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Inspiring science, enhancing life

# HSBC hydrogen week

## **The future with Fuel Cells and Hydrogen**

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25<sup>th</sup> February 2021

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**A world that's  
cleaner and  
healthier;  
today and  
for future  
generations**



# The move to net zero is accelerating: “building back greener”



# Let's look at some of JM's technologies for the hydrogen transition

**Blue**  
hydrogen production

IChemE Global Awards 2020  
Winner  
Johnson Matthey, UK  
Low Carbon Hydrogen –  
Critical to Energy Transition

- Leading technology
- Commercialisation
- Building on our expertise



**Green**  
hydrogen production

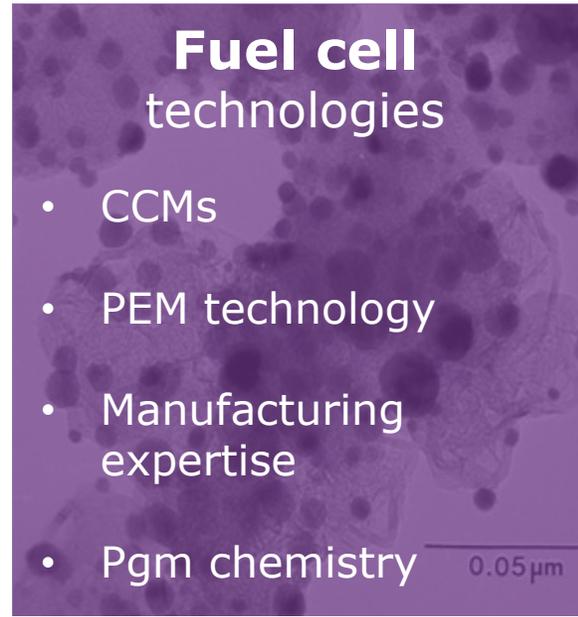
- CCMs
- PEM technology
- Electrochemistry



**Fuel cell**  
technologies

- CCMs
- PEM technology
- Manufacturing expertise
- Pgm chemistry

0.05 μm



**Chemical**  
building blocks

- Existing technology
- Syngas conversion, Fischer Tropsch
- Jet fuel, ammonia, methanol, formaldehyde



Hydrogen production technologies

Use of hydrogen

# JM continues to support an integrated hydrogen economy...

-from hydrogen to base chemical building blocks to specialty chemicals and fuels

## Research



- R&D investment
- Sample and small series production
- Partnering for pilot scale demonstration

## Commercialisation



- Accelerated growth
- Blue Hydrogen, commercial launch
- Appointment of MD in green hydrogen
- JM Hydrogen Council

## Strategy



- Hydrogen and fuel cells sales already c.£100 million
- Fit with portfolio of small chemical building blocks
- JM is a Global Hydrogen Council Board member and on UK Govt Hydrogen Advisory Council

## ...and our stakeholders are recognising it

JM receives  
London Stock Exchange's Green  
Economy Mark

**16<sup>th</sup> July 2020**

JM recognised as a constituent of the  
FTSE4Good Index Series

**13<sup>th</sup> August 2020**

JM's leading Low Carbon Hydrogen  
technology scoops IChemE award

**11<sup>th</sup> November 2020**

JM recognised by  
Dow Jones  
Sustainability Index

**24<sup>th</sup> November 2020**

JM recognised as #1 B2B brightest  
brand

**3<sup>rd</sup> February 2021**

JM joins UK All-Party Parliamentary  
Group on Hydrogen

**15<sup>th</sup> February**

Market is accelerating and we are delivering for our customers

JM and SFC Energy AG sign multi-million pound deal and joint development agreement for supply of fuel cell components

11<sup>th</sup> January 2021

**HyNet North West**

Future Hydrogen Sources

CO<sub>2</sub> Storage

Future CO<sub>2</sub> Shipping

Liverpool

Industrial Gas Users

Future Power Generation

Jobs and Skills

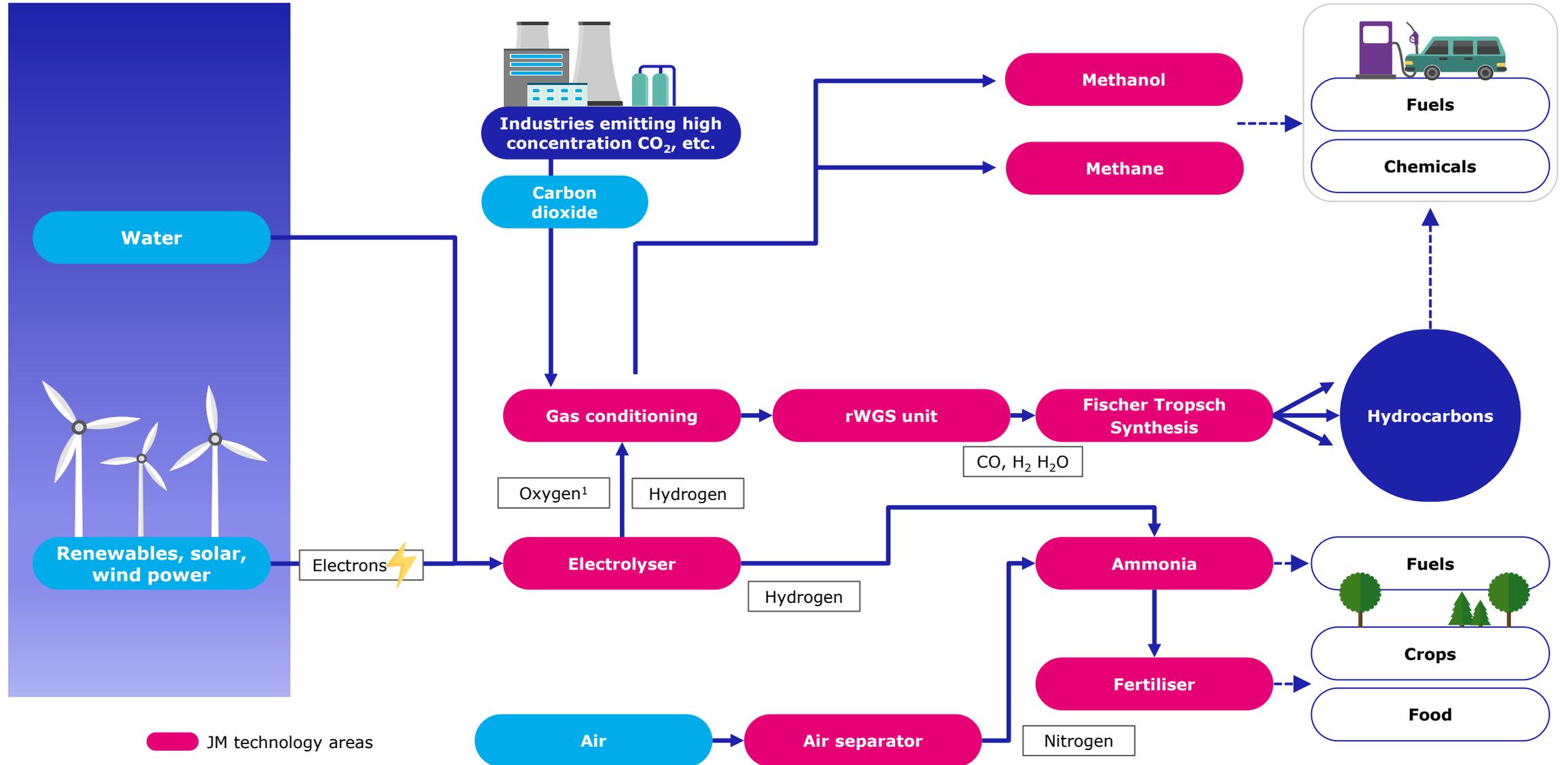
HyNet:  
A step closer to the UK's first hydrogen hub which will use JM's low carbon hydrogen technology

15<sup>th</sup> January 2021

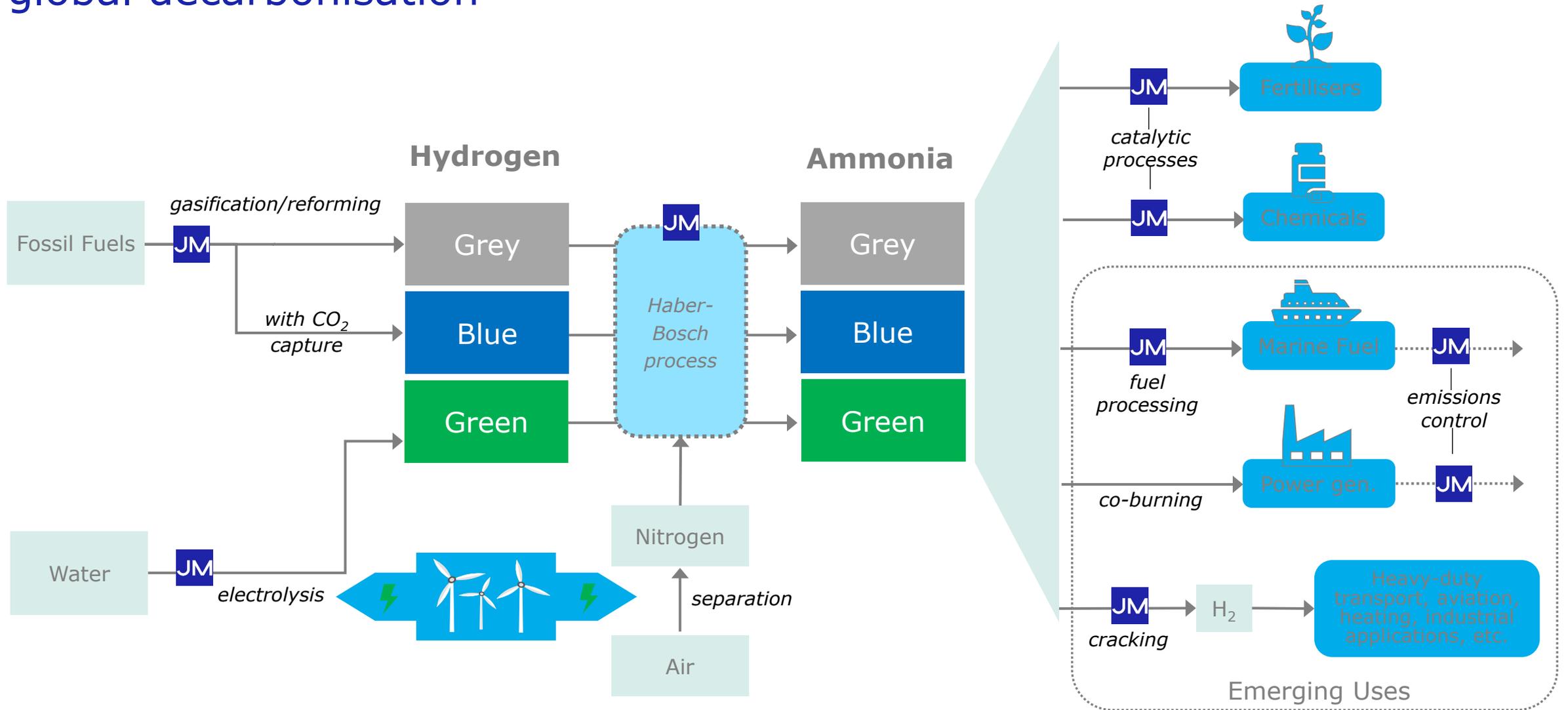
JM announces manufacturing capacity for products enabling 10s of MWs of green hydrogen; ability to scale up to multi-GW

20<sup>th</sup> January 2021

# Turning green hydrogen into chemical building blocks: a vision



# Grey, blue and green ammonia: existing and new uses emerging from global decarbonisation





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Q&A

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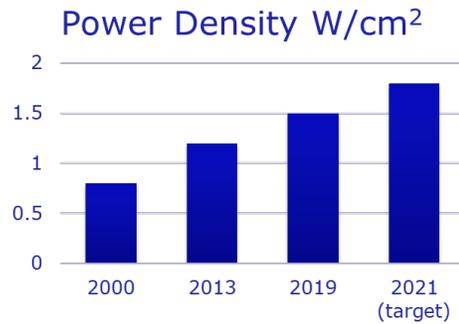
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## Appendix

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# Fuel Cells: JM has a strong competitive advantage...

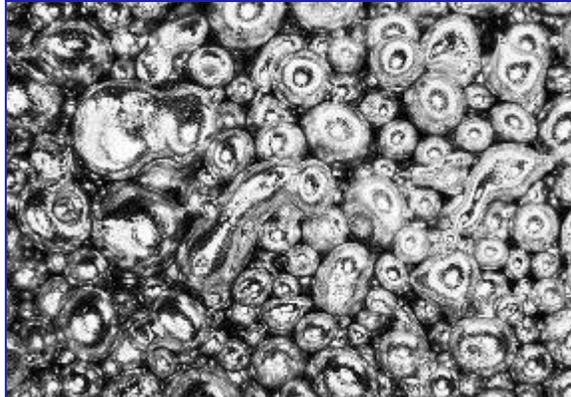
## Science



Catalyst and membrane expertise

Optimisation for high performance

## Pgm expertise



Potential closed loop offering

Lower carbon intensity

Ability to reduce cost

## Trusted partner



Stationary, auto and non-auto markets

Existing customers

Over 20 years' experience

## Established manufacturing



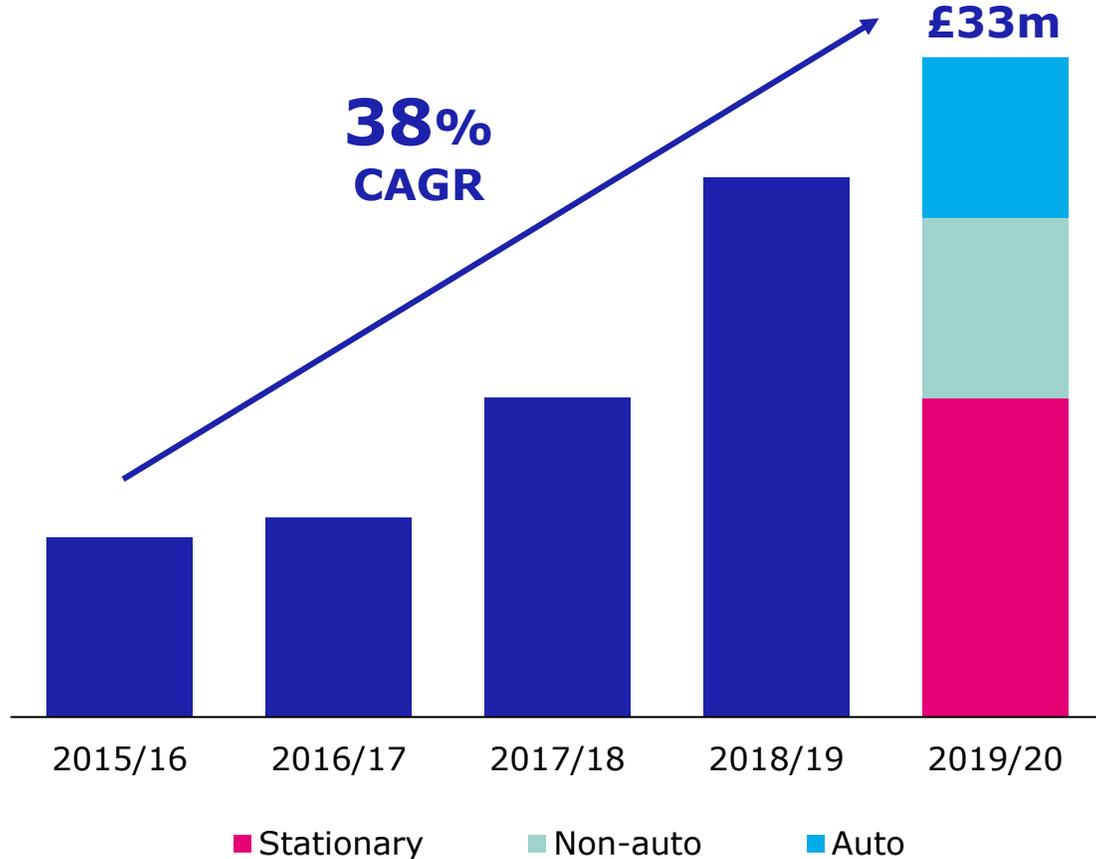
Well along experience curve

Doubling capacity 2020/2021

Further expansion

...JM has an established, profitable and growing business

### Fuel cell sales (£m)



Customers include major global truck and auto OEMs

Estimated addressable truck market of c.£1bn p.a. in 2030<sup>1,2</sup>  
>£10bn p.a. in 2040<sup>2,3</sup>

Note: Sales excluding precious metals.

1. Based on LMC, KGP and JM assumptions which equate to i) c.0.4 million trucks.

2. Source: McKinsey cost estimations and OEM targets.

3. Based on LMC, KGP and JM assumptions which equate to i) c.3 million trucks and ii) c.14.5 million autos, of which c.60% is assumed to be non-captive in 2040. Estimated CCM value per auto vehicle is c.£800.

# JM has a strong presence across hydrogen production technologies

## JM's technologies

Grey	Blue	Green
Natural gas	Natural gas	Renewable electricity
Leading catalyst supplier 40% segment share <sup>1</sup>	Differentiated technology and catalyst supplier	Expect to supply catalyst coated membrane
Steam methane reforming No CCS	Advanced gas reforming CCS	Electrolysis
High GHG emissions (11 tCO <sub>2</sub> /tH <sub>2</sub> )	Low GHG emissions (0.2 tCO <sub>2</sub> /tH <sub>2</sub> )	Potential for zero GHG emissions
\$1 – \$2.1 per kg H <sub>2</sub>	\$1.5 – \$2.9 per kg H <sub>2</sub>	\$3 – \$7.5 per kg H <sub>2</sub>

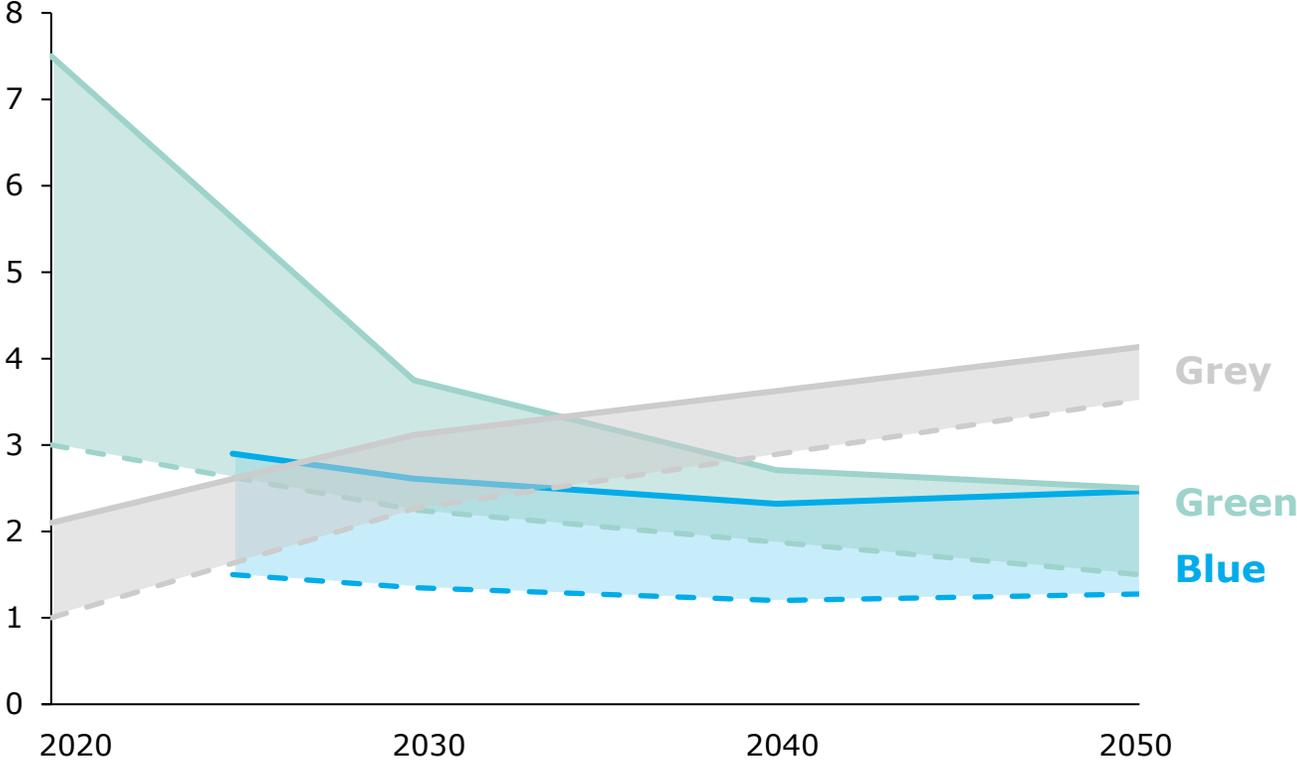
Note: GHG – greenhouse gas; CCS – carbon capture and storage; tCO<sub>2</sub>/tH<sub>2</sub> – tonne of carbon dioxide per tonne of hydrogen.

Source: IEA, The Future of Hydrogen, Karuizawa, Japan, June 2019.

1. Based on Johnson Matthey data.

# Green hydrogen becomes more competitive over the medium term

**Estimated hydrogen cost**  
(\$ per kg H<sub>2</sub>)

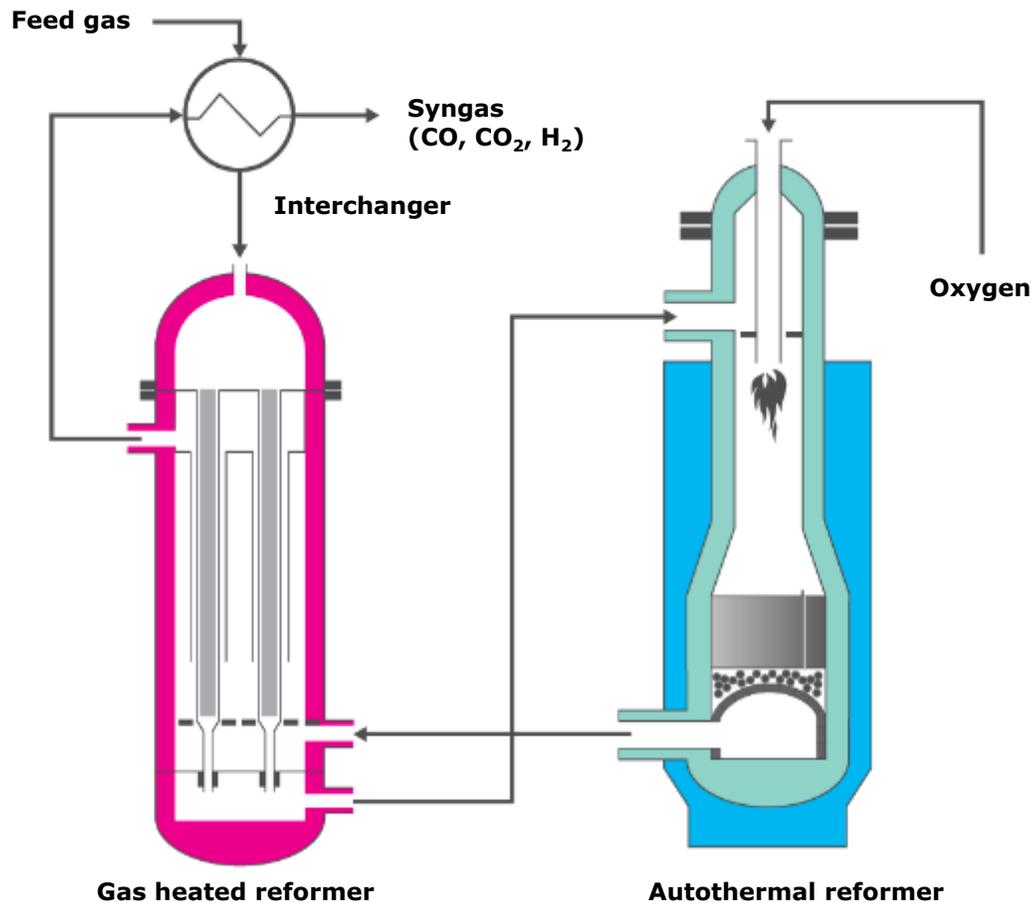


**Blue hydrogen** advantaged in certain regions and likely to be a long term solution in places with the right geology and infrastructure e.g. US and UK

**Green hydrogen** will be a solution in some regions as both renewable energy and capital costs decline

# JM's award winning blue hydrogen technology builds on our expertise in grey hydrogen and methanol

## Johnson Matthey's blue hydrogen technology



**Methane** (CH<sub>4</sub>) from natural gas is reacted with steam to produce **hydrogen** (H<sub>2</sub>) and **carbon dioxide** (CO<sub>2</sub>)

**Most efficient process – 9% less natural gas usage<sup>1</sup>**

**Lowest capex – 40% lower capital cost<sup>1</sup>**

**98% of produced CO<sub>2</sub> captured: single stream at high pressure and purity** enabling easier transport or storage

# World's most progressed low carbon hydrogen projects have JM's LCH™ technology at their heart

## HyNet Phase 1 North West England

Trialling decarbonised hydrogen as a fuel and feedstock

Phase 1: 80kt of hydrogen p.a.  
Equivalent to world scale hydrogen plant

Used in industry, homes and transport

## Acorn Phase 1 North East Scotland

North Sea natural gas reformed into clean hydrogen and CCS

Phase 1: 55kt of hydrogen p.a.

Used in transport and the gas grid to decarbonise heating

Engaged with a growing global pipeline of over 15 projects

Estimated addressable market of c.£1.5bn to c.£2bn p.a. in 2030<sup>1,2</sup>

Note: CCS – carbon capture and storage.

1. Based on total hydrogen demand (Hydrogen Council, "Hydrogen, Scaling up" report, 2017); average plant size of 160kt p.a. (equivalent to twice the size of HyNet project Phase 1).

2. Assumes c.30% of the market is blue hydrogen (Johnson Matthey, IEA, BP).

# JM is a trusted partner in the rapid scale up of green hydrogen

## Comparable technology to fuel cells

- CCM is heart of system and key for performance and cost reduction
- Competitive advantage in pgm catalysis and thrifting
- Ability to scale quickly

## Potential closed loop offering

- End of life options designed in from R&D stage
- Pgm recycling expertise

## Experience in enabling new technologies

- Fuel cells
- Fischer Tropsch
- Technology for waste to aviation fuel

90GW of  
electrolyser  
capacity by 2030  
Hydrogen Council  
(February 2021)

Testing  
with leading  
electrolyser  
players



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