<td>Natural gas</td>
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<tr>
<td>Example customers and partners</td>
<td>&gt;40 yrs</td>
<td>&gt;60 yrs</td>
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<tr>
<td>Competitors</td>
<td>Haldor Topsoe</td>
<td>Clariant</td>
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<td></td>
<td>Albemarle</td>
<td>Grace</td>
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<td>Air Liquide</td>
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<td>thyssenkrupp</td>
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Success built on deep science and engineering insights and track record of value creation for customers

Science and technology expertise developed over decades
- Catalysis and metal chemistry are at the heart of JM
- >1,500 granted patents
- Close partnerships ensure R&D focuses on customers' needs

Award winning digital solutions services
- Unrivalled modelling capabilities and proprietary machine learning enable customers to optimise plant operations and increase productivity

Long-standing partnerships creating holistic solutions
- Complementary partnerships to:
  - Accelerate project delivery
  - Enhance commercial offering
  - Develop new technology

Example partners

Satisfied JM customers¹
JM scores 12% above the benchmark
- Reputation: 8.7 (/10)
- Technical competence: 95% positive mentions

¹. Source: Commissioned customer survey, 2021; 271 customer responses out of 331 contacted.
Superior performance drives recurring revenue model

Illustrative plant revenue stream¹

Licensing model offers opportunities for additional catalyst sales during the plant lifetime

Refill-centric model with many key customer relationships lasting 20+ years

c.80% to 85% of CT sales are recurring⁴

1. This illustrative licensing example covers methanol, ammonia, oxo alcohols and BDO (butanediol) technologies.
2. For example, average of 4 years for methanol, 5 years for ammonia and 2-3 years for oxo alcohol and BDO (butanediol).
3. Average revenue over the last 4 years based on an assumed 4 year refill cycle.
4. Includes all catalyst and additive sales.
Growth opportunities
Jane Toogood
Growth opportunities fuelled by key megatrends

- Decarbonisation
- Energy transition
- Circularity
- Legislation and government incentives
Our existing technologies unlock these new opportunities

Traditional feedstocks
- Coal
- Natural gas
- Oil

Sustainable feedstocks
- Renewable energy
- Biomass and waste
- Captured CO₂

Syngas
- H₂
- CO
- CO₂

Catalysts and process technology

J M

Sustainable chemicals

Sustainable fertilisers

Decarbonised chemicals

Transportation fuel

Heat and power

Sustainable Aviation Fuel

Energy transition applications

JM supplies catalyst and/or process technology

Note: H₂ – hydrogen; CO – carbon monoxide; CO₂ – carbon dioxide.
LCS – Low carbon solutions; FT CANS™ – Fischer-Tropsch CANS.
FT CANS™ in collaboration with bp. BioForming® in collaboration with Virent.
New markets progressively scale

New addressable markets\(^1\)

\[ £2-10bn \]

Positioned to win with existing offerings

**JM’s offering**

**Blue Hydrogen**
- Award-winning low carbon hydrogen process is the most efficient blue hydrogen technology

**Sustainable fuels**
- Patented technologies for sustainable fuel production

**Low carbon solutions**
- Enhanced carbon capture solution

<table>
<thead>
<tr>
<th>Process technology</th>
<th>Catalyst</th>
<th>Addressable market to 2030¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>£1bn to £8bn²</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>£1bn to £2bn²</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>c.150 plants in Europe and North America²</td>
</tr>
</tbody>
</table>

1. Cumulative addressable revenue to 2030.
Blue hydrogen: critical in the transition to net zero

Blue hydrogen

A long-term, scalable and cost effective replacement for fossil fuels, to enable decarbonisation of industry, transport and heat

Blue hydrogen is a low carbon hydrogen produced from natural gas, with the by-product CO₂ captured and safely stored e.g. in depleted oil wells

Blue hydrogen supports hydrogen’s deployment at scale, by building on existing infrastructure to deliver step change progress in the transition to net zero

JM’s offering

JM’s LCH™ technology – licensing of leading process technology for low carbon hydrogen

Optimised catalyst, proprietary equipment and digital solutions

Configured to deliver excellent economics and carbon footprint reduction
Blue hydrogen: strong competitive advantage

**Competitive advantage**

Blue hydrogen:

**Strong competitive advantage**

**Ambition to be #1 technology supplier for blue hydrogen projects**

- Proven technology at scale
- Builds on many years' experience and market leading technology for grey hydrogen and methanol
- Most efficient process with leading performance¹:
  - Reduces CO₂ emissions >95%
  - while using 9% less feedstock and reducing capex by 40%

**Hard to replicate know-how and experience**

- Existing customers
  - First mover advantage (HyNet) and pipeline of >35 projects
- Competitors include, for example:
  - Haldor Topsoe and Air Liquide
- Award winning process

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¹ Compared to conventional steam methane reforming technology with carbon capture and storage. Johnson Matthey Technol. Rev., 2020, 64 (3), 357 37. 9% efficiency saving based on a project equivalent to the size of HyNet Phase 1 (80kt p.a.) would give a saving of c.£6m to £7m p.a.
Blue hydrogen: first revenues through 2025 and accelerating beyond

**Global blue hydrogen production**¹
(million tonnes per annum)

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Supports hydrogen’s deployment **at scale** by building on existing infrastructure to deliver step change progress in the transition to net zero.

Adoption driven by **geology** (carbon storage locations), **infrastructure** (pipelines) and **high cost of alternative routes** to low carbon hydrogen.

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1. Demand based on IEA’s Sustainable Development Scenario (with grey/blue/green hydrogen split based on IEA’s Net Zero Emissions scenario)
2. JM estimates. Assumes standard plant of 0.08 Mtpa (300MW / 100kNM3/h)
HyNet: selected for world’s first large scale blue hydrogen project

**Project details**

<table>
<thead>
<tr>
<th>Phase 1:</th>
<th>2026</th>
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</thead>
<tbody>
<tr>
<td>Technology:</td>
<td>LCH™</td>
</tr>
<tr>
<td>Product:</td>
<td>Blue hydrogen</td>
</tr>
<tr>
<td>Uses:</td>
<td>Local industry and natural gas blending</td>
</tr>
</tbody>
</table>

**Purpose**

Help the UK meet its net zero targets by 2050 by:

Producing low carbon hydrogen for industrial, transport, home and business use

Construct carbon capture and storage infrastructure to enable capture of emissions from local industrial sites

**CT role and technology**

JM’s LCH™ technology will be used in the plant for the production of low carbon hydrogen

The technology will enable over 95% of the CO₂ used in the process to be captured and stored

3 Terawatt hours (TWh) of low carbon hydrogen per year beginning in 2026, increasing by 2030 to over 30 TWh

600,000 tonnes of CO₂ captured per year beginning in 2026, increasing by 2030 to 10 million tonnes
Sustainable Aviation Fuels: at the forefront of decarbonising aviation

A ‘drop-in’ fuel that can be used in existing aircraft and fuelling infrastructure to decarbonise aviation

The four main pathways for SAF production:

1. Fischer-Tropsch (FT)
   process converts carbon and hydrogen into fuels via 1) syngas from waste/biomass gasification or 2) green hydrogen with captured CO₂
   FT offers the highest CO₂ emission reduction potential¹

2. Hydrogenated vegetable oils and derivatives (HVO and HEFA)
   Bio-based fuel
   Capacity limited by oil availability

3. Alcohol to jet
   Conversion of alcohols to jet fuel
   Limited by geography, cost and less competitive on GHG reduction

4. Bioforming
   Use of biomass derived sugars as a feedstock
   Produces essential component for 100% drop-in SAF fuels

¹ World Economic Forum – Clean Skies for Tomorrow Sustainable Aviation Fuels as a Pathway to Net-Zero Aviation, November 2020.

Note: GHG – greenhouse gas.
Sustainable Aviation Fuels: a broad range of unique patented solutions

JM’s offering
Suite of patented and proprietary technologies and catalysts targeting large sustainable pathways

01 FT CANS™
Scalable technology jointly developed with bp for efficient conversion of syngas from waste and biomass into a sustainable synthetic crude

02 Virent Bioforming®
Converts biomass sugars into renewable fuels

03 HyCOgen™
Enables the conversion of green hydrogen and captured CO₂ into syngas for FT processing

Note: FT CANS™ in collaboration with bp. BioForming® in collaboration with Virent.
Sustainable Aviation Fuels: strong competitive advantage

### Market leader in syngas
- Essential for sustainable fuels production

### Technologies ready today
- Pipeline of >25 projects
- Virent Bioforming® enabled first passenger flight using 100% SAF

### Competitors include, for example:
- Sasol/Haldor Topsoe collaboration

### Our suite of technologies allows
- Access to a **broader range of feedstocks** (e.g. waste, biomass, green hydrogen and CO₂)
- Enables use of **100% SAF** and full decarbonisation of fuels

### Operational efficiency
- 50% reduction in Fischer-Tropsch unit capex compared to conventional technology¹

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**Ambition to be #1 technology supplier**

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¹ Compared to conventional fixed-bed FT.
Sustainable Aviation Fuels: enabling the decarbonisation of aviation

Global sustainable aviation fuels demand\(^1\)
(million barrels per annum)

Enables *decarbonisation of flight with* no adaptation of aircraft or fuel infrastructure

IATA SAF ambitions (% sustainable)\(^2\):
- **5%** by 2030
- **39%** by 2040
- **65%** by 2050

Commitments are gathering pace
“IAI to power 10% of its flights with SAF by 2030”

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1. Source: International Air Transport Association (IATA), McKinsey and JM estimates.
2. Source: International Air Transport Association (IATA).
Sustainable Aviation Fuels: Fulcrum Sierra BioFuels Plant

Project details

Operational: 2022

Technology: bp/JM FT CANS™

Product: High quality low carbon synthetic crude oil for refinery processing into fuels

Uses: Transportation fuel (incl. biojet fuel)

Purpose

Demonstrate commercial-scale biojet fuel production to convert waste that would otherwise be landfilled into low carbon, renewable transportation fuel

175,000 tonnes of municipal solid waste feedstock processed annually

11 million gallons annual production of renewable synthetic crude oil, to be processed by Marathon Petroleum into transportation fuel

Equivalent to more than 250 transatlantic return flights

CT role and technology

In collaboration with bp, JM is licensing our CANS™ modular reactor system using Fischer-Tropsch (FT) technology. Compared to conventional fixed-bed FT technology, CANS™ results in a 3-fold increase in production per reactor, enabling c.50% capital investment cost reduction.

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Demonstrate commercial-scale biojet fuel production to convert waste that would otherwise be landfilled into low carbon, renewable transportation fuel

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# Sustainable fuels: Siemens Energy Haru Oni e-fuels project

## Project details

<table>
<thead>
<tr>
<th><strong>Pilot Phase:</strong></th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology:</strong></td>
<td>JM licensed methanol technology</td>
</tr>
<tr>
<td><strong>Product:</strong></td>
<td>Sustainable fuels (methanol and gasoline)</td>
</tr>
<tr>
<td><strong>Uses:</strong></td>
<td>Transportation fuel</td>
</tr>
</tbody>
</table>

## Purpose

Demonstrate technology for world's first large-scale commercial plant producing climate neutral methanol and gasoline from green hydrogen and CO₂ recovered by direct air capture.

## CT role and technology

The project is being developed by Siemens Energy in partnership with JM and other major corporations including Porsche and MAN. JM will license methanol technology and supply the engineering, catalyst and equipment for the project.

900,000 litres of sustainable methanol produced per year as early as 2022, growing by 2024 to 55 million litres of sustainable fuels and by 2026 to... c.550 million litres
Low carbon solutions: carbon capture key to decarbonising chemicals

>1,500 syngas plants producing ammonia, hydrogen, and methanol – emitting c.800m tonnes of CO₂ p.a.¹

Over 85% of emissions captured through 2030 will come from plant retrofits²

CO₂ capture and storage (CCS) is key to decarbonising chemical production

Initial opportunity of c.150 hydrogen plants with potential for retrofit in Europe and North America³

An enhanced carbon capture retrofit solution

Combines JM’s advanced reforming expertise with existing unit operations initially in hydrogen plants

Chemical sector share of industrial CO₂ emissions⁴

Reduction in direct emissions from primary chemicals by 2030⁵

Reduction in direct emissions from primary chemicals by 2050⁵

2. Source: IEA, CCUS in Clean Energy Transitions, 2020
Low carbon solutions: leading the decarbonisation of syngas plants

JM is a recognised leader in the design of the world’s largest reformers for syngas generation and its conversion to products such as methanol.

### Competitive Advantage

- Efficient carbon capture process compared to competing technologies:
  - >90% reduction in CO₂
  - 20-30% lower capex
  - 40% space reduction
- 60 years’ leadership in design, operation and optimisation of syngas plants
- Innovative and ready-now solution at scale: turns grey hydrogen into blue hydrogen, giving existing customers running start at net zero
- Long-standing relationships as a leading supplier of catalysts and services to grey hydrogen plants
- Competitors include, for example: Air Liquide, BASF, Fluor, and Mitsubishi Heavy Industries

### Ambition

- To be a leading provider in decarbonisation solutions for syngas
- To retrofit 20-30 syngas plants by 2030/31, reducing CO₂ emissions by c.20m tonnes p.a
- Broadening application of technology to decarbonise wider chemicals industry

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1. In comparison to competing technology based on publicly available information.
Progressing our pipeline of opportunities

Positive market drivers

Addressing climate change with our world class technologies

Delivering strong leadership positions and growth

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Pipeline today</th>
<th>Short to medium-term</th>
<th>Long-term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue hydrogen</td>
<td>&gt; 35 projects</td>
<td>Early revenues Scaling technology</td>
<td>Breakout growth from technology scale up and pipeline delivery</td>
</tr>
<tr>
<td>Sustainable aviation fuel</td>
<td>&gt; 25 projects</td>
<td>Progressing pipeline</td>
<td></td>
</tr>
<tr>
<td>Low carbon solutions</td>
<td>&gt; 10 projects</td>
<td>Licensing income from grey hydrogen plant retrofit for existing customers</td>
<td>Licensing income from retrofits for wider syngas and chemicals customer base</td>
</tr>
</tbody>
</table>

01. Market leading technologies in new, growing and large addressable markets
02. High single digit growth over the medium term underpinned by low carbon solutions
03. Long-term growth through delivery of pipeline and market leadership positions across blue hydrogen, sustainable fuels and low carbon solutions
Four key takeaways

01 Market leader with favourable exposure in core segments

02 Recurring revenue model with trusted customer relationships

03 Large new market opportunities driven by long-term megatrends

04 Proven technology deployed in pioneering projects supports growth

High single digit growth over the medium term
Q&A

JM
Blue hydrogen builds on our expertise in grey hydrogen and methanol

Johnson Matthey’s blue hydrogen technology

Methane (CH₄) from natural gas is reacted with steam to produce hydrogen (H₂) and carbon dioxide (CO₂).

Highly efficient process – 9% less natural gas usage¹

Low capex – 40% lower capital cost¹

>95% of produced CO₂ captured: single stream at high pressure and purity enabling easier transport or storage

1. Compared to conventional steam methane reforming technology with carbon capture and storage. Johnson Matthey Technol. Rev., 2020, 64, (3), 357–37. 9% efficiency saving based on a project equivalent to the size of HyNet Phase 1 (80kt p.a.) would give a saving of c.£6m to £7m p.a.

Note: Feed gas is methane from natural gas; syngas is predominantly carbon monoxide (CO), carbon dioxide (CO₂) and hydrogen (H₂).
FT CANS™ technology enables sustainable fuels production from syngas

Innovative catalyst and engineering solution

1. Compared to conventional fixed-bed FT.