



# MATERIALENTWICKLUNG IN DER INDUSTRIE

Brennstoffzellenforum Hessen 28.10.2021 | Dr. Florian Eweiner

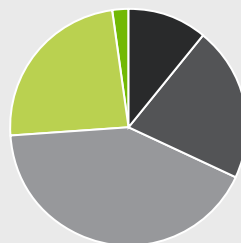
## AGENDA

- 1 | HERAEUS – A SHORT OVERVIEW
- 2 | HYDROGEN APPLICATIONS FOR CO<sub>2</sub> ABATEMENT
- 3 | MATERIAL DEVELOPMENT ON INDUSTRIAL SCALE

## A GLOBALLY SUCCESSFUL PORTFOLIO COMPANY



**31.5 bn. €**  
TOTAL REVENUE  
in 2020



Germany 11%  
Rest of Europe 21%  
Asia 42%  
America 24%  
Africa/Australia 2%

**7%** expenditures for  
RESEARCH &  
DEVELOPMENT



Based on revenues excl. Precious Metals

**11** market-oriented  
GLOBAL BUSINESS UNITS

**TOP 10**  
FAMILY-OWNED COMPANIES in Germany

More than  
**100** SITES  
in **40** COUNTRIES



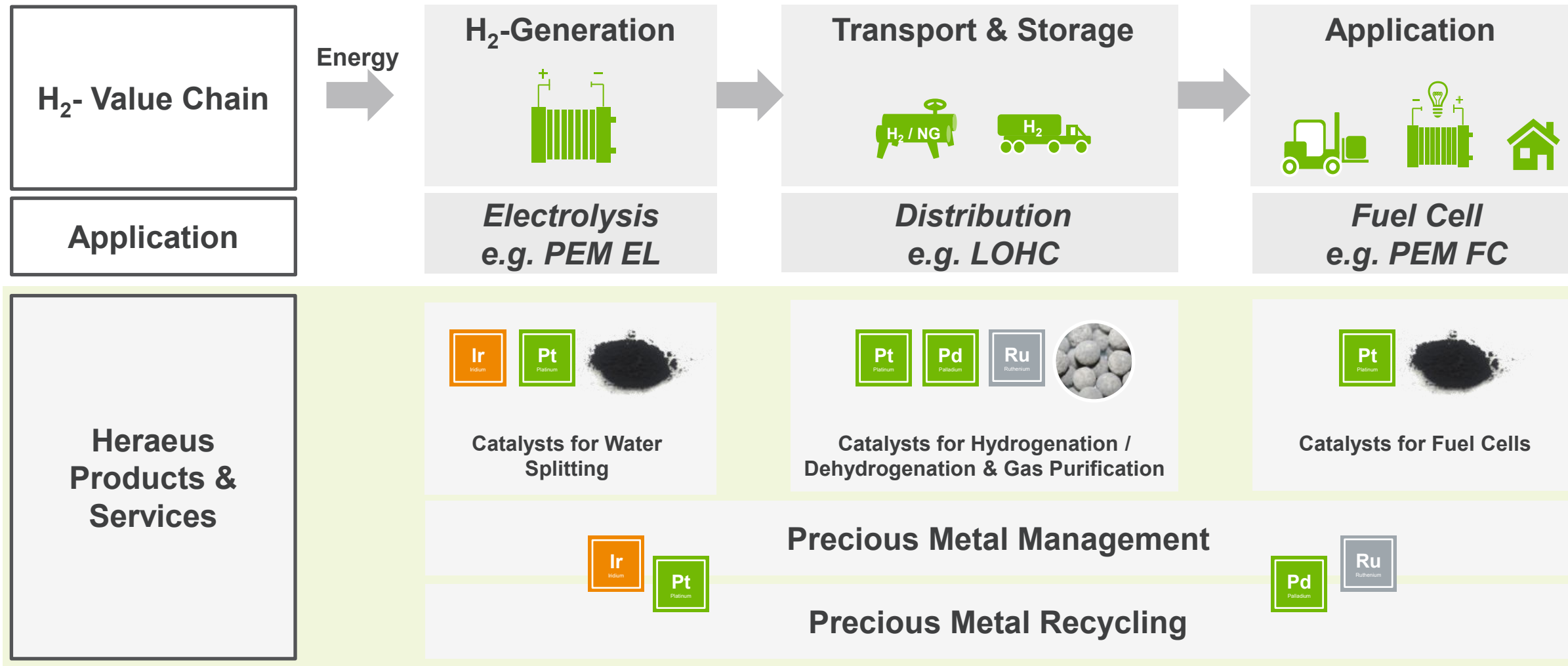
Approx.  
**14.800**  
EMPLOYEES  
worldwide



Germany 37%  
Rest of Europe 17%  
Asia 28%  
America 17%  
Africa/Australia 1%

including staff leasing

## PRECIOUS METALS AND THE HYDROGEN ECONOMY



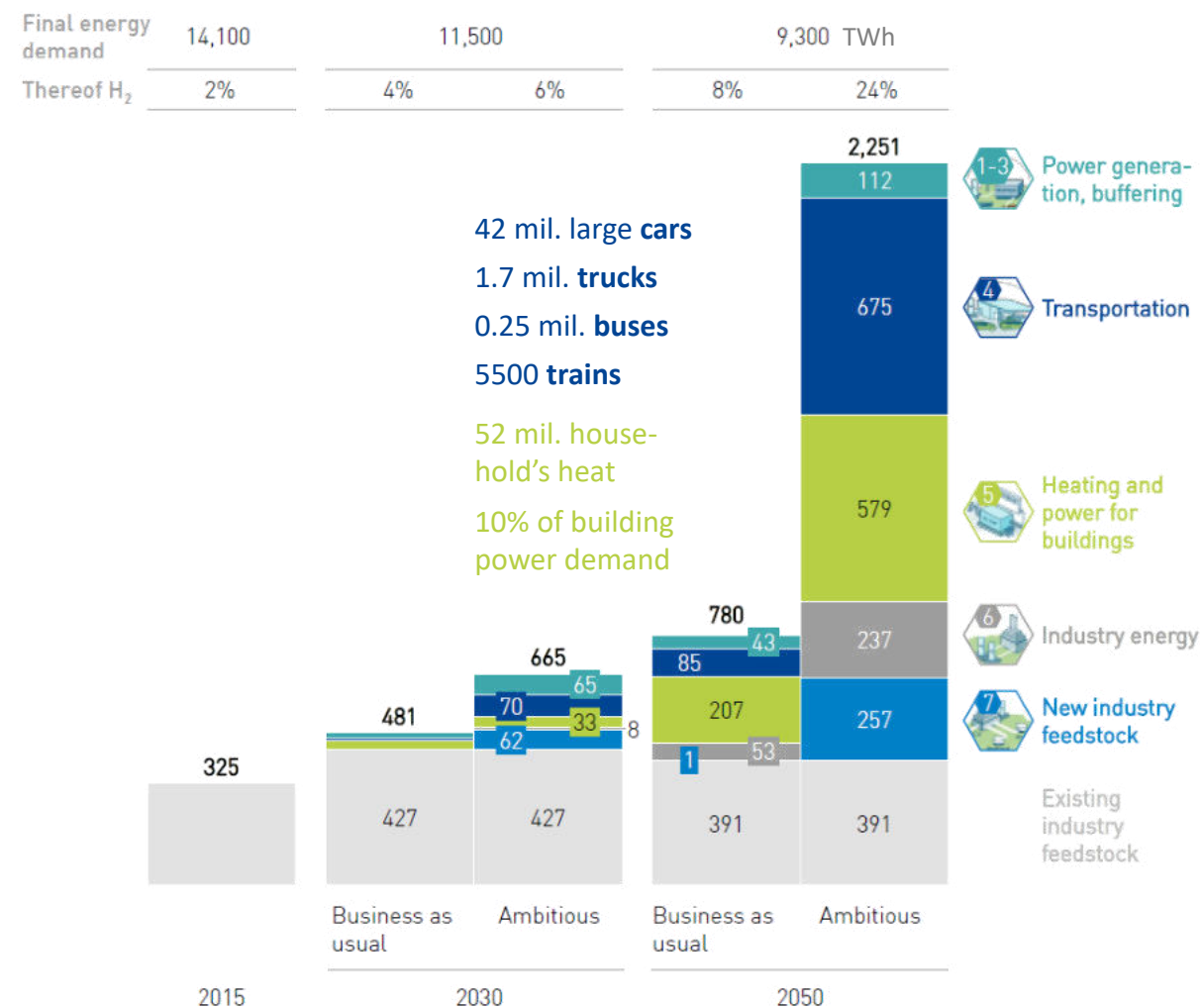
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## THERE IS HUGE POTENTIAL DEMAND FOR HYDROGEN IN EUROPE

### FCH JU sees potential for covering one quarter of European energy demand by H<sub>2</sub> in 2050

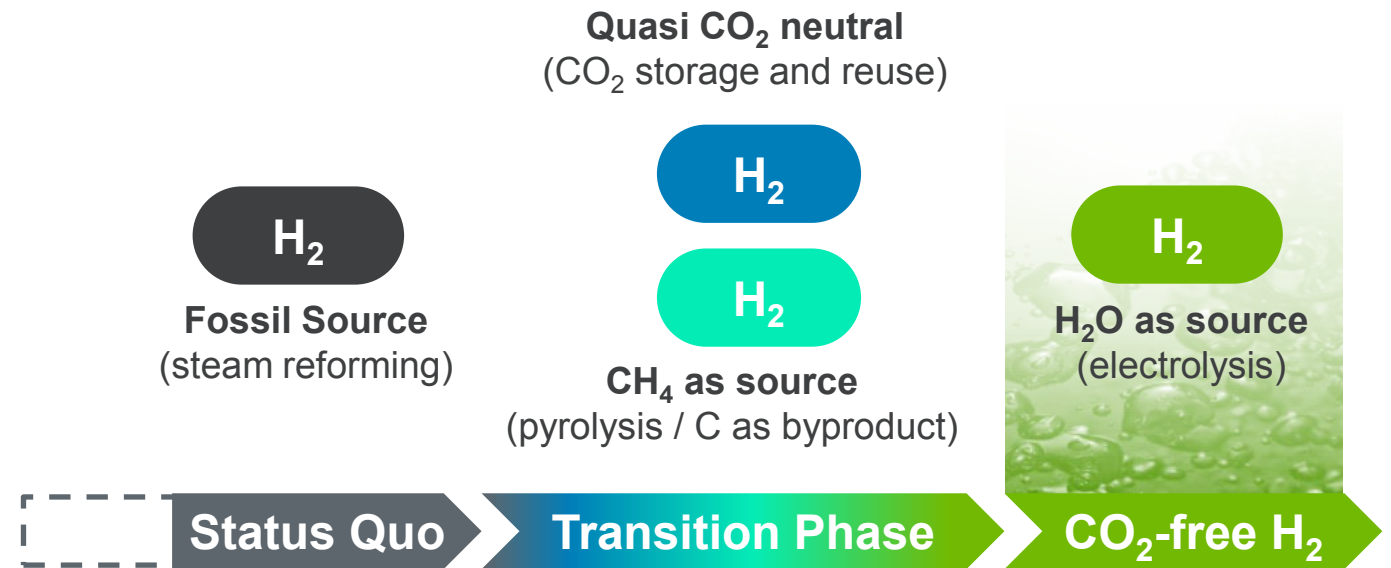
- Industry, transport and heating + energy have the biggest impact on CO<sub>2</sub> savings
- Use cases and demand for hydrogen just related to these sectors are enormous



# HYDROGEN CAN CLOSE 50% OF THE CO<sub>2</sub> EMISSIONS GAP – IF IT'S GREEN

**FCH JU estimates green H<sub>2</sub> is an indispensable component for reaching the 2-degree scenario by 2050**

- H<sub>2</sub> has to be CO<sub>2</sub>-free – transition phase with CO<sub>2</sub>-neutral technologies possible
- Goal: **green hydrogen via water electrolysis**



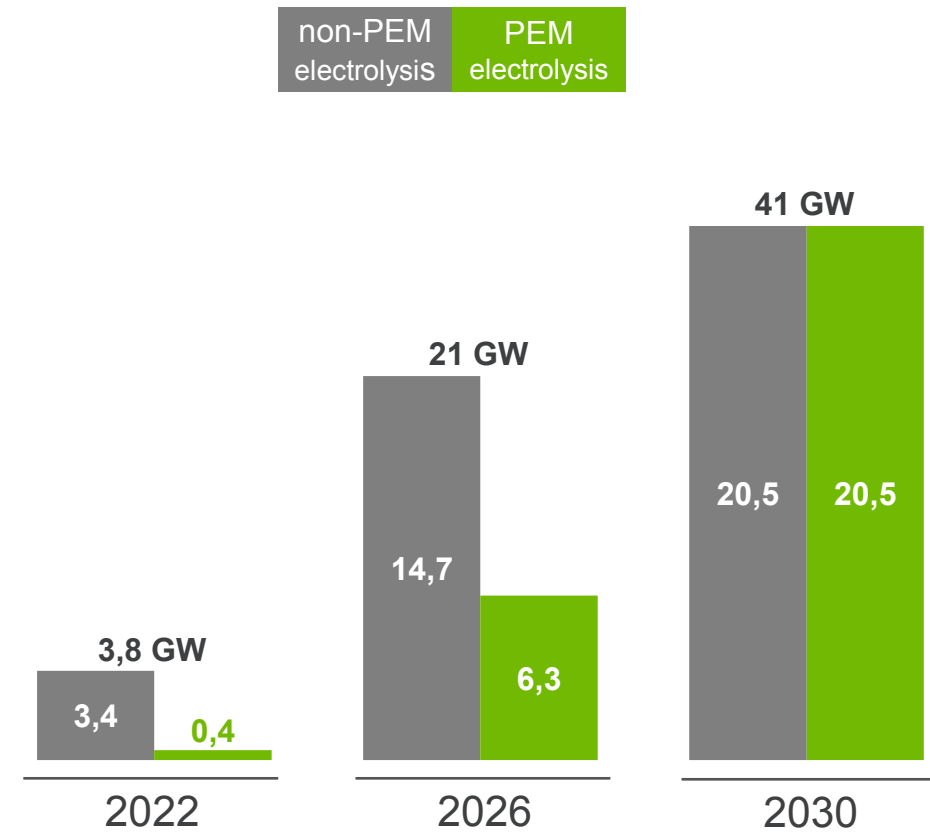
# ELECTROLYSIS ON THE RISE – PEM WILL PLAY A BIGGER ROLE

**Installed electrolysis capacity is expected to increase to ~40 GW in Europe in 2030**

- Most studies are aligned that the share of PEM electrolysis will rise to 50% during that time
- With additional PEM installations the need for precious metal Ir will increase

⇒ Sustainable precious metal sourcing strategies have been established from the beginning on

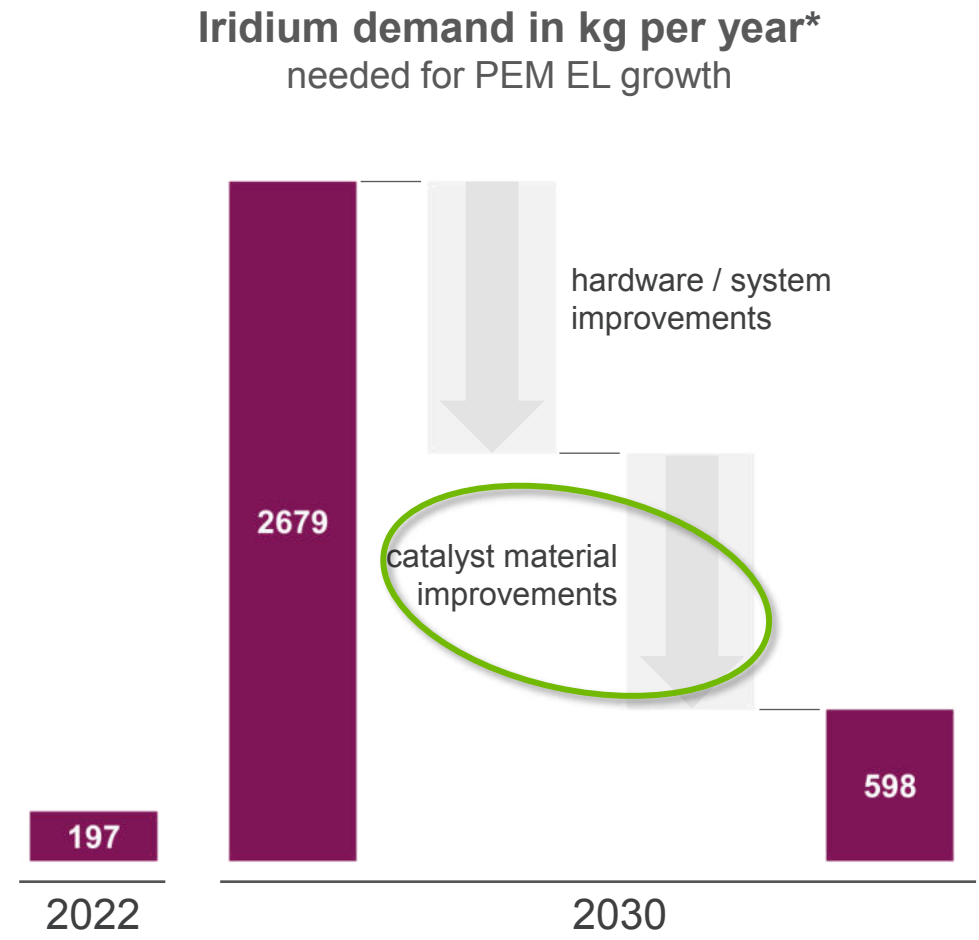
## Outlook: electrolysis power installed in Europe



# IRIDIUM DEMAND OF PEM-EL GROWTH IS SIGNIFICANT

## What does this mean for Iridium demand?

- with unchanged loadings of ca. 1 kg Iridium per MW, the growth of PEM-EL would cause a demand of ca. **2.7 t Ir** per year in 2030
- improvements in hardware, system and operation can enhance efficient use of the precious metal only partially
- improved **catalyst materials can further reduce the Iridium demand** significantly

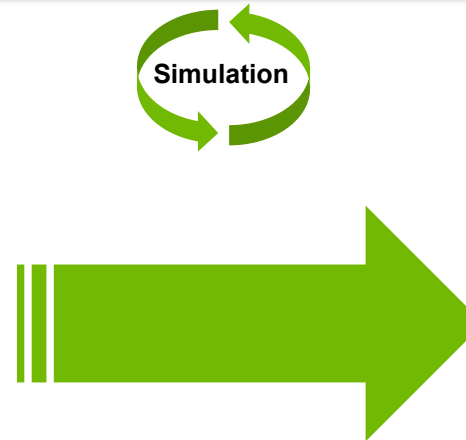
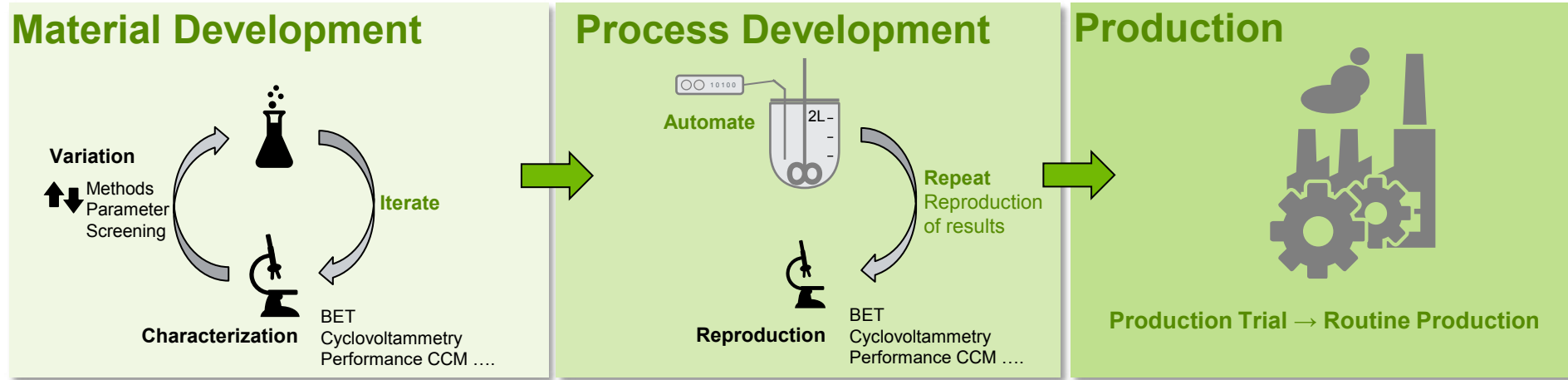


\*) estimation from recent progress reported

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# MATERIAL DEVELOPMENT AND SCALE UP

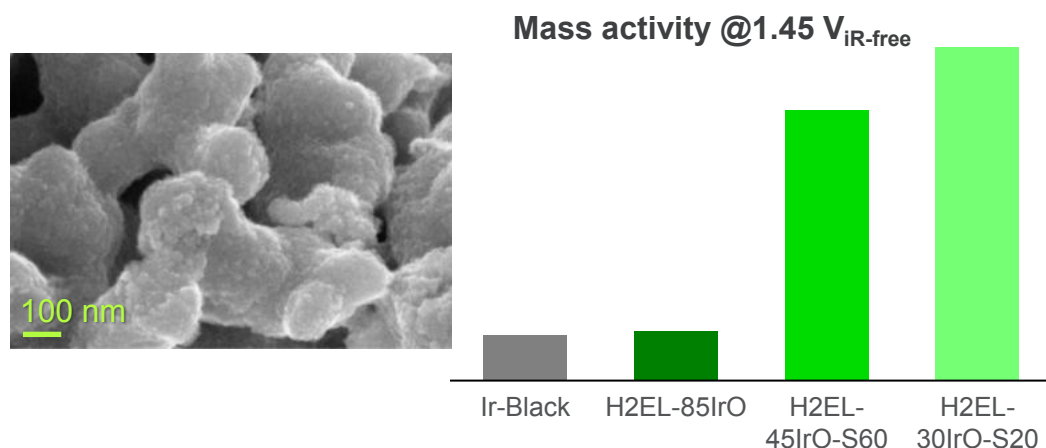


Wet filter cake (~6 kg)

## INNOVATION FOR CONTROLLING THE USE OF IRIDIUM

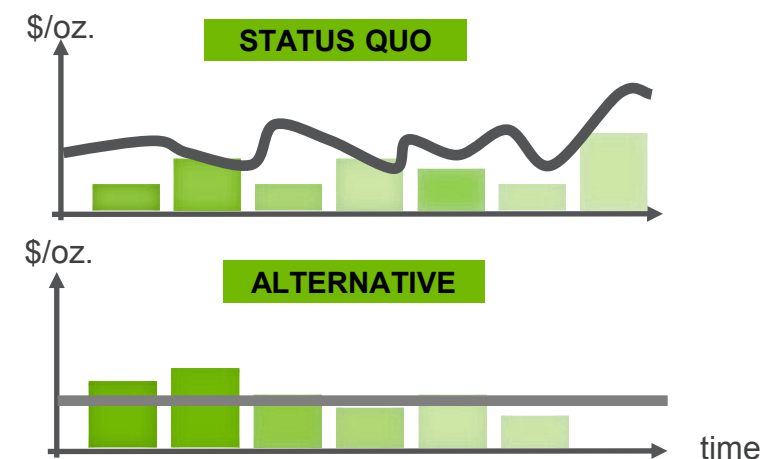
## Material concepts to optimize Ir efficiency

- Optimized electrode processability through **Ir black**
- Reduction of Ir up to **50%** in the electrode through **unique morphology of IrO<sub>2</sub>**
- **GW industrialization** of PEM electrolysis with **supported** Ir-based materials



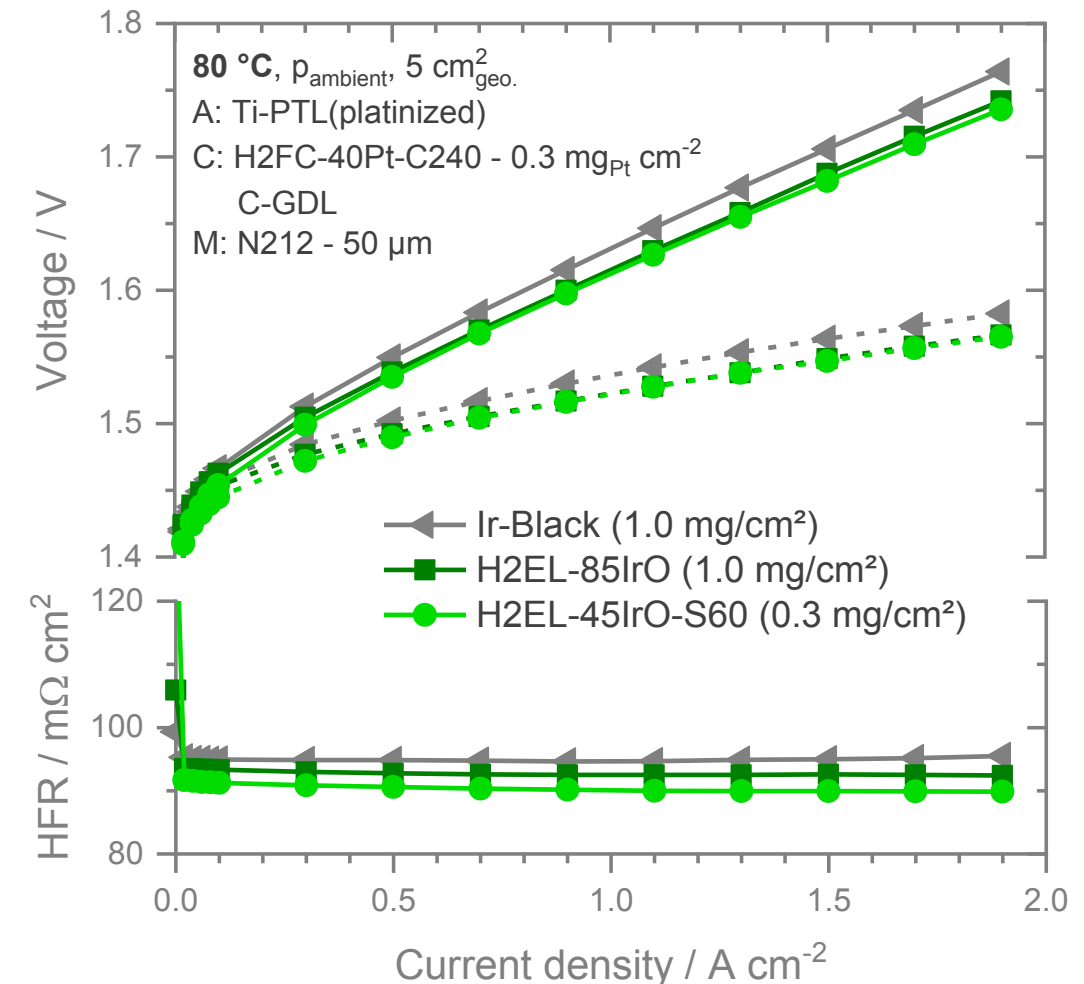
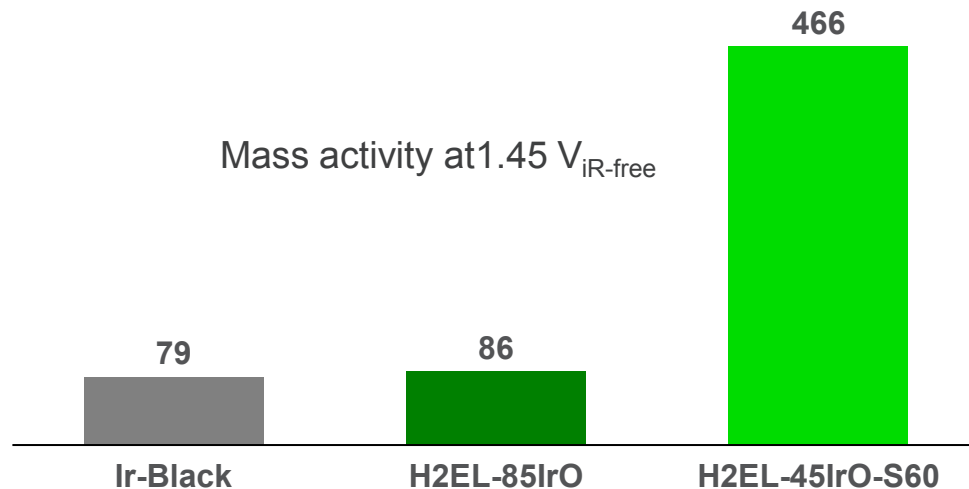
## Trading &amp; Recycling concepts

- **Management of price volatilities**
- **Recycling strategies** from new waste streams with high return rates
- **Expansion of recycling capabilities** to match requirements for PEMs



## Ir-ANODE CATALYSTS – HIGH PERFORMANCE AT VARIOUS LOADINGS

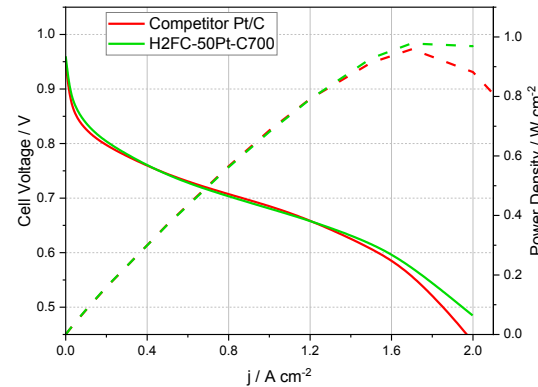
- H2EL-IrO performance at the same level as H2EL-Ir → high volumetric density helps at lower loadings to maintain a high quality electrode
- At low Ir-loadings supported materials brings benefit in electrode quality → enables electrolysis at  $\sim 0.3 \text{ mg}_{\text{Ir}}/\text{cm}^2$  at same performance



# PEM FC CATALYSTS BY HERAEUS – VARIOUS USE CASES

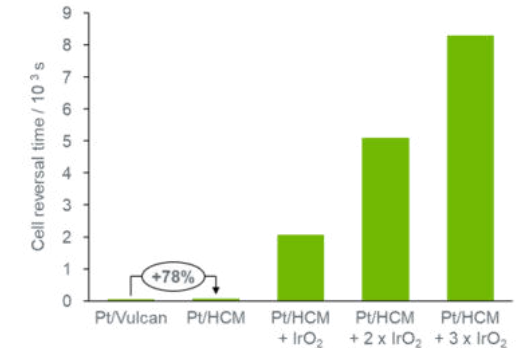
## Allrounder

- 10 to 60 wt.% Pt on **standard carbon support**
- Optimized Pt surface utilization



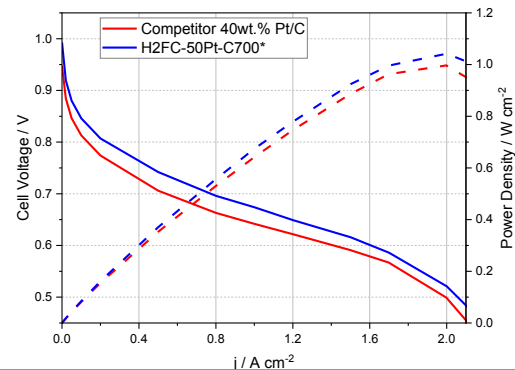
## Robustness

- 10 to 40 wt.% Pt on tailored carbon
- High **carbon corrosion stability**
- OER additive for H<sub>2</sub> starvation stress



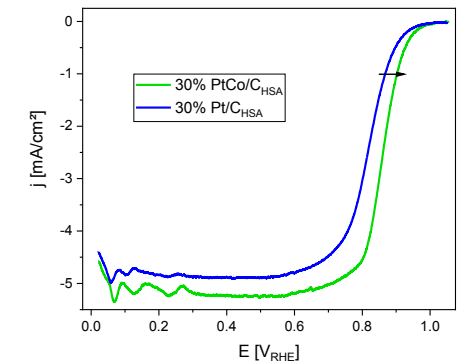
## Specialists

- 10 to 60 wt.% Pt on modified carbon support
- High Pt surface utilization under **dry conditions**



## Activity

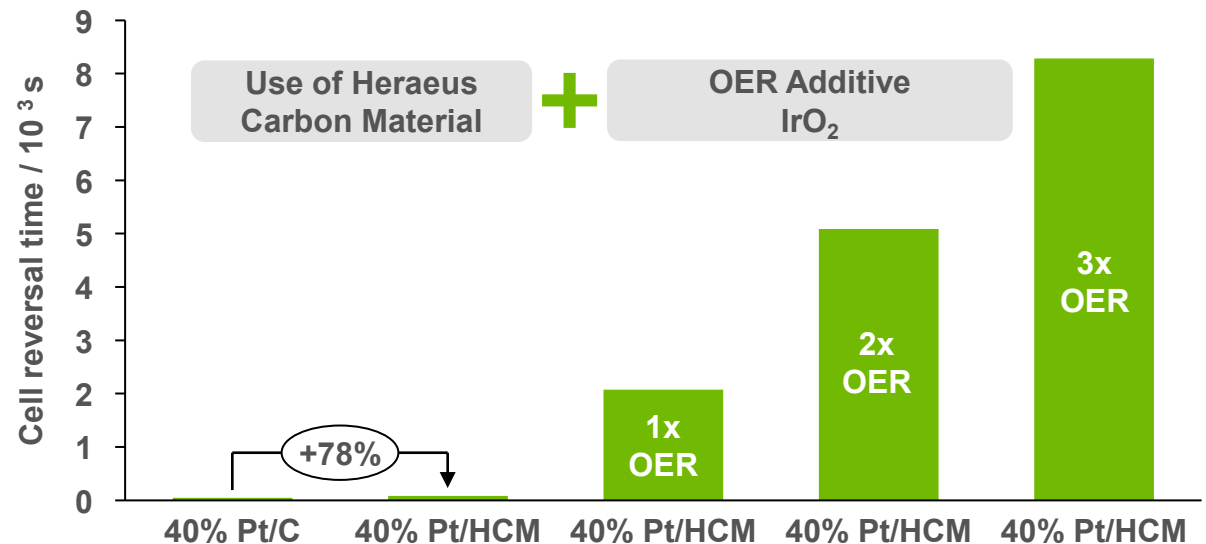
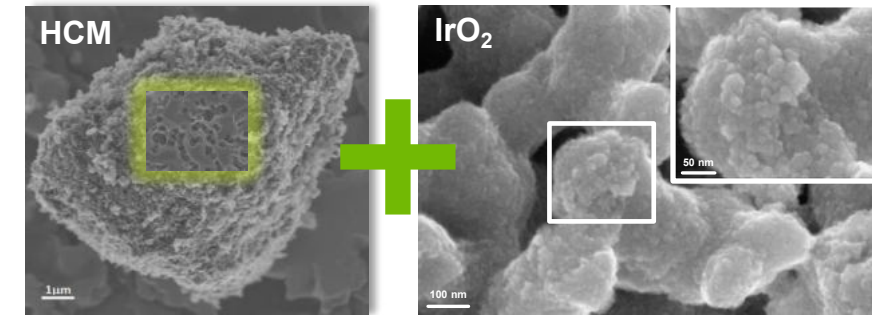
- 10 to 40 wt.% PtCo alloy on various carbon materials
- High intrinsic activity
- Pt savings



# HIGH CORROSION RESISTANCE UNDER H<sub>2</sub> STARVATION

## Pt on Heraeus Carbon Materials + Ir-Additive

- Pt on in-house produced carbon (**HCM**) → improved **corrosion resistance** under cell reversal conditions
  - Addition of high surface Iridium dioxide **IrO<sub>2</sub>** → **Adjustable cell reversal tolerance** (CRT) time fulfilling the application requirements
- ⇒ No significant performance loss observable
- ⇒ **Longer lifetime** of fuel cell stack with respect to starvation events
- ⇒ **Combination** of Pt/HCM & IrO<sub>2</sub> for full benefit



# A HYDROGEN STRATEGY REQUIRES A RAW MATERIAL STRATEGY

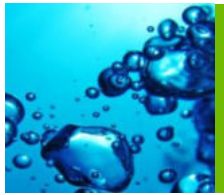
European and National Hydrogen Strategies do not consider requirements for critical raw materials for the generation and use of hydrogen sufficiently! We plead for...

- Increase R&D for further **reduction of Iridium loadings**
- Increase R&D for **Recycling of Iridium**
  - Open up new recycling streams
  - Higher recycling rates
  - Subsidies for investments in recycling operations for precious metals from hydrogen applications
- Introduction of “**Top-Runner**” Programs
  - Link subsidies for PEM Electrolyzers to an efficient use of Iridium
- **Stronger involvement of producers of critical components** for electrolyzers in the political discussion concerning the ramp-up of an hydrogen economy



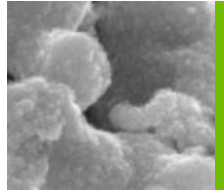
## SUMMARY

Heraeus is a competent partner for **material innovation**, **recycling** and **precious metal management**.



### PEM electrolysis for green Hydrogen

- PEM electrolysis will grow, as green and decentralized production of hydrogen becomes imperative.



### Critical raw material: Iridium

- Innovations at Heraeus facilitate PEM EL growth by mitigating supply- and price risks



### Stable, reliable materials for fuel cells

- Combining Heraeus competencies in carbon, heterogeneous catalysis and precious metals

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