Johnson Matthey
Inspiring science, enhancing life

Catalyst Technologies Seminar

Driving growth in a net zero world

8th March 2022

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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 decade[1]**

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 Giovanzana

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

JM

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

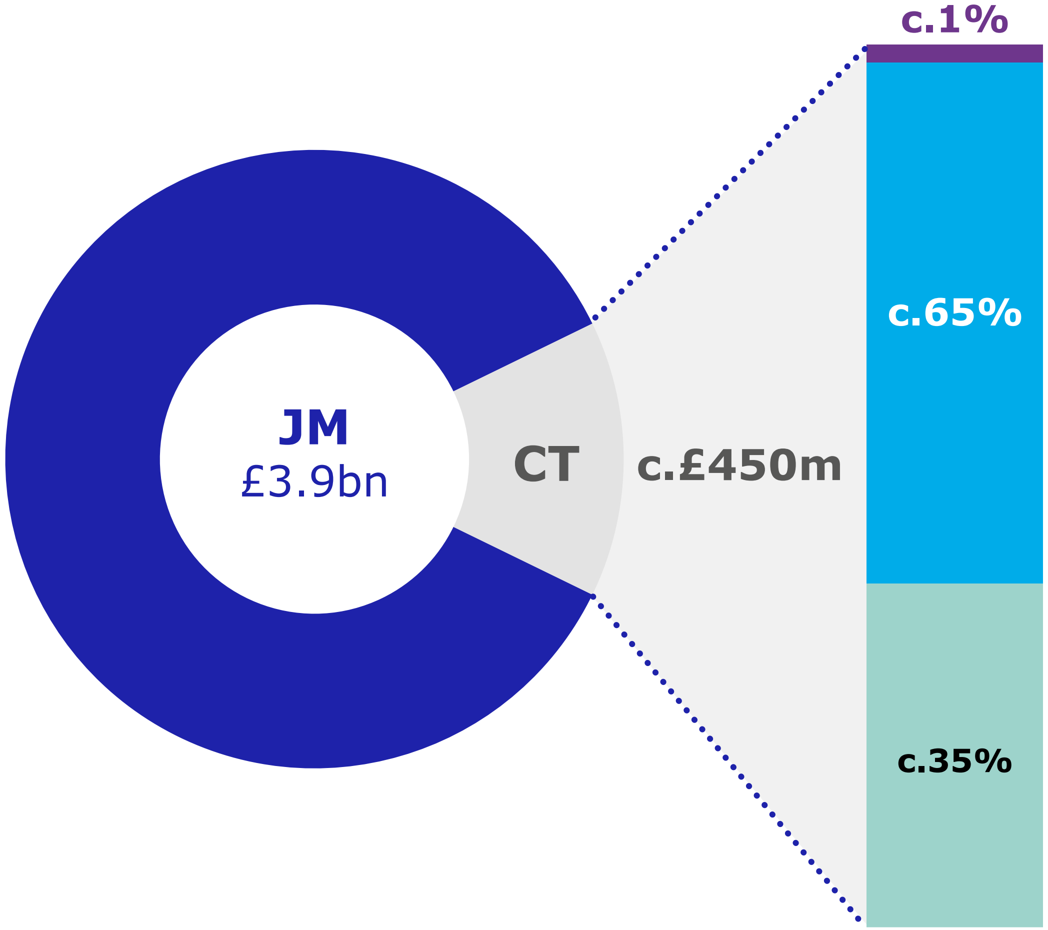
High single digit growth over the medium term

Catalyst Technologies overview

Alberto Giovanzana

Catalyst Technologies is a global leader

2020/21 sales



CT today

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

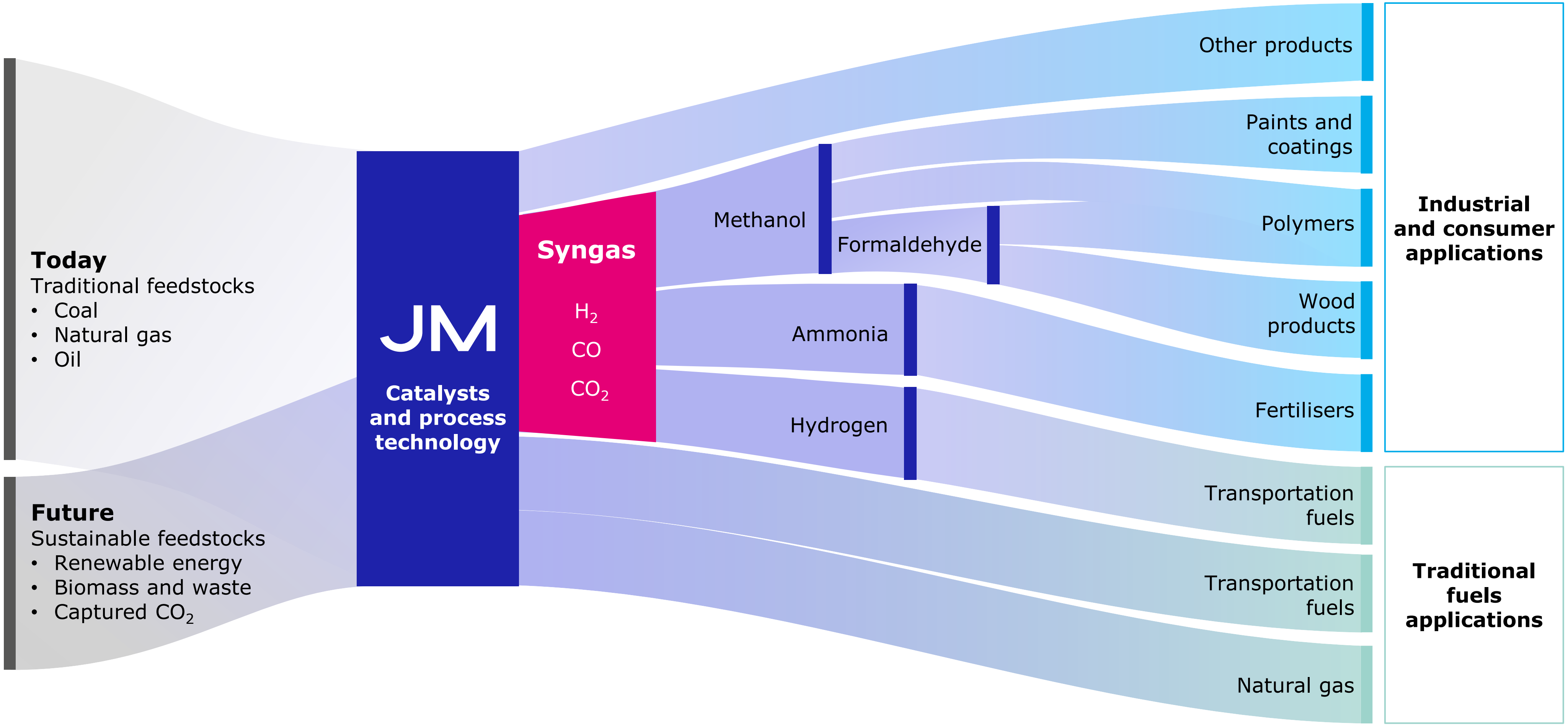
The combination maximises value to customers and supports long-term relationships

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



Syngas building blocks are **c.40%** of major primary chemicals[1]

JM supplies catalyst and/or process technology

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: H_2 – hydrogen; CO – carbon monoxide; CO_2 – carbon dioxide

A leading provider of catalysts and technology

	Industrial and consumer			Traditional fuels		
	 **Methanol**	 **Ammonia**	 **Formaldehyde**	 **Hydrogen**	 **Refining additives**	 **Natural gas purification**
Global segment position	#1	Top 3	#1	#1	Top 2	#1
End applications	Paints, coatings, polymers	Fertilisers	Wood products	Transportation fuels		Natural gas
Example customers and partners	methanex the power of agility >40 yrs	CF >60 yrs	DOW >50 yrs	KBR c.2 yrs	thyssenkrupp >20 yrs	
Competitors	HALDOR TOPSØE	CLARIANT	ALBEMARLE	GRACE	Air Liquide	

JM

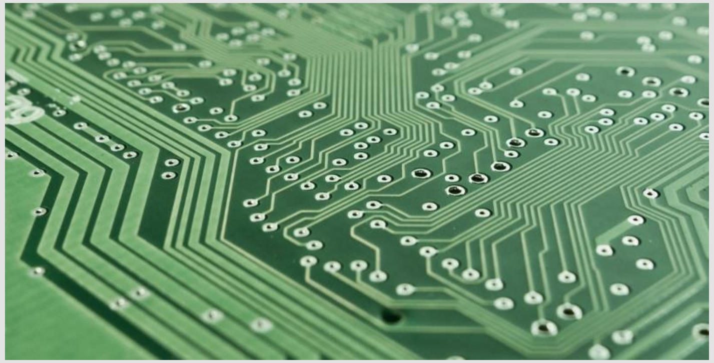
Success built on deep science and engineering insights and track record of value creation for customers

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

Dow, Virent, bp, Siemens Energy, thyssenkrupp, KBR, NextChem

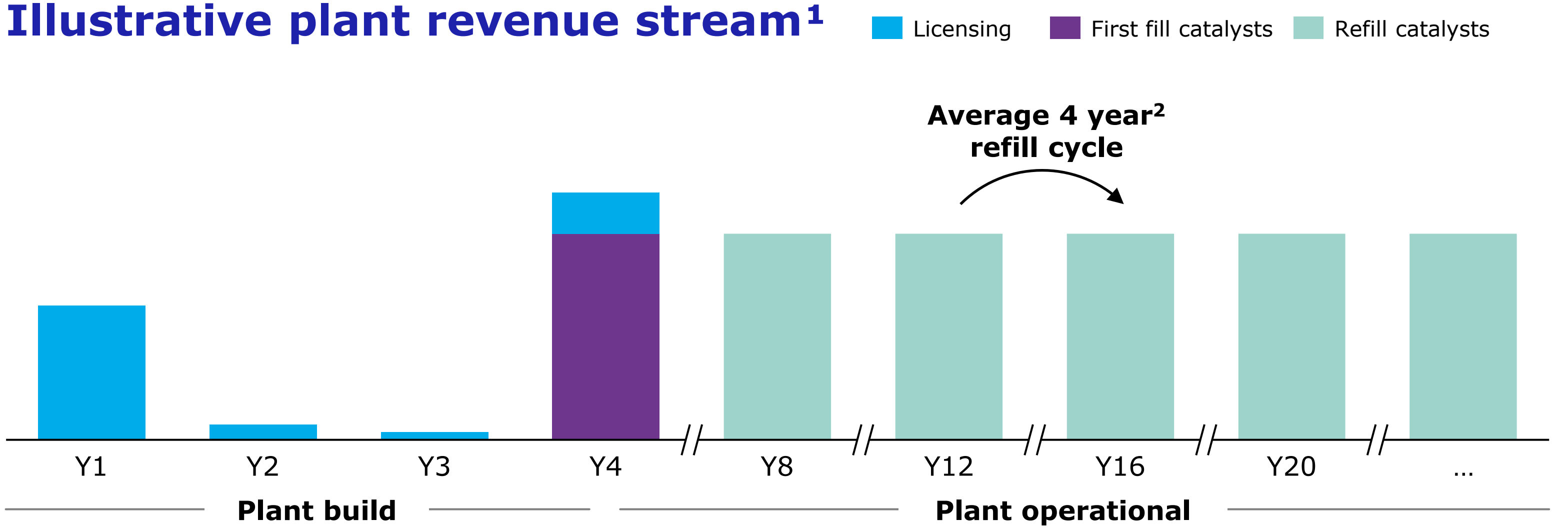
Satisfied JM customers[1]
JM scores 12% above the benchmark

- 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 stream[1]



Licensing	First fill catalysts	Refill catalysts
Upfront payment for process technology and engineering	**Catalyst fills for new build plants**	**Catalyst refills for existing plants** (value and frequency varies by segment)
£5m Average revenue per license[3]	**£5m** Average revenue per first fill[3]	**£5m** Average revenue per refill[3]

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.

JM

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 recurring[4]

Growth opportunities

Jane Toogood

JM

Growth opportunities fuelled by key megatrends

Decarbonisation

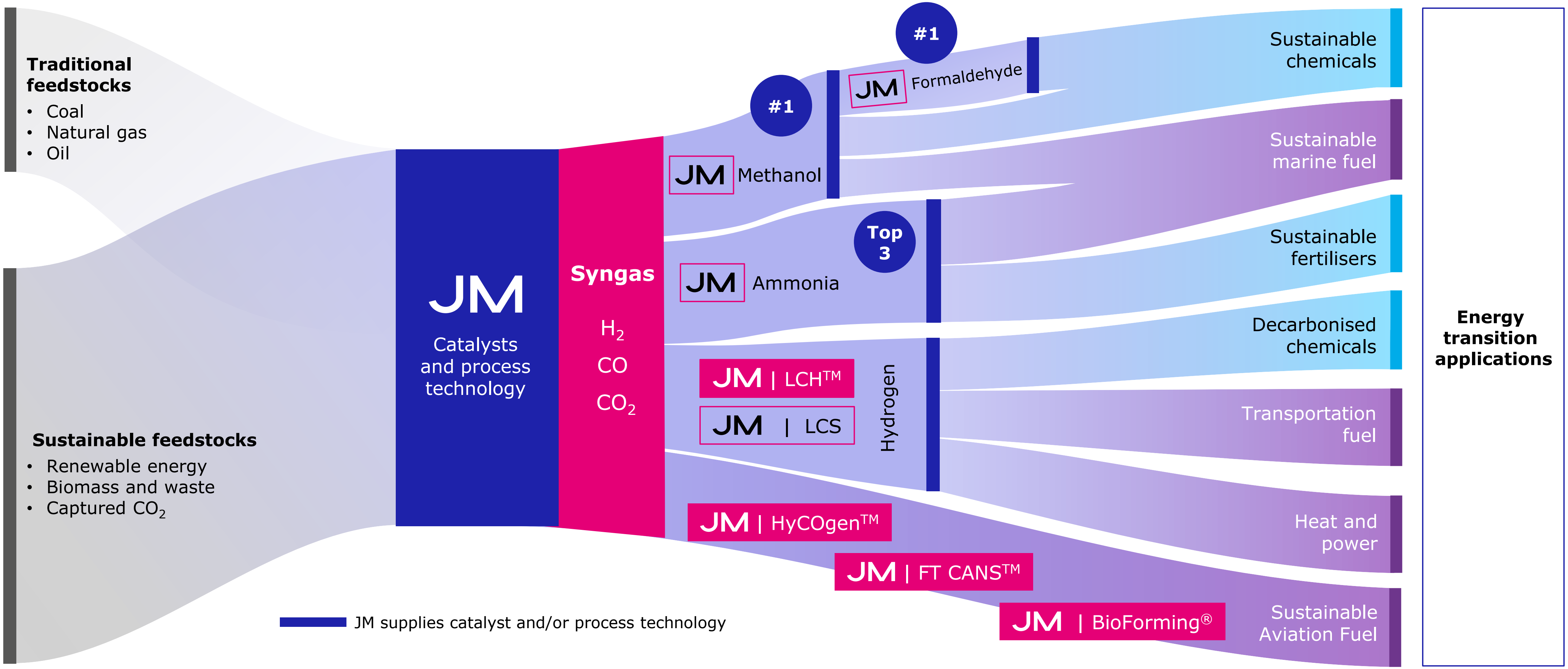
Energy transition

Circularity

Legislation and government incentives

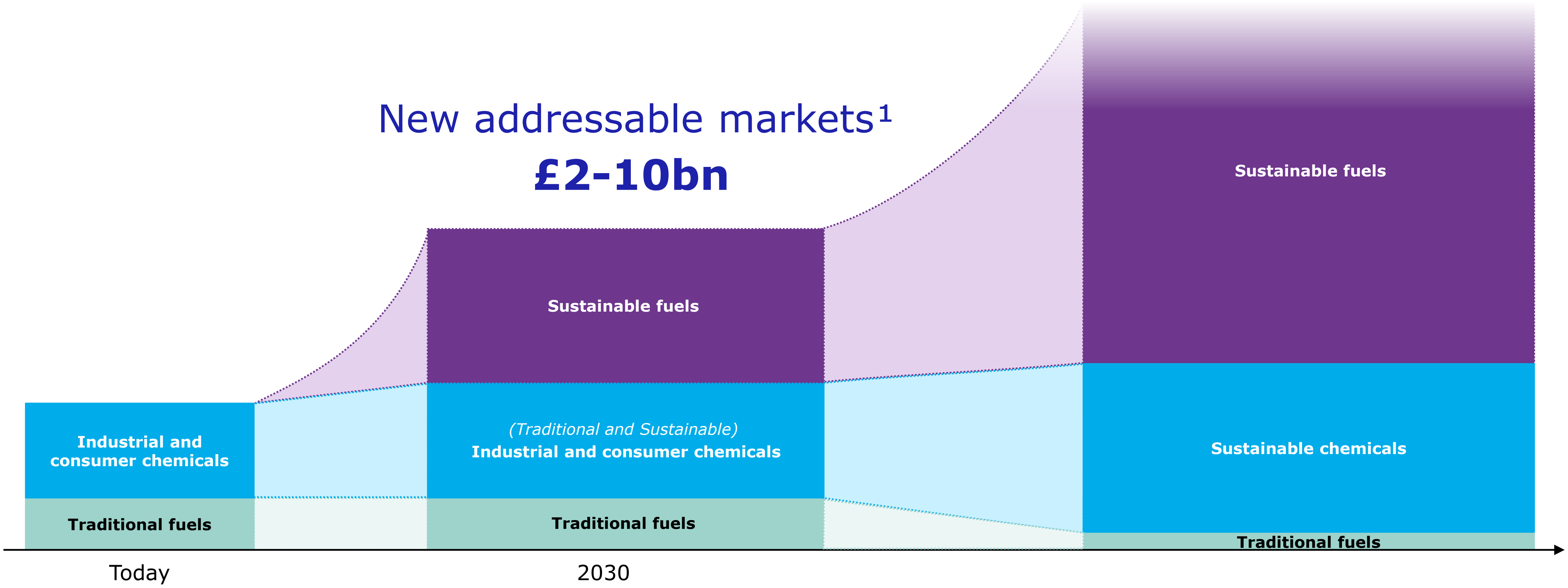
JM

Our existing technologies unlock these new opportunities



Note: H_2 – hydrogen; CO – carbon monoxide; CO_2 – 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



1. Source: JM estimates based on blue hydrogen demand (IEA Sustainable Development Scenario and Net Zero Energy Scenario), sustainable aviation fuel demand (IATA) and low carbon solutions (JM).
Note: Of the £2-10bn total new addressable markets, £1-8bn relates to blue hydrogen and £1-2bn relates to sustainable fuels.

Positioned to win with existing offerings

	JM's offering	Process technology	Catalyst	Addressable market to 2030[1]
 **Blue Hydrogen**	**Award-winning low carbon hydrogen** process is the most efficient blue hydrogen technology	✓	✓	£1bn to £8bn[2]
 **Sustainable fuels**	**Patented technologies** for sustainable fuel production	✓	✓	£1bn to £2bn[2]
 **Low carbon solutions**	**Enhanced carbon capture solution**	✓	✓	c.150 plants in Europe and North America[2]

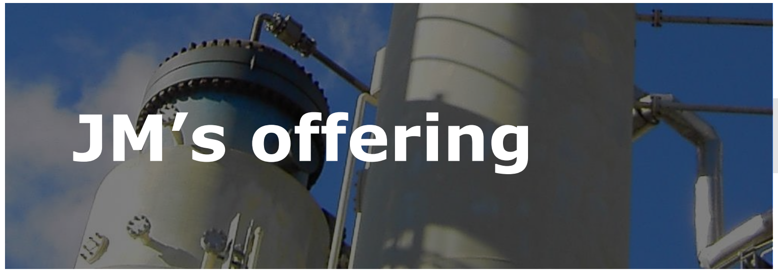
1. Cumulative addressable revenue to 2030.
2. Source: JM estimates based on blue hydrogen demand (IEA Sustainable Development Scenario and Net Zero Energy Scenario), sustainable aviation fuel demand (IATA) and low carbon solutions (JM).

Blue hydrogen: critical in the transition to net zero

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

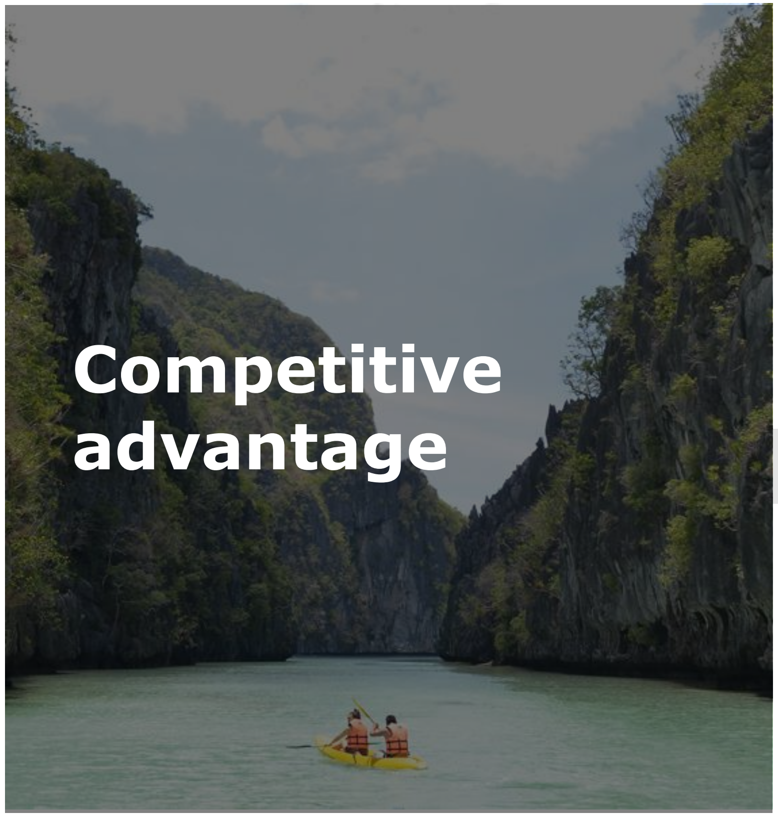
Blue hydrogen is a **low carbon hydrogen** produced from natural gas, with the by-product CO_2 captured and safely stored e.g. in depleted oil wells

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 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



Hard to replicate know-how and experience

Proven technology at **scale**

Builds on many years' **experience** and market leading technology for grey hydrogen and methanol

Most efficient process with leading performance[1]:

Reduces CO_2 emissions >95% while using 9% less feedstock and reducing capex by 40%

Existing customers

First mover advantage (HyNet) and pipeline of >35 projects

Competitors include, for example:

Haldor Topsoe and Air Liquide

Award winning process

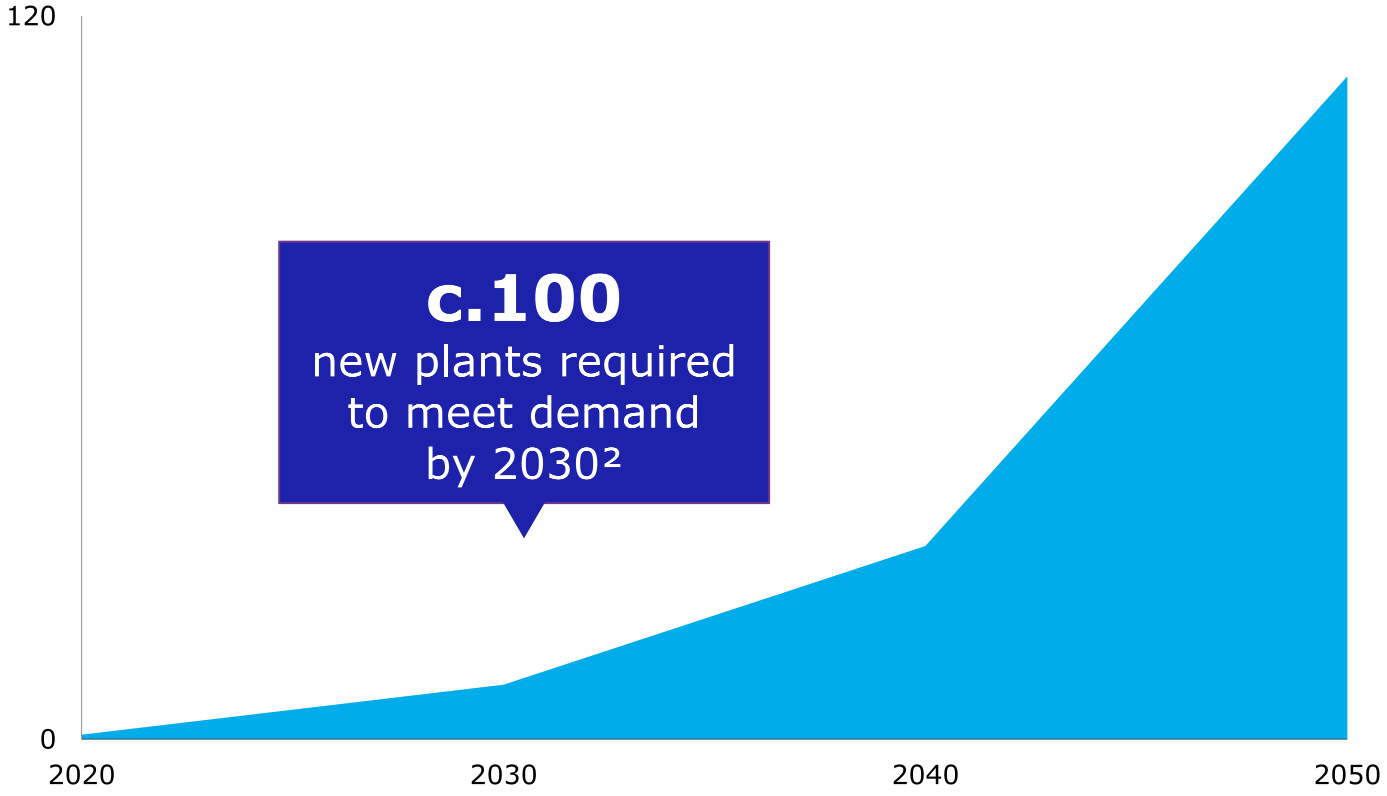
Ambition to be #1 technology supplier for blue hydrogen projects

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)



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

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

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

Phase 1:	2026
Technology:	LCH™
Product:	Blue hydrogen
Uses:	Local industry and natural gas blending

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 CO_2 used in the process to be captured and stored

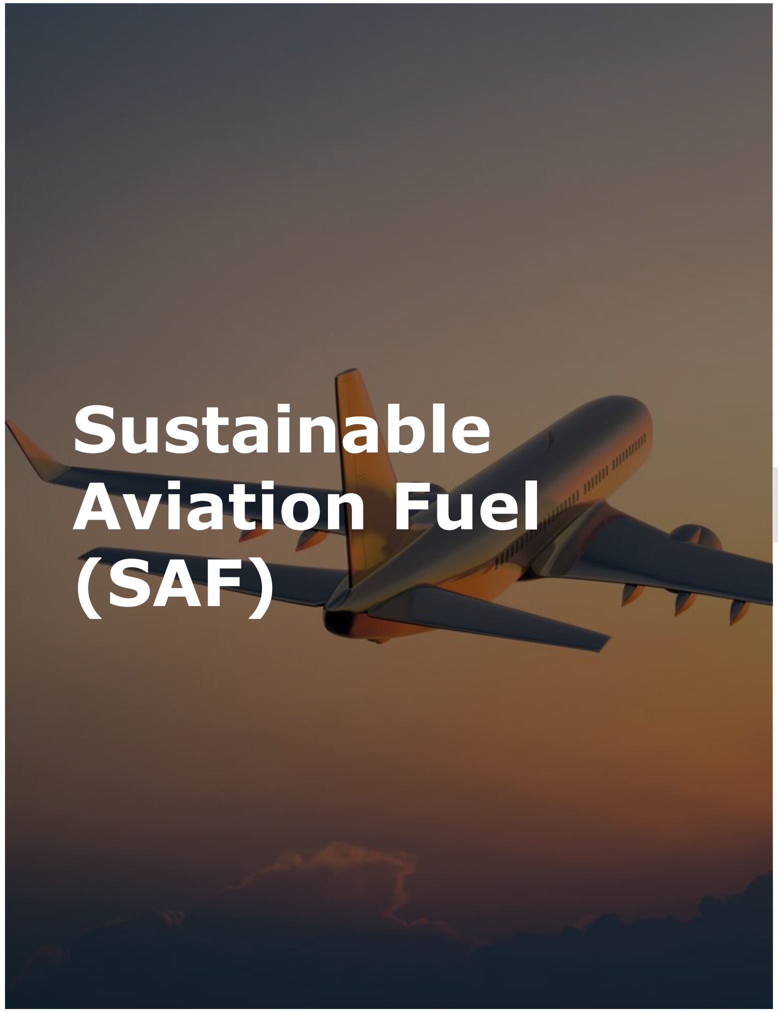
3 Terawatt hours (TWh) of low carbon hydrogen per year beginning in 2026, increasing by 2030 to over

30 TWh

600,000 tonnes of CO_2 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 CO_2

FT offers the highest CO_2 emission reduction potential[1]

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

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 CO_2 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 CO_2)

Enables use of **100% SAF** and full decarbonisation of fuels

Operational efficiency

50% reduction in Fischer-Tropsch unit capex compared to conventional technology[1]

Ambition to be #1 technology supplier

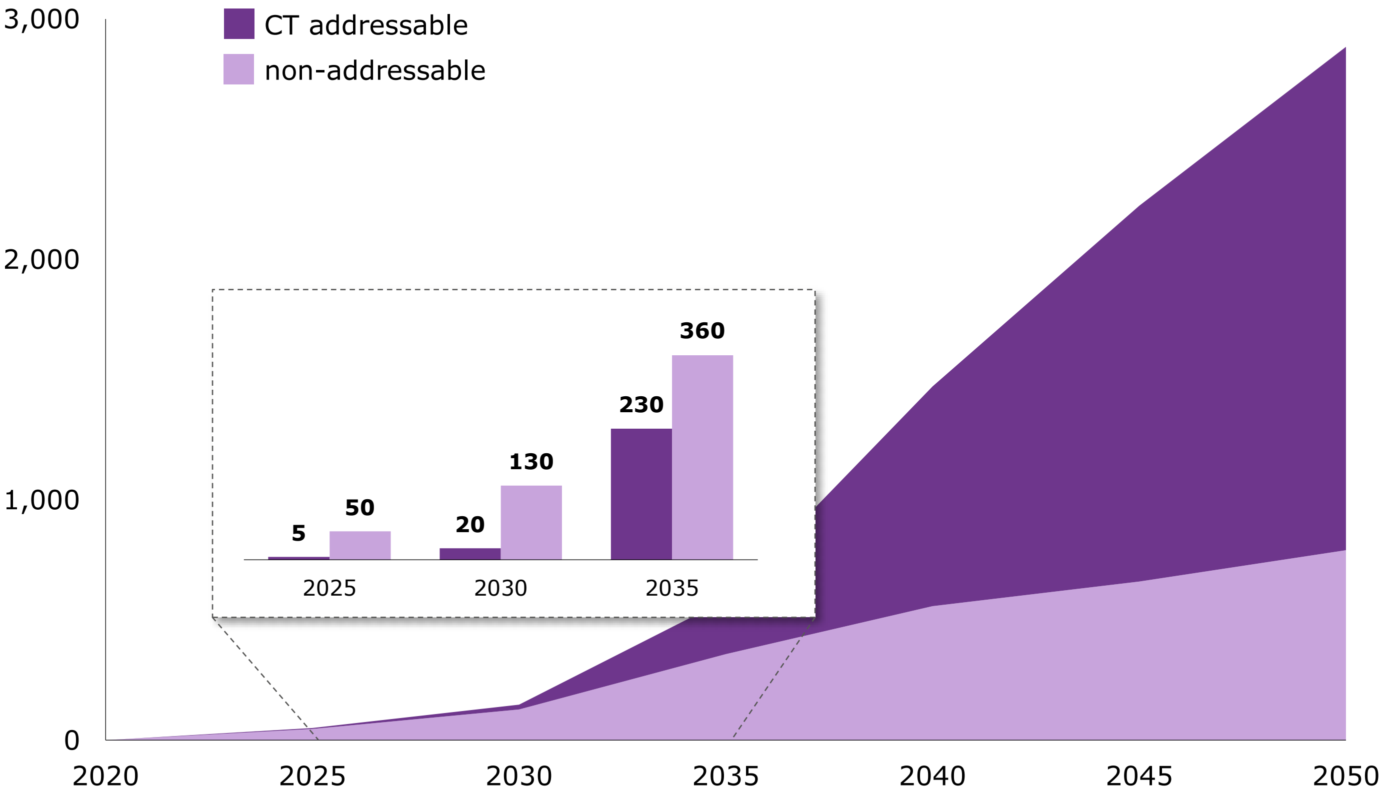
JM

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

"IAG to power 10% of its flights with SAF by 2030"

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)

175,000 tonnes
of municipal solid waste feedstock processed annually

Purpose

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

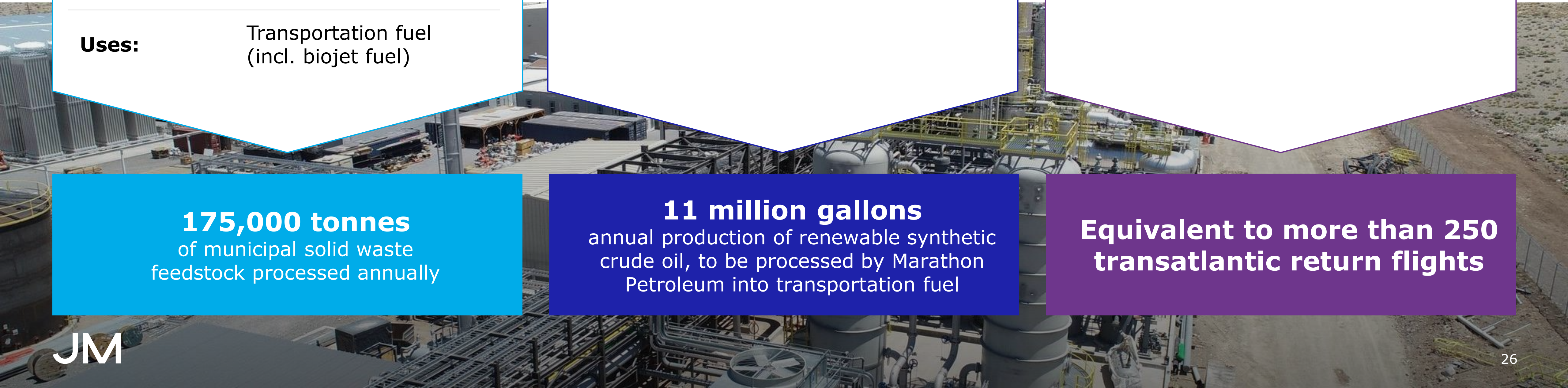
11 million gallons
annual production of renewable synthetic crude oil, to be processed by Marathon Petroleum into transportation fuel

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

Equivalent to more than 250 transatlantic return flights



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Sustainable fuels: Siemens Energy Haru Oni e-fuels project

Project details

Pilot Phase:	2022
Technology:	JM licensed methanol technology
Product:	Sustainable fuels (methanol and gasoline)
Uses:	Transportation fuel

Purpose

Demonstrate technology for world's **first large-scale commercial plant producing climate neutral methanol and gasoline** from green hydrogen and CO_2 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 CO_2 p.a.[1]

CO_2 capture and storage (CCS) is key to decarbonising chemical production

Over 85% of emissions captured through 2030 will come from **plant retrofits**[2]

Initial opportunity of **c.150 hydrogen plants** with potential for retrofit in Europe and North America[3]

An enhanced carbon capture retrofit solution

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

18% Chemical sector share of industrial CO_2 emissions[4]

10% Reduction in direct emissions from primary chemicals by **2030**[5]

95% Reduction in direct emissions from primary chemicals by **2050**[5]

1. Source: IEA, The Future of Hydrogen, 2018.
2. Source: IEA, CCUS in Clean Energy Transitions, 2020
3. Source: JM estimate.
4. Source: IEA, The Future of Hydrogen, 2019.
5. Source: IEA, Net Zero Scenario.

JM

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

Efficient carbon capture process compared to competing technologies[1]

>90% reduction in CO_2 | 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

- To be a leading provider in decarbonisation solutions for syngas
- To retrofit 20-30 syngas plants by 2030/31, reducing CO_2 emissions by c.20m tonnes p.a
- Broadening application of technology to decarbonise wider chemicals industry

1. In comparison to competing technology based on publicly available information.

Progressing our pipeline of opportunities

Positive market drivers

Emissions legislation and government incentives	Decarbonisation	Circularity	Delivering net zero targets

Addressing climate change with our world class technologies

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

Delivering strong leadership positions and growth

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

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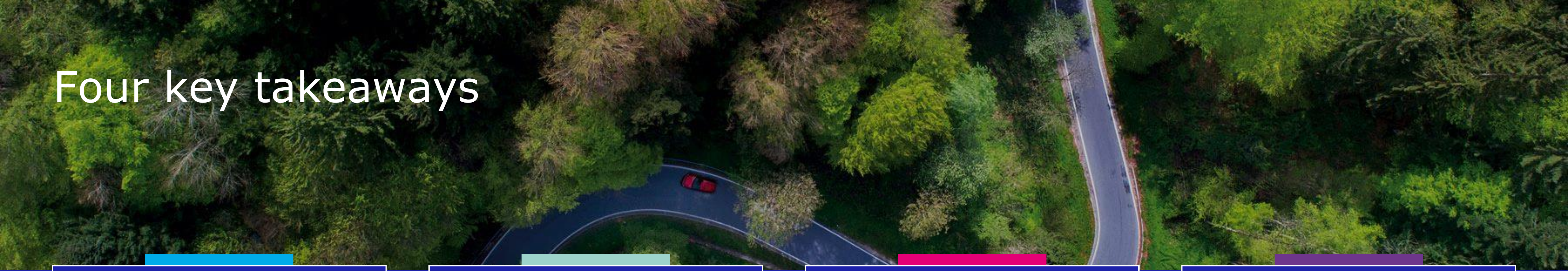


Four key takeaways

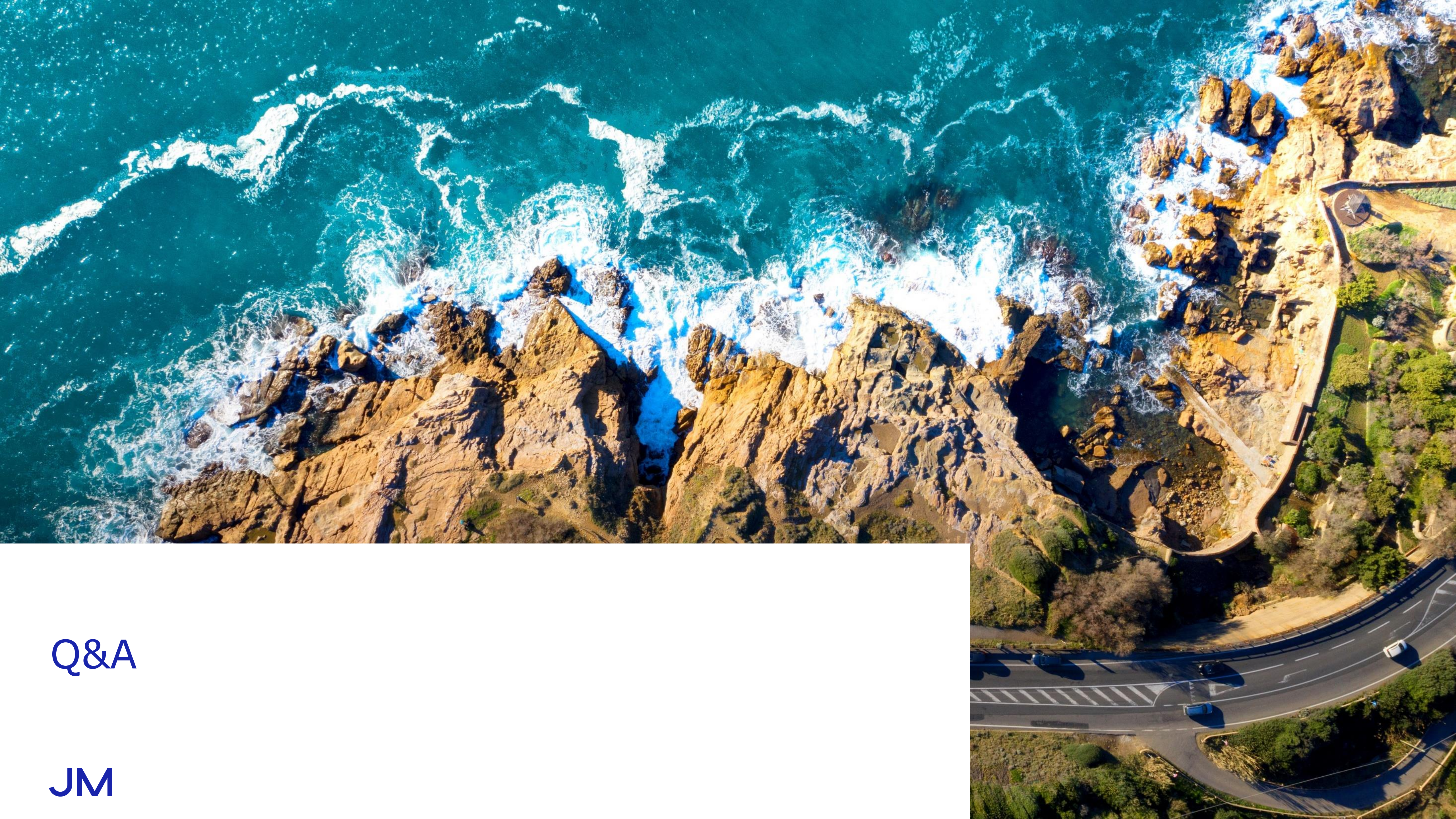
01
Market leader with favourable exposure in core segments

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

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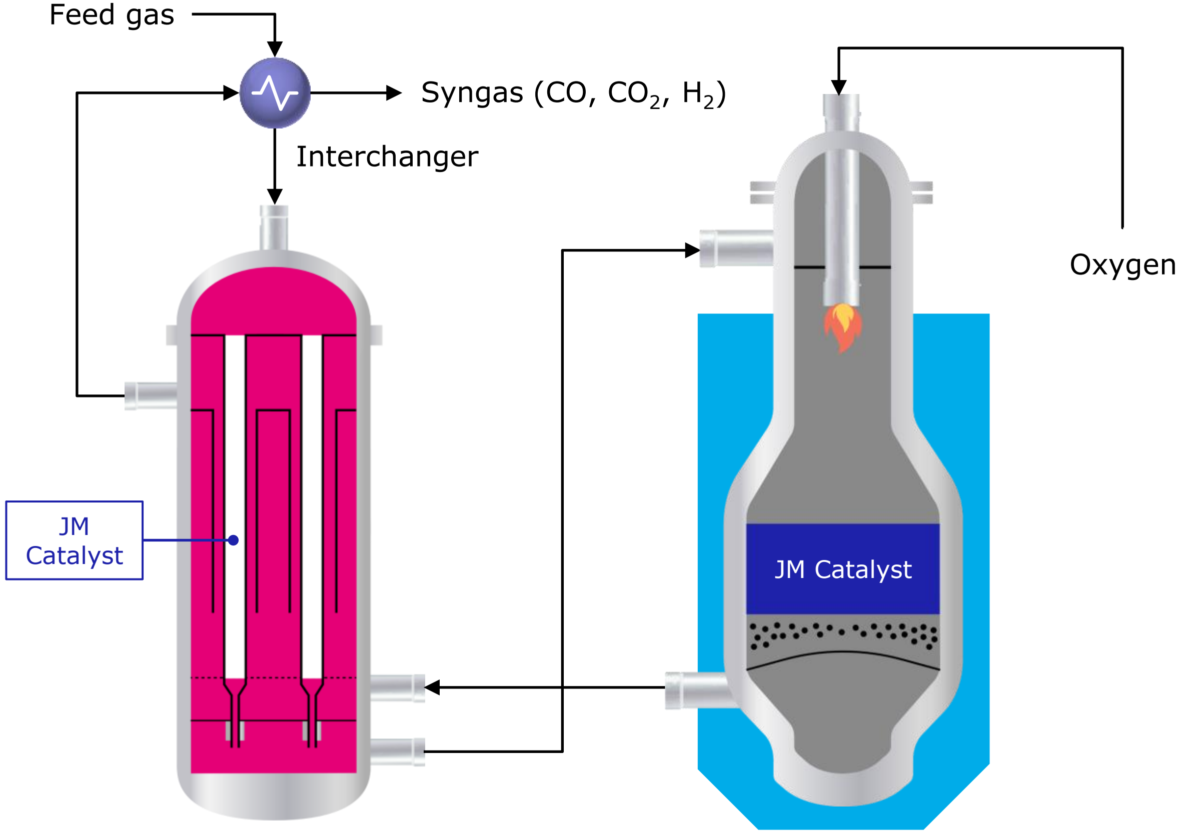
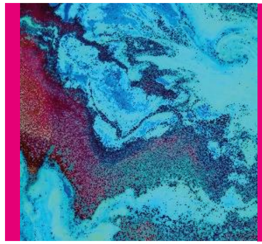
Appendix

Blue hydrogen builds on our expertise in grey hydrogen and methanol

Johnson Matthey's blue hydrogen technology



Gas heated reformer **Autothermal reformer**



Methane (CH_4) from natural gas is reacted with steam to produce **hydrogen** (H_2) and **carbon dioxide** (CO_2)

Highly efficient process – 9% less natural gas usage[1]

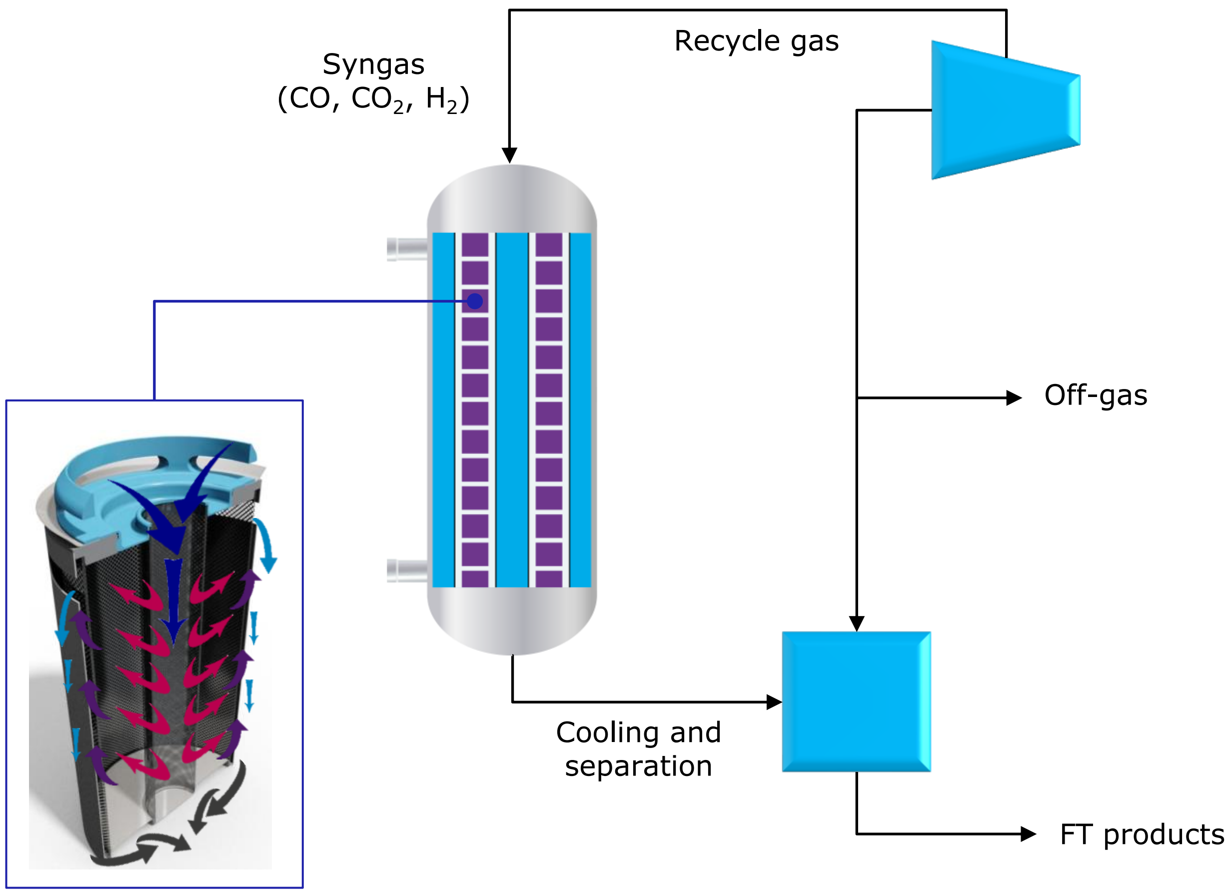
Low capex – 40% lower capital cost[1]

>95% of produced CO_2 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 (CO_2) and hydrogen (H_2).

FT CANS™ technology enables sustainable fuels production from syngas

Innovative catalyst and engineering solution



An **efficient** and **intensified** process

Lower capex – 50% reduction in Fischer-Tropsch unit capex compared to conventional technology[1]

>90% CO conversion in **single stage** recycle loop to improve process efficiency

High quality product and **low production costs** across the wide range of project capacities anticipated for SAF

1. Compared to conventional fixed-bed FT.