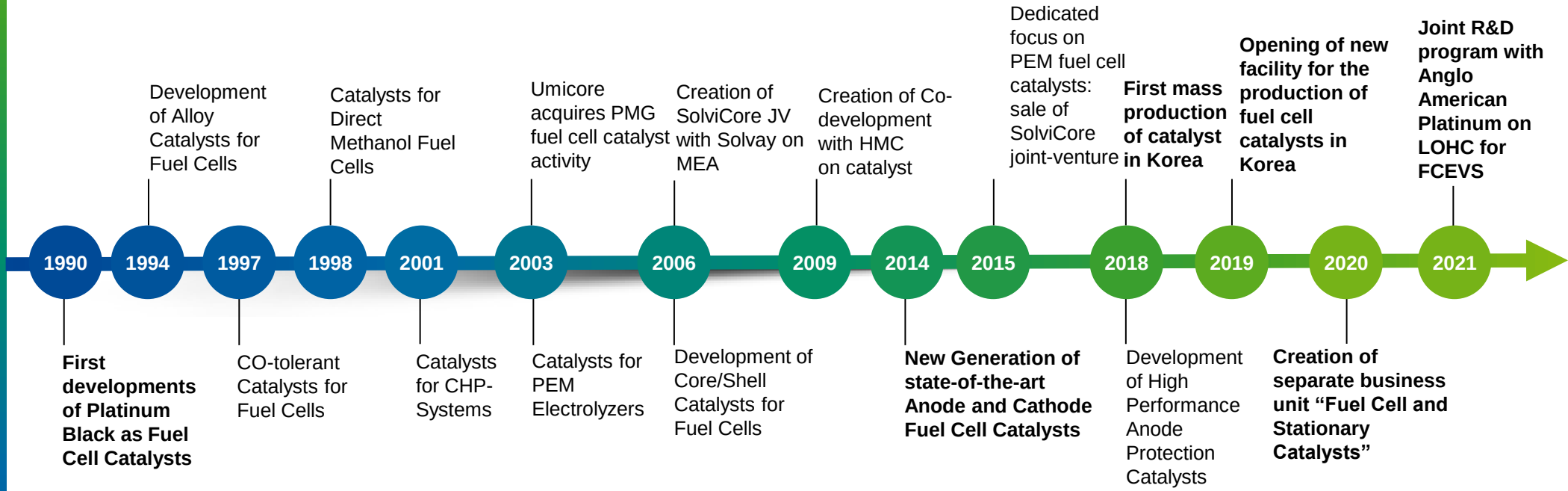
umicore
materials for a better life

Umicore’s position in catalysts to support the green hydrogen economy

26 April 2021

More than 30 years of experience in catalysts for green hydrogen economy



Over 30 years more than 250 fuel cell patents filed around the world

Global footprint: 2 production sites and 4 R&D centres in Asia and Europe

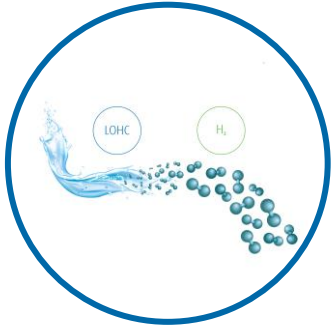
Attractive growth opportunities in the hydrogen economy

MOBILITY OPPORTUNITY

TRANSPORTATION FUEL CELLS

Attractive near-term growth potential

LIQUID ORGANIC HYDROGEN CARRIER FOR TRANSPORTABLE FUEL



Long-term growth potential

ENERGY OPPORTUNITY

GREEN HYDROGEN (ELECTROLYSIS)

Long-term growth potential

Active business

Profitable with a turnover* of € 40 Mn in 2020

Business incubation program

R&D program and joint development agreements to establish future growth and success

*Turnover: including metal content

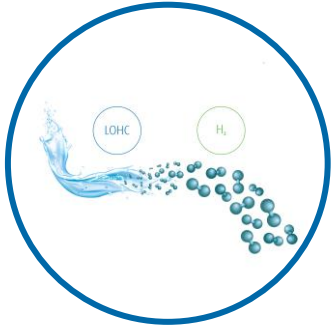
Attractive growth opportunities in the hydrogen economy

MOBILITY OPPORTUNITY

TRANSPORTATION FUEL CELLS

Attractive near-term growth potential

LIQUID ORGANIC HYDROGEN CARRIER FOR TRANSPORTABLE FUEL



Long-term growth potential

ENERGY OPPORTUNITY

GREEN HYDROGEN (ELECTROLYSIS)

Long-term growth potential

Fuel Cell Recycling

Attractive growth opportunities in the hydrogen economy

MOBILITY OPPORTUNITY

TRANSPORTATION FUEL CELLS

Attractive near-term growth potential

LIQUID ORGANIC HYDROGEN CARRIER FOR TRANSPORTABLE FUEL

Long-term growth potential

ENERGY OPPORTUNITY

GREEN HYDROGEN (ELECTROLYSIS)

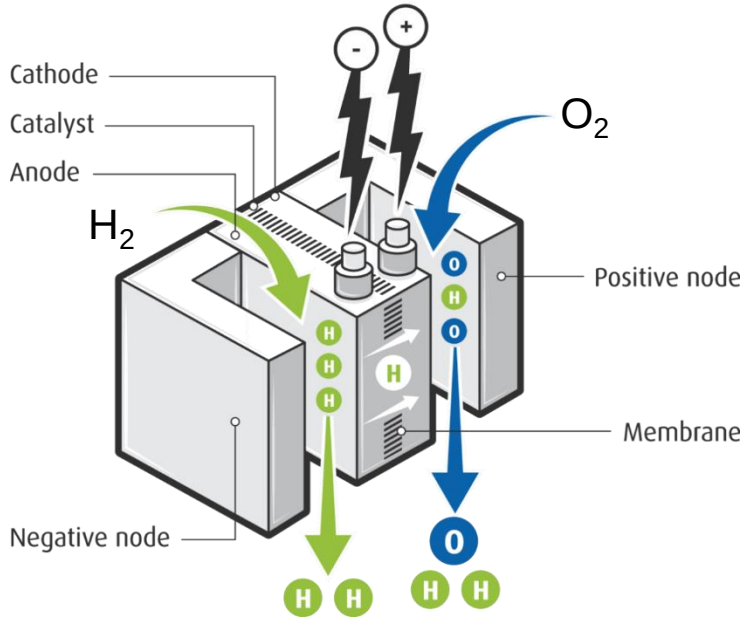
Long-term growth potential

Near-term growth potential in fuel cell catalysts for HDV and long-range LDV

MOBILITY OPPORTUNITY

TRANSPORTATION FUEL CELLS

Umicore produces catalysts for the cathode and anode electrode of PEM fuel cells



Near-term growth potential in fuel cell catalysts for HDV and long-range LDV

MOBILITY OPPORTUNITY

TRANSPORTATION FUEL CELLS

Application	▪ Fuel cells as perfect solution to cater long range HDV and buses, providing strong propulsive power	▪ Most LDV to be battery electric except long range LDVs (> ~750 km)
Key fuel cell technology	▪ Proton-exchange membrane	
Legislation	▪ Supportive in Korea, Japan, China and Europe	
Est. market size by 2030	▪ HDV & LDV: 150 GW (current: ~4 GW)*	
Est. catalyst demand by 2030	▪ 120t (current: < 4t) taking into account increasing thrifting of precious metals	

*Source: "European Union Study on Value Chain and Manufacturing Competitiveness Analysis for Hydrogen and Fuel Cells Technologies" (Sept. 2019) and assuming 0.8g catalyst per kW

Growth potential for HDV and long range LDV in Korea, Japan, China and Europe

Umicore: ongoing sales and scaling up in view of increasing customer demand

Qualified supplier of more than 10 OEMs across regions: car and truck OEMs as well as stack producers and system manufacturers

Considered **benchmark catalyst materials** by leading fuel cell companies

R&D and production capacity in Germany and Korea; mass production plant commissioned in Korea end 2019

Key customer cooperations with OEMs as well as system integrators, stack and MEA suppliers

Qualified supplier of more than 10 OEMs
(car and truck OEMs as well as stack producers and system manufacturers)

Ramp-up timeline for already qualified business awards

And ongoing engagements for new platforms globally…

SOP: start of production

Supplier of Hyundai Motor Company for fuel cell catalysts

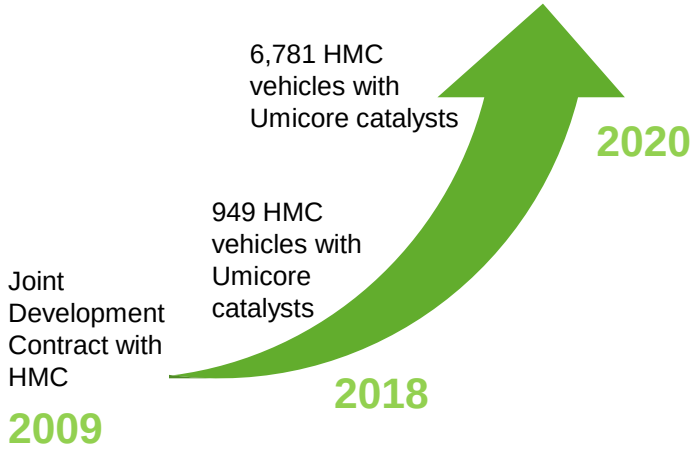
Hyundai MC: one of the first manufacturers to make hydrogen fuel cell vehicles commercially available

Focus on advanced fuel cell technology to boost range, performance, durability

Launch of NEXO, the only fuel cell SUV in the world, in 2018 with 135kW powertrain and range of 665km

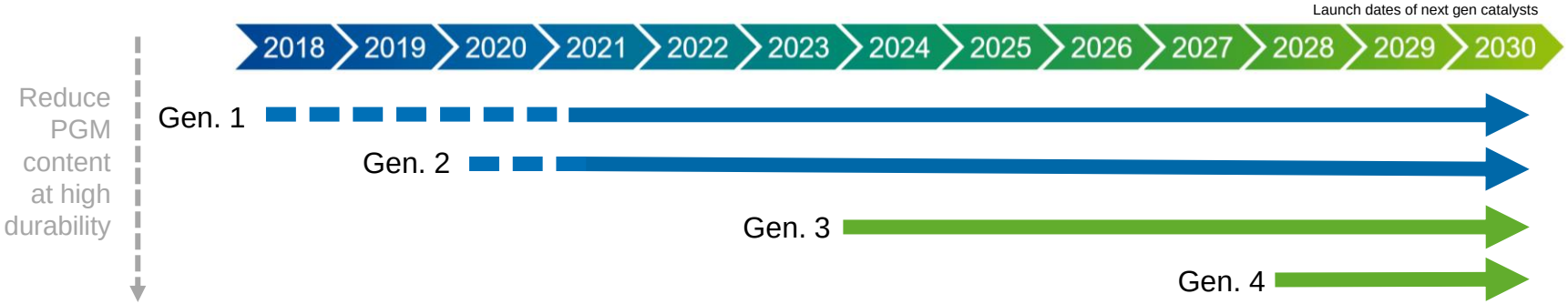
Umicore is supplier and co-developer of PEM fuel cell catalysts with Hyundai Motor Company since September 2009, providing the high performance and durability catalyst requirements

Hyundai NEXO vehicle



Leading technology on fuel cell catalysts

Roadmap to reduce PGM loading and make fuel cell applications more cost competitive



Research network on fuel cells with key institutes in Europe, US and Korea

Open innovation with best-in-class academia and research institutes

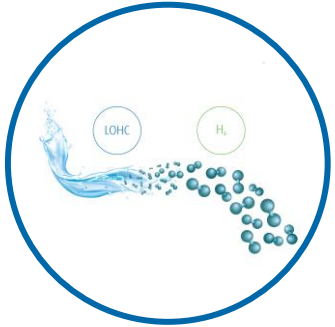
Attractive growth opportunities in the hydrogen economy

MOBILITY OPPORTUNITY

TRANSPORTATION FUEL CELLS

Attractive near-term growth potential

LIQUID ORGANIC HYDROGEN CARRIER FOR TRANSPORTABLE FUEL



Long-term growth potential

ENERGY OPPORTUNITY

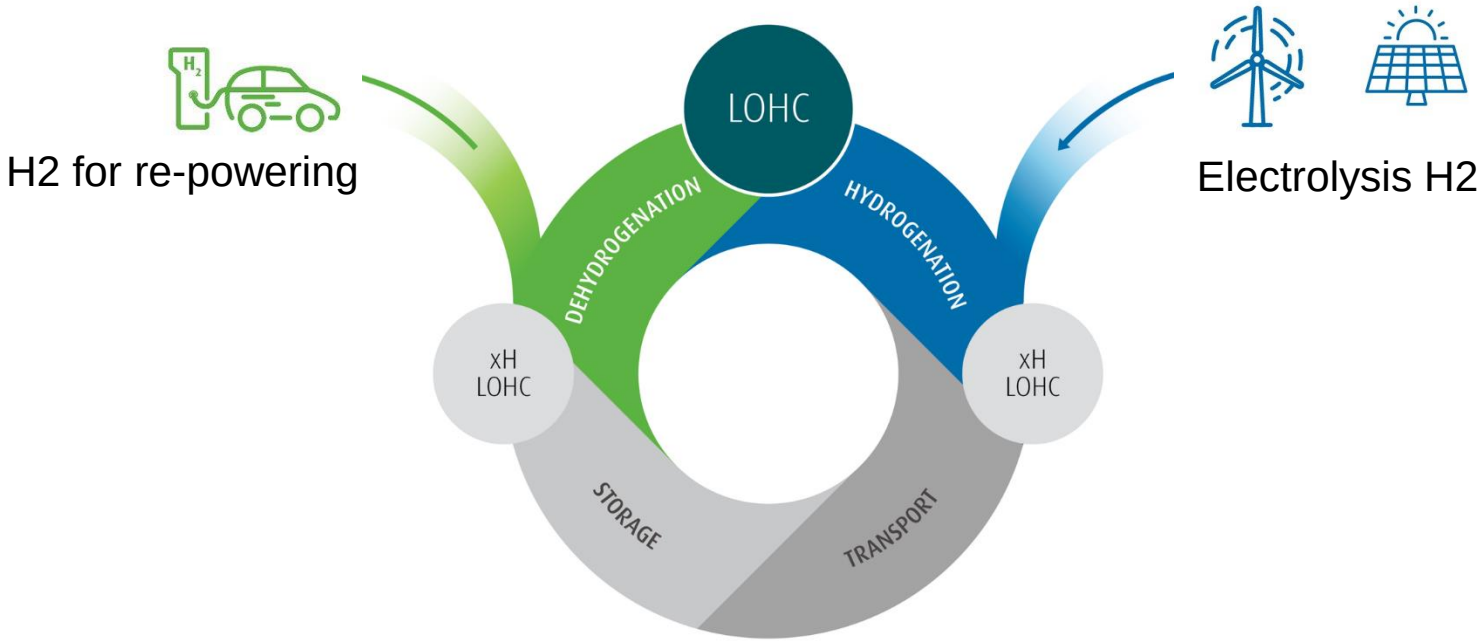
GREEN HYDROGEN (ELECTROLYSIS)

Long-term growth potential

Long-term growth potential in liquid organic hydrogen carrier technology for transportable hydrogen fuel

MOBILITY OPPORTUNITY

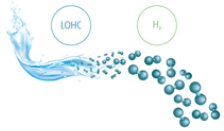
LIQUID ORGANIC HYDROGEN CARRIER (LOHC)



Long-term growth potential in liquid organic hydrogen carrier technology for transportable hydrogen fuel

MOBILITY OPPORTUNITY

LIQUID ORGANIC HYDROGEN CARRIER (LOHC)



Application	▪ LOHC are organic compounds that can absorb and release hydrogen through chemical reactions and can therefore be used as storage for hydrogen ▪ Offer options for (i) transporting hydrogen over long distances as it allows safer, more practical and more cost-efficient hydrogen transport and (ii) simplification of the fueling process
Key fuel cell technology	▪ Requires PGM-catalysts for hydrogen storage/release
Legislation	▪ CO_2 regulation accelerating hydrogen economy: Asia, Europe, US to lead

Joint research and development program with Anglo American Platinum to develop PGM-based technologies for LOHC applications on fuel cell electric vehicles

Pilot project with industrial and academic partners on early-stage LOHC product development

Aiming for a significant simplification of the fueling process by enabling dehydrogenation at lower temperatures and pressures, thereby providing a viable alternative to onboard storage of compressed hydrogen

Long-term opportunity in the refueling of FCEVs

Attractive growth opportunities in the hydrogen economy

MOBILITY OPPORTUNITY

TRANSPORTATION FUEL CELLS

Attractive near-term growth potential

LIQUID ORGANIC HYDROGEN CARRIER FOR TRANSPORTABLE FUEL

Long-term growth potential

ENERGY OPPORTUNITY

GREEN HYDROGEN (ELECTROLYSIS)

Long-term growth potential

Long-term market potential in catalysts for green hydrogen (electrolysis)

ENERGY OPPORTUNITY

GREEN HYDROGEN (H2) - ELECTROLYSIS

Application	▪ Electrolysis produces hydrogen from water using renewable and non-renewable electricity sources ▪ Green hydrogen when electricity produced from renewable sources
Key technology	▪ Proton-exchange membrane or alkaline
Legislation	▪ Initiatives to promote green hydrogen in Europe (Green Deal), Japan, Korea and Australia
Est. market size by 2030 for PEM catalysts	▪ 90 GW (current: 0.1 - 0.2 GW) ▪ Green hydrogen expected to be cost competitive as of 2030 - 2035
Est. PEM catalyst demand by 2030	▪ 6-7t (current: < 0.3t)

*Source: "International Renewable Energy Agency (Dec. 2020), assuming 0.7g catalyst per KW

Long-term market potential in electrolysis for green hydrogen, however long term market potential dependent on CO_2 legislation as well as preferred technology

Umicore well positioned to capture future growth in catalysts for electrolysis:

- Strong knowhow and expertise in PEM catalysts
- Continued R&D investment
- Ongoing collaboration with best-in-class research institutes

Ongoing research on green hydrogen

Open innovation with best-in-class research institutes

PAUL SCHERRER INSTITUT PSI

JÜLICH Forschungszentrum

DLR

FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

TECHNISCHE UNIVERSITÄT DARMSTADT

Consortia memberships on green hydrogen (electrolysis)

Hydrogen Council

BLAUWE CLUSTER

WaterstofNet

Hydrogen Europe

Key takeaways

Increasing government initiatives to promote hydrogen-based economy

Attractive near-term growth potential in fuel cell catalysts used in HDV and long range LDV

Longer term opportunities for catalysts in LOHC for transport & storage and green hydrogen production

Umicore uniquely positioned to capture significant near-term growth in fuel cell based HDV and LDV:

- Established portfolio of PEM catalysts with outstanding performance and durability
- Already qualified supplier of more than 10 car & truck OEMs, system integrators, stack and MEA suppliers
- Global presence with R&D and industrial production in Korea and Germany, HQ in China
- Strong R&D and research partnerships

Ongoing collaboration programs and R&D in view of longer-term growth potential in LOHC and green hydrogen