

Green hydrogen – drivers and markets

Dr Jenny Watts

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1.0078

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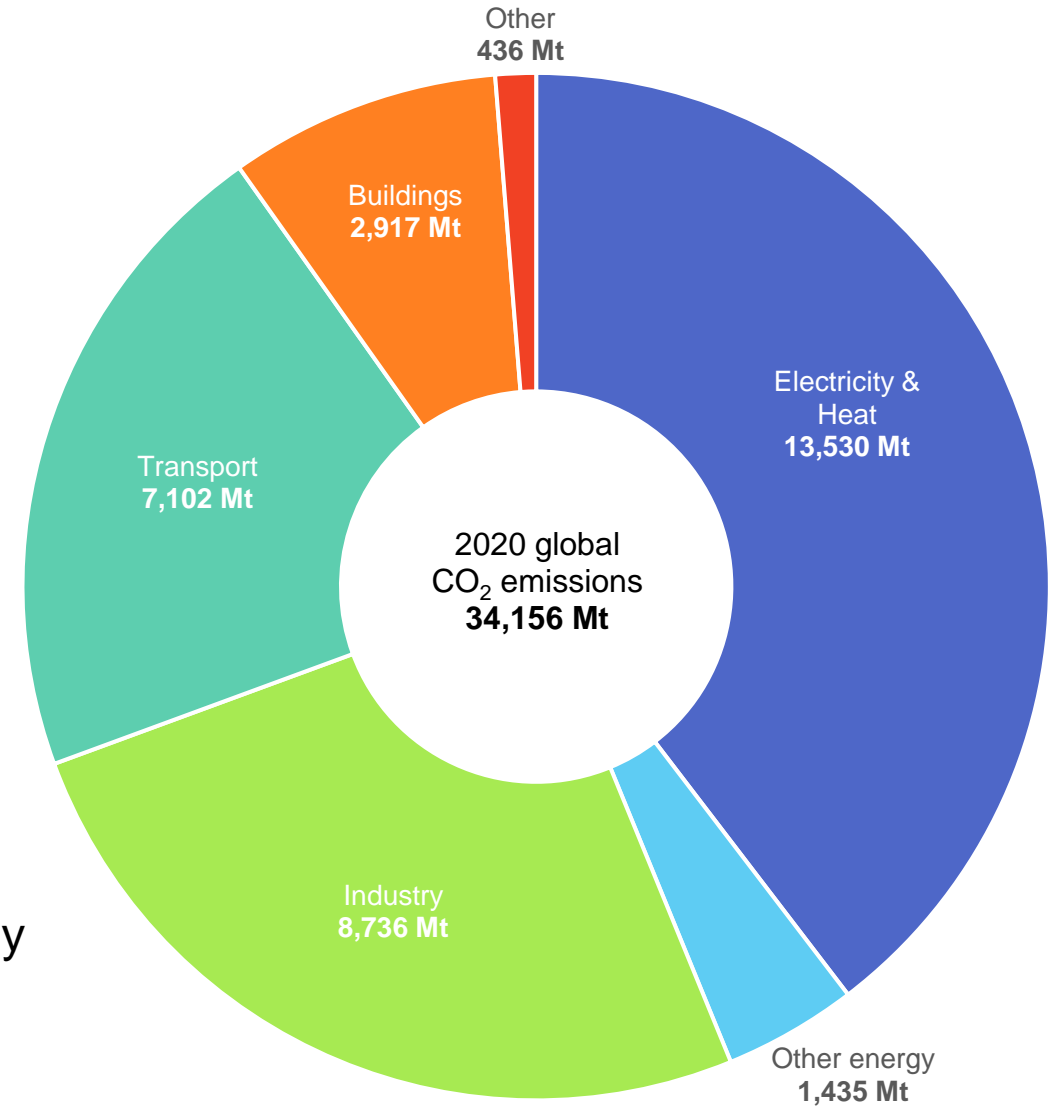
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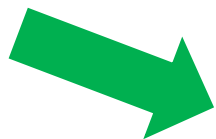
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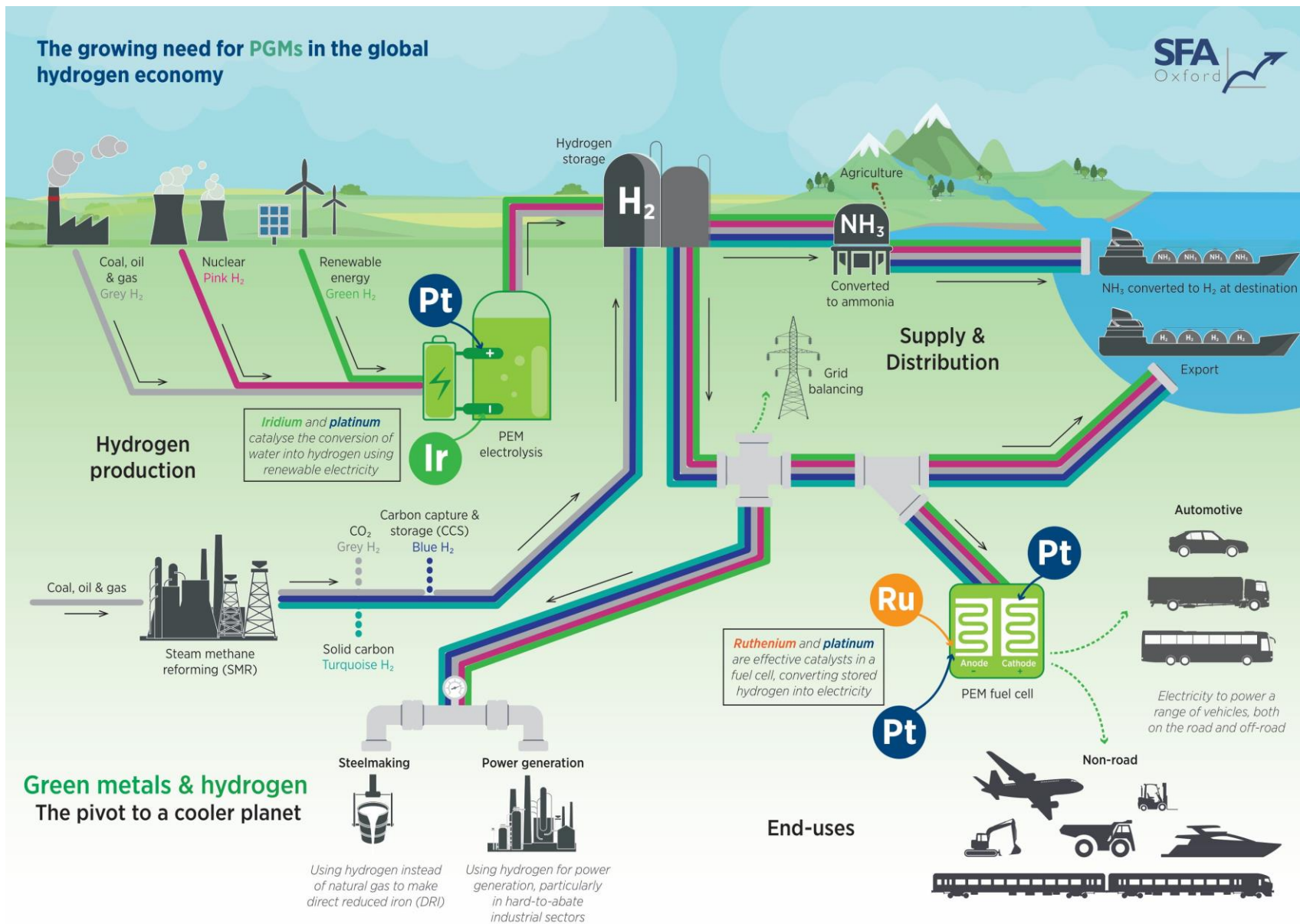
- ✓ World aims to limit global warming
- ✓ No more than 1.5°C above pre-industrial levels
- ✓ Cut greenhouse gas emissions by >30 Gt p.a. by 2030
- ✓ Focus on 6 main sectors
- ✓ Target the quickest and biggest win sectors...
- ✓ ...energy, industry, transport
- ✓ Hydrogen as the ‘new oil’
- ✓ Green hydrogen goes hand-in-hand with renewable energy



Source: IEA, World Energy Outlook October 2021

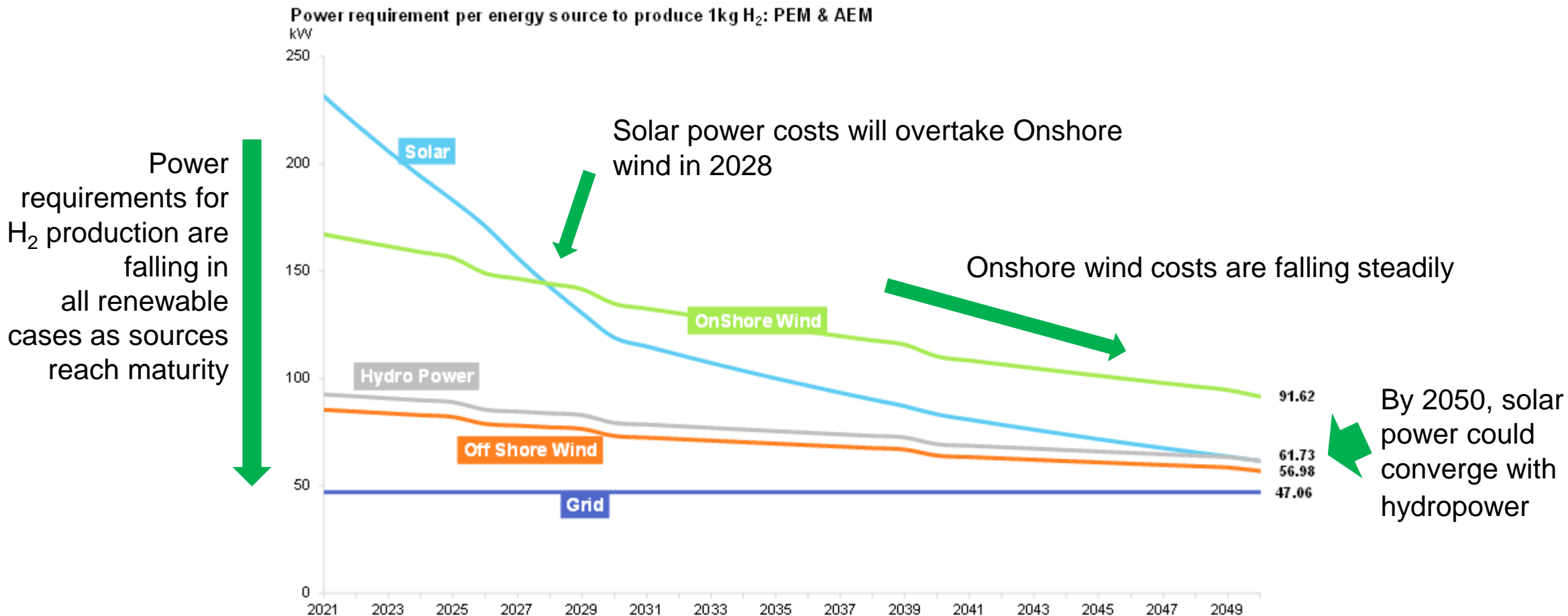
Route	Carbon footprint
Grey from steam methane reforming (SMR) of oil, gas or coal	High
Turquoise from methane pyrolysis producing solid carbon as a by-product	Low
Blue from SMR but with the CO ₂ emissions captured and stored (CCS)	Low
Pink from electrolysis from nuclear energy	Low
Green from electrolysis from renewable wind or solar energy	Zero





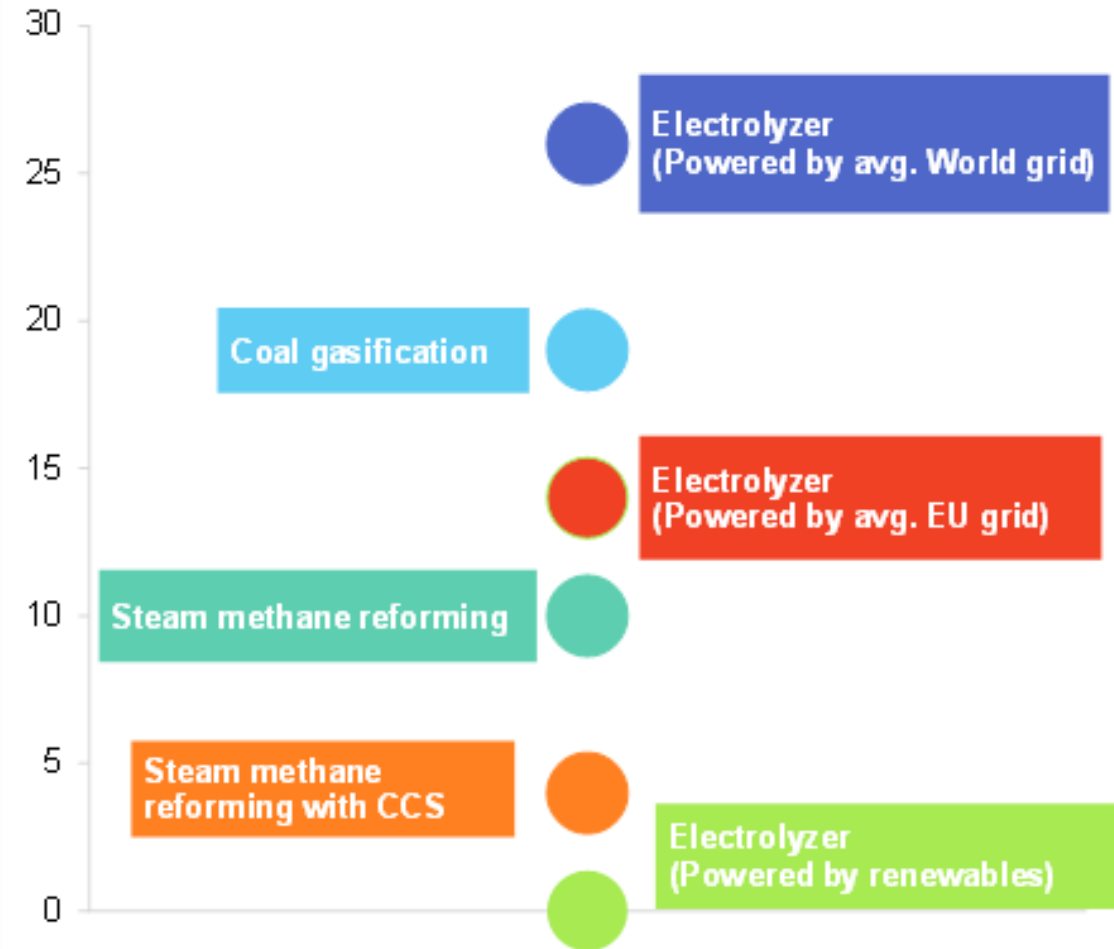
Source: SFA (Oxford)

Green hydrogen increasingly competitive as renewable energy costs fall



- ✓ CO₂ emissions mitigated in the various industrial processes available to produce hydrogen
- ✓ Maximising hydrogen's potential will require
 - ✓ governments to set the right legislation
 - ✓ industry collaboration & partnerships

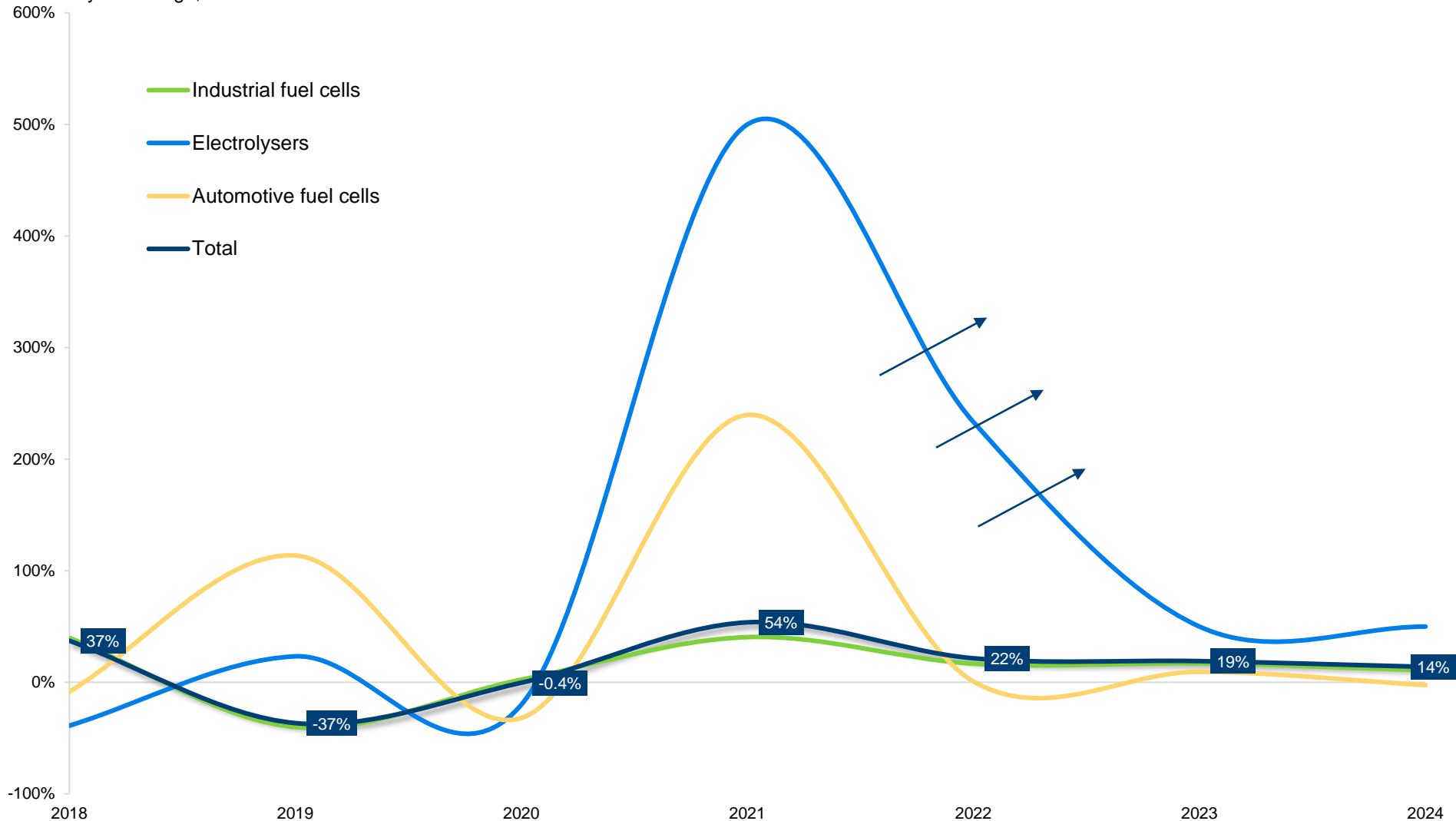
GHG emissions from hydrogen production
kg CO₂ eq./kgH₂



Source: SFA (Oxford), Siemens Gamesa & Siemens Energy

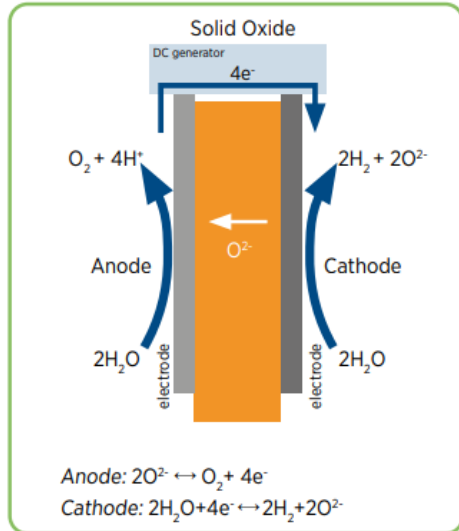
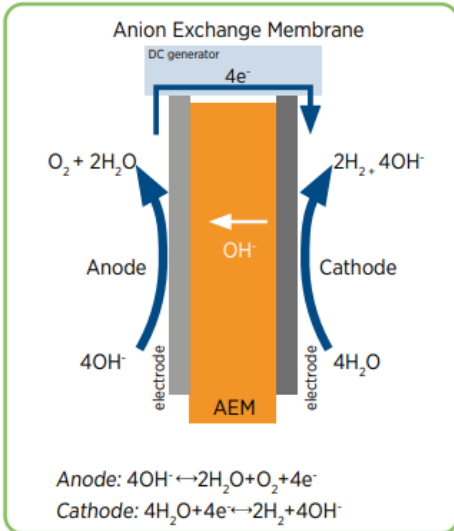
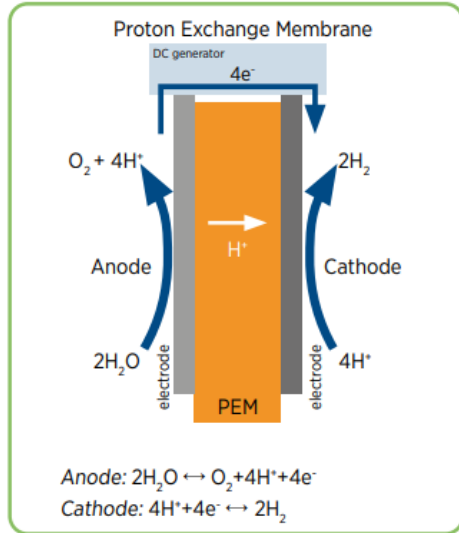
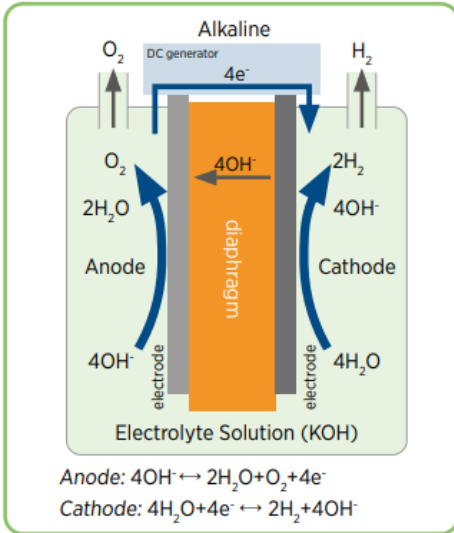
Hydrogen: PGM demand

Year-on-year change, %

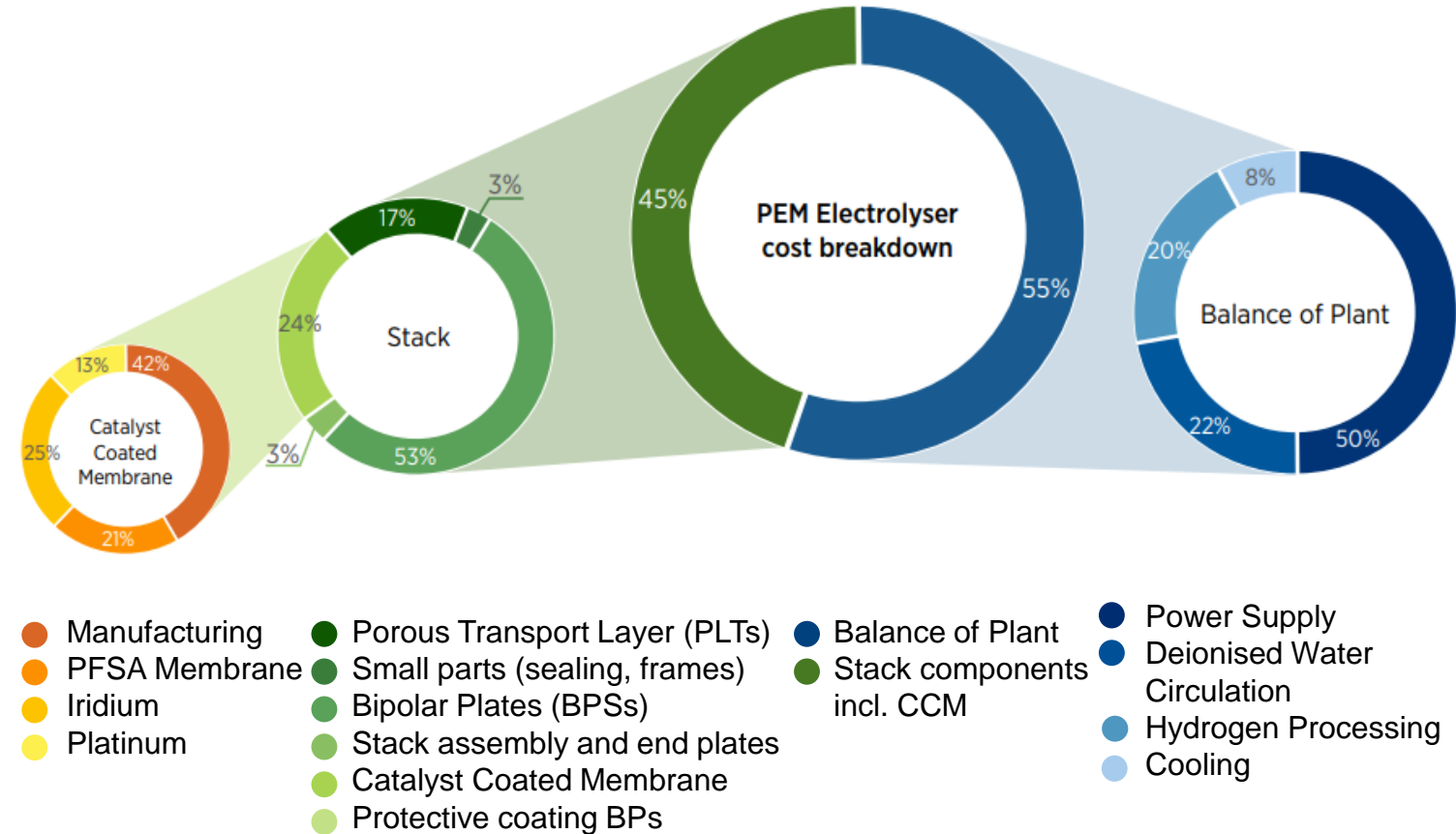


Source: SFA (Oxford)

Commercial water electrolysis technologies



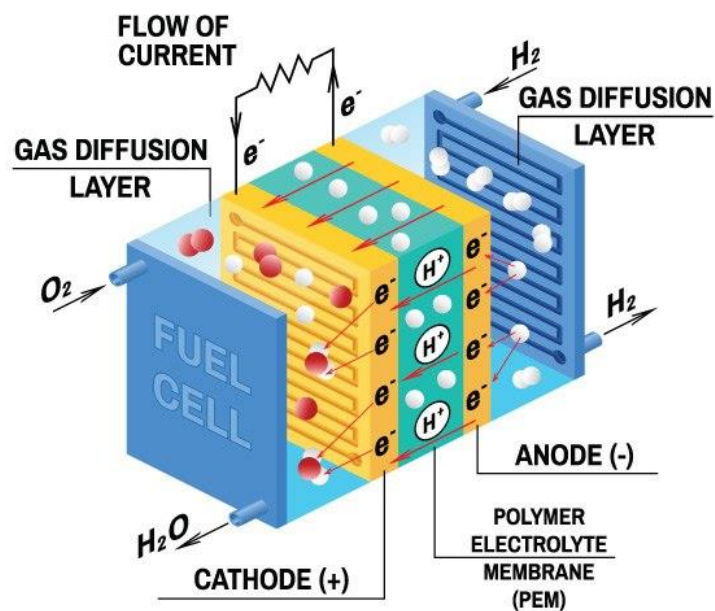
Cost breakdown for a 1 MW PEM electrolyser, moving from full system, to stack, to CCM



Scalable and modular from this ...

...via this...

POLYMER ELECTROLYTE MEMBRANE (PEM) FUEL CELL

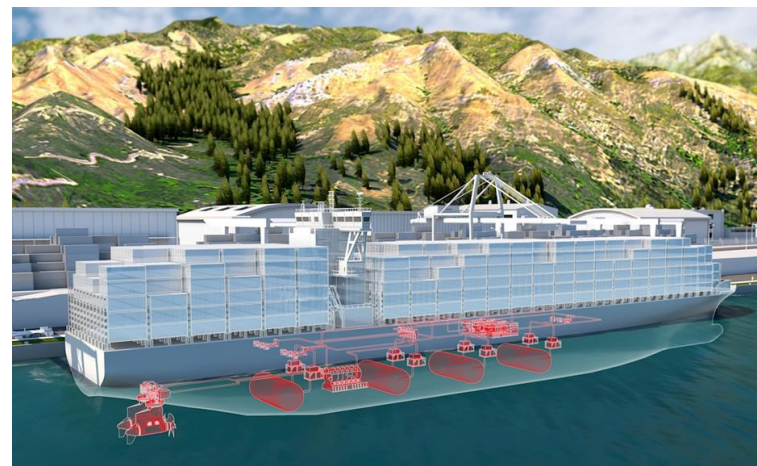


Source: sigmaaldrich.com



Source: Foshan Feichi fuel cell bus manufacturing facility

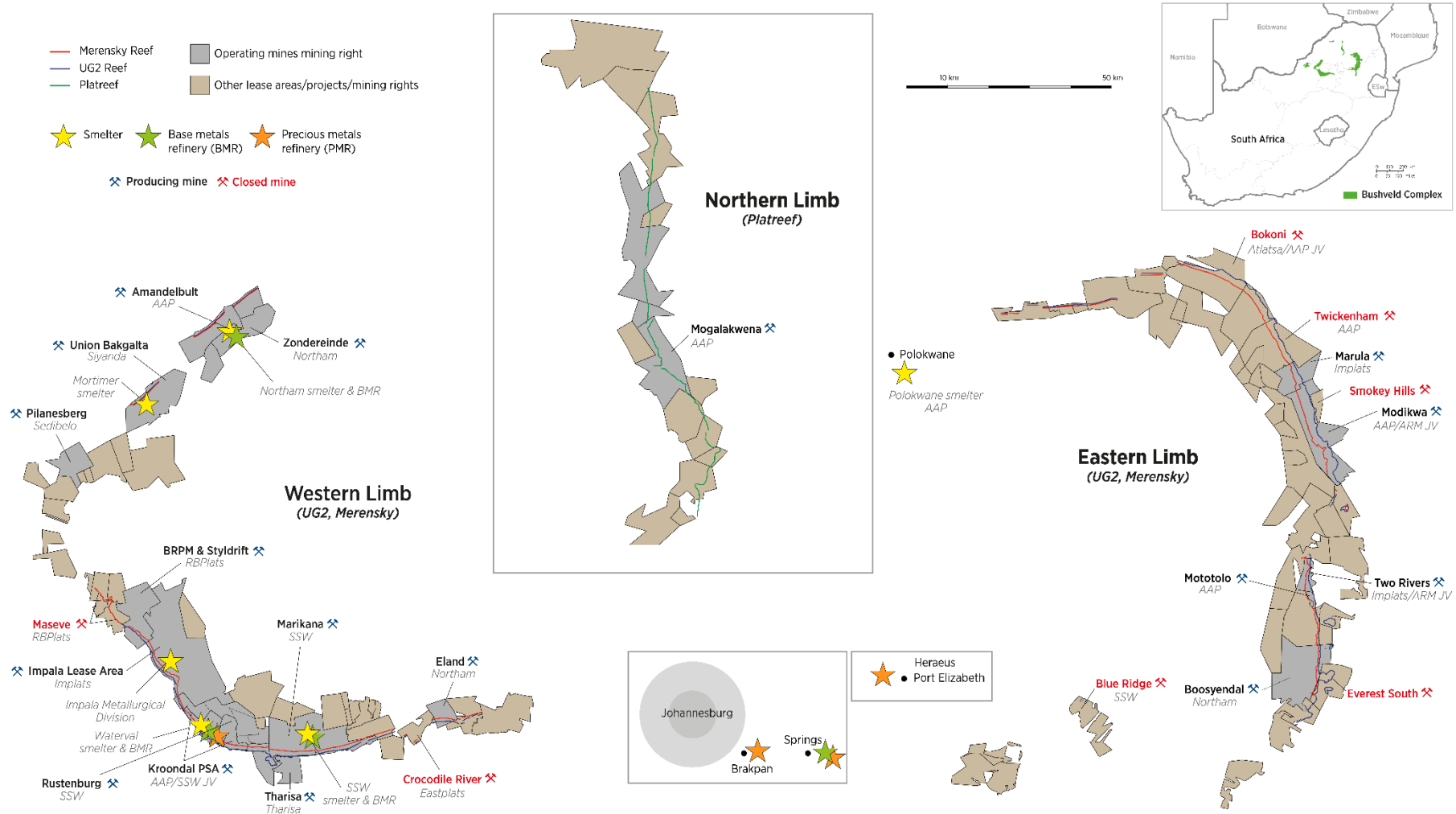
...to this



Source: ABB



Source: Alstom

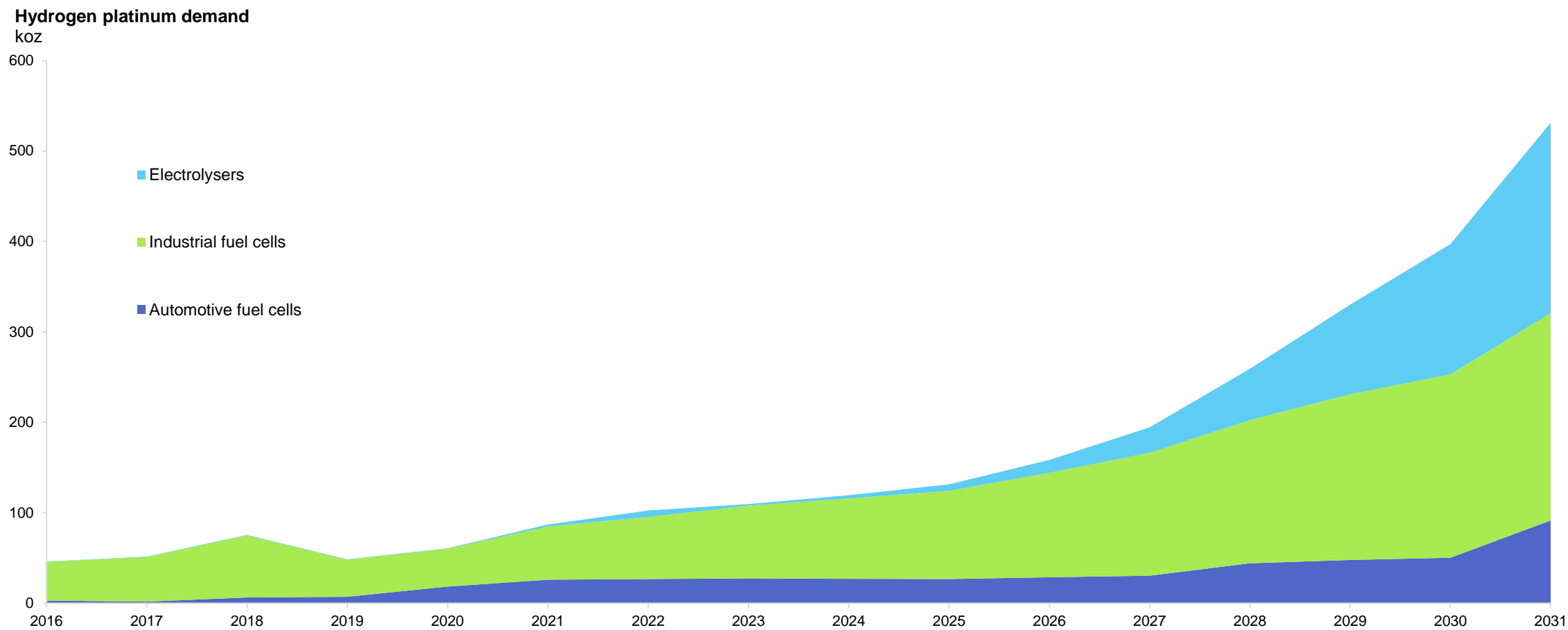


A secure supply chain for the hydrogen metals:

- ✓ 16 operating PGM mines plus various other sources (e.g. chrome mining and tailings reprocessing)
- ✓ fully capitalised
- ✓ huge resource base with several active projects
- ✓ known geology
- ✓ established, skilled labour force
- ✓ extraction technology refined over many decades
- ✓ mine-to-market routes in place

Source: SFA (Oxford)

The hydrogen economy needs iridium, ruthenium and platinum...and those metals need hydrogen



Source: SFA (Oxford)



consulting analysts in tomorrow's commodities and technologies

The Oxford Science Park

Consultant's Report Provision of PGM market intelligence and long-term metal price forecasts

SFA (Oxford)
September 2021

Strictly confidential

Prepared in confidence for
SFA (Oxford)



2050 PGM: Joining the Dots to 'Net Zero'



Zeroing in on 'Net Zero' Joining the dots on the implications for PGMs

As politicians target environmental ambitions for the rest of this century, SFA (Oxford)'s clients are asking for ever longer-term outlooks for PGMs. This has encouraged SFA to look beyond its established and definitive 10-year market outlook of PGM demand/supply modelling and forecasting - into less definitive uncharted waters and far distant horizons where big trends dominate small cycles and causation is less easily distinguished from correlation.

This unique 2050 report starts from 'home port' - SFA's 10-year view. Anchored in our tried and tested PGM demand/supply modelling which then extrapolates a framework of macroeconomic, environmental regulatory and technological scenarios.

Given that there are no exact compass bearings to take us 'from here to there', our projections beyond 2030 to 2050 identify a selection of high-level, well-reasoned potential pathways. These include a combination of global trends in population ageing and regional government indebtedness which are likely to impact many PGM end-uses, such as jewellery, autos and industrial applications. That said, the report also investigates today's PGM uses that may endure longer than many expect, and the potential for inflationary impacts on employment and depleted government finances to create a perfect storm for investors seeking safe havens, including PGMs.

SFA's broad-brush approach beyond 2030 reflects that the very long-term and broad horizons in this report prohibit accurate forecasting. We address present day concerns, including:

- What if Net Zero 2050 were achieved and the electric vehicle fleet dominated car buying?
- What does this mean for PGMs, battery materials... and supply challenges?
- What if the 'consensus' macro projections were to come true? What if we detour from these?

Finally, our report's extrapolations to 2050 provide an indicative view from SFA on the bandwidth of market balances and prices, highlighting content for PGM sector conceptual thinking.

The report will be available at the end of December 2021

Pre-order your report now for the special price of £14,000.

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