Aalto Hydrogen Innovation Centre

Dr. Sam Cross

Co-ordinator, Aalto Hydrogen Innovation Center

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Energia-alan tutkimusseminaari

30.1.24

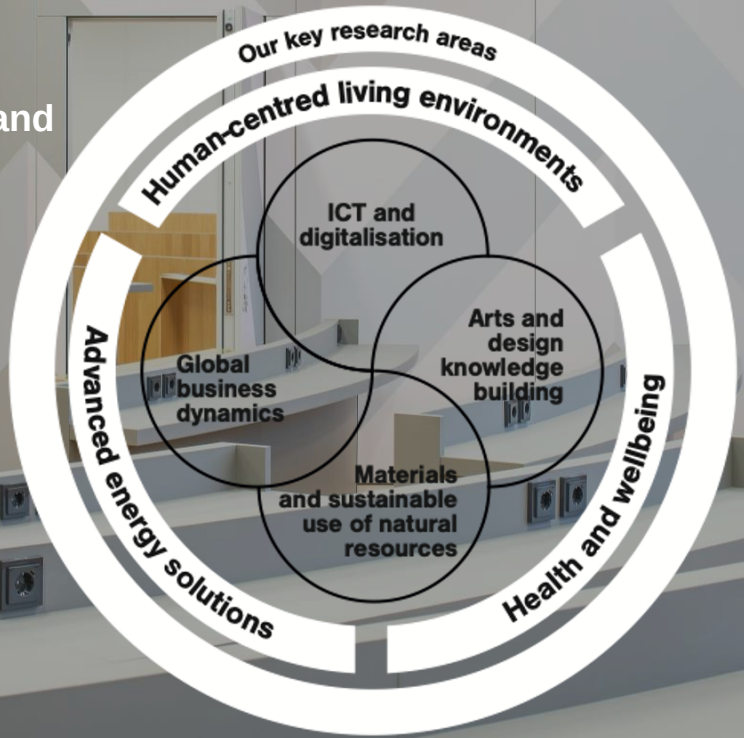
A quick introduction to Aalto:

Six dynamic schools work across cross-cutting research areas…

School of Arts, Design and Architecture

School of Business

School of Chemical Engineering



School of Electrical Engineering

School of Engineering

School of Science

….There is H_2 related research across all schools…

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Aalto Hydrogen Innovation Center

Building an ecosystem for the pathway towards a hydrogen economy

Established September 2023

The H_2 Innovation Center works to enable a sustainable hydrogen society by facilitating world-leading research at Aalto, and collaboration between our research community, companies, policymakers and external research organizations.

The first priority of the school will be the creation of a **H2 doctoral school** with collaborative topics across schools. First doctoral candidates will start in autumn 2024.

Leadership team:

Director - **Prof. Mika Järvinen**

Head of H_2 doctoral school – **Prof. Tanja Kallio**

Head of H_2 infrastructure – **Prof. Marko Hinkkanen**

Center Co-Ordinator – **Dr. Sam Cross**

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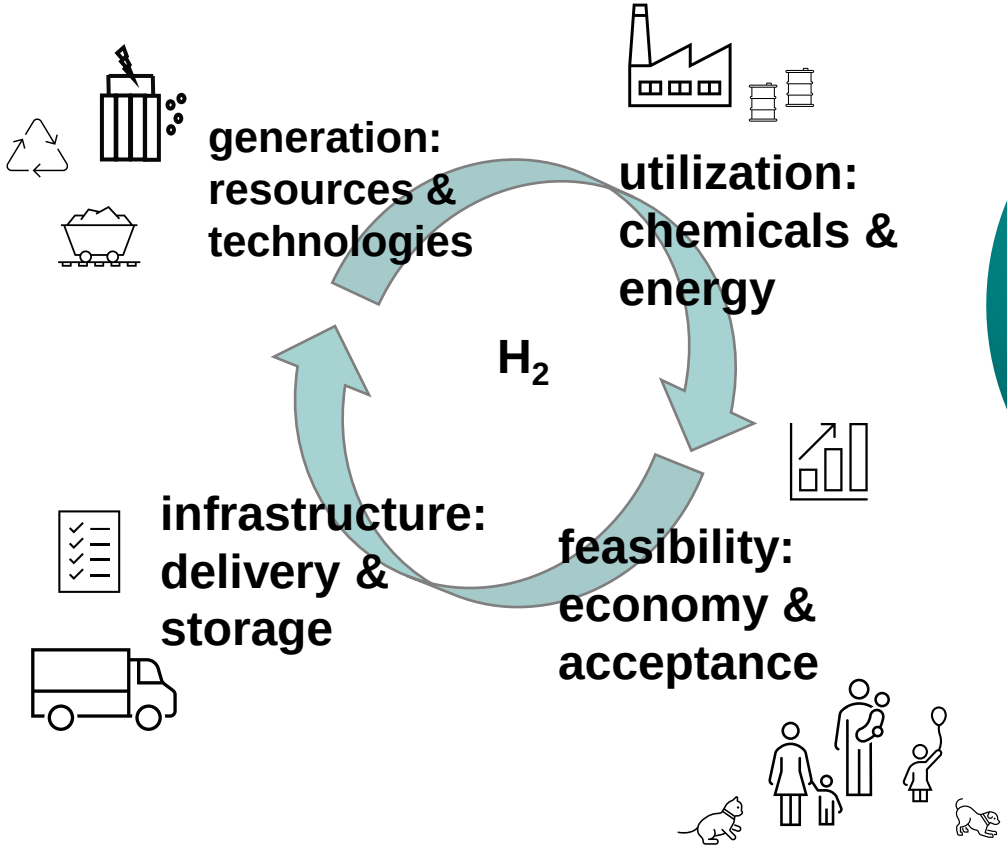
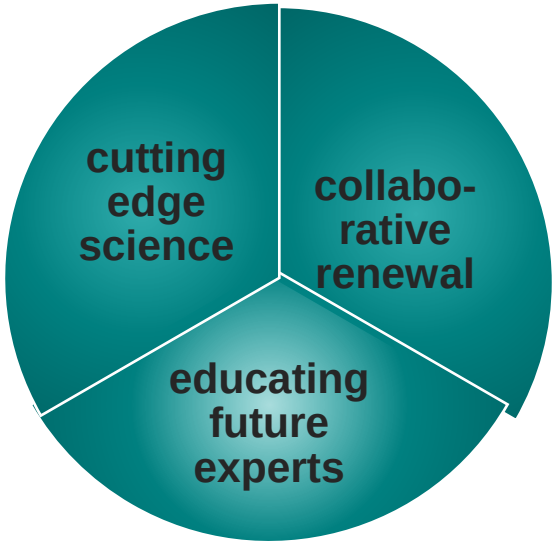
Join the Center mailing list via this link:

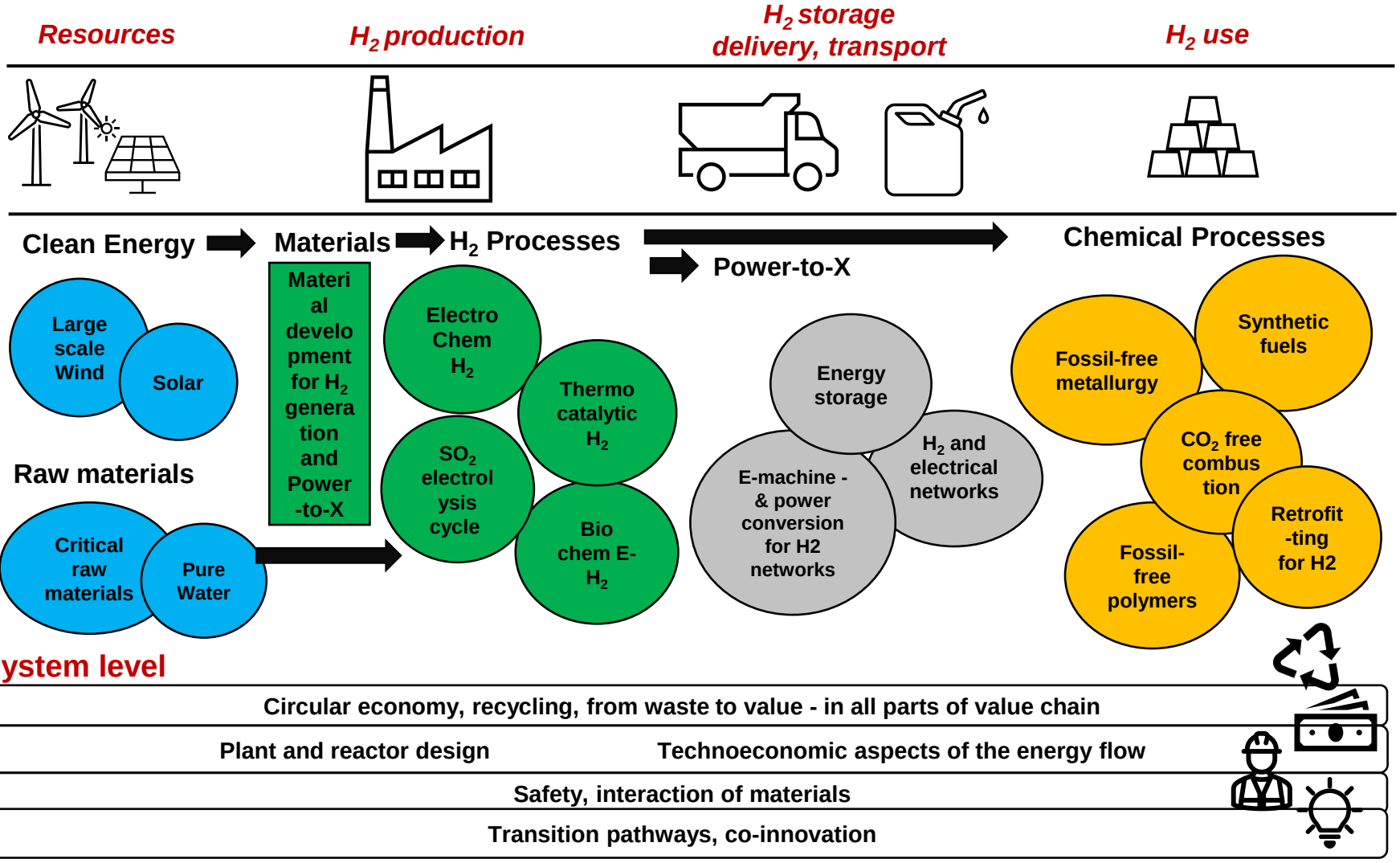
Center website:

www.aalto.fi/H2

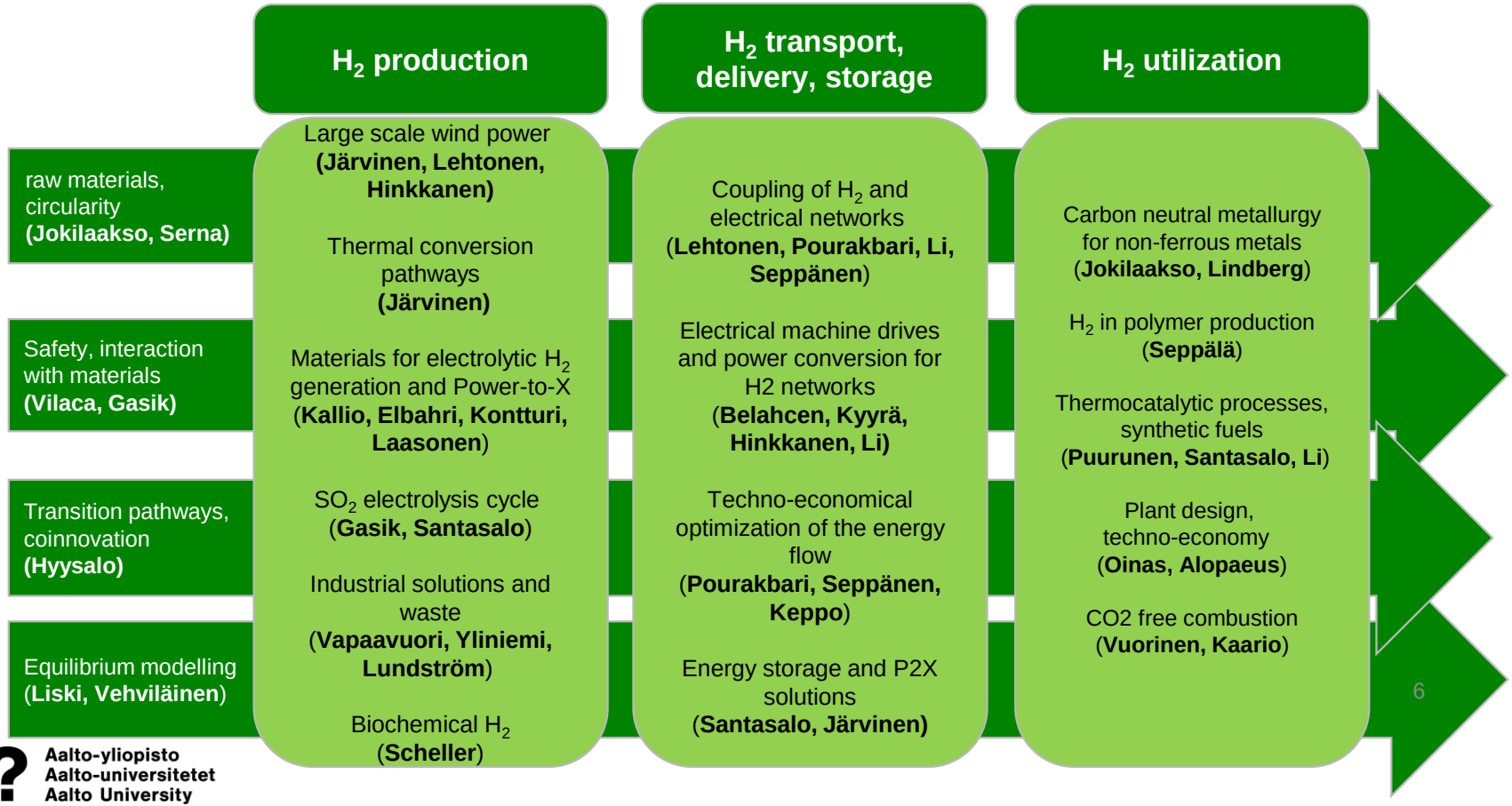
AaltoH$_2$IC: Enabling a sustainable H$_2$ Future






Resources
H_2 production
H_2 storage delivery, transport
H_2 use
Clean Energy
Materials
H_2 Processes
Power-to-X
Chemical Processes
Large scale Wind
Solar
Raw materials
Critical raw materials
Pure Water
Material development for H_2 generation and Power-to-X
Electro Chem H_2
Thermo catalytic H_2
SO_2 electrolysis cycle
Bio chem E-H_2
Energy storage
E-machine - & power conversion for H2 networks
H_2 and electrical networks
Fossil-free metallurgy
Synthetic fuels
CO_2 free combustion
Retrofit -ting for H2
Fossil-free polymers
System level
Circular economy, recycling, from waste to value - in all parts of value chain
Plant and reactor design
Technoeconomic aspects of the energy flow
Safety, interaction of materials
Transition pathways, co-innovation

H_2 investigations at Aalto (for reference)



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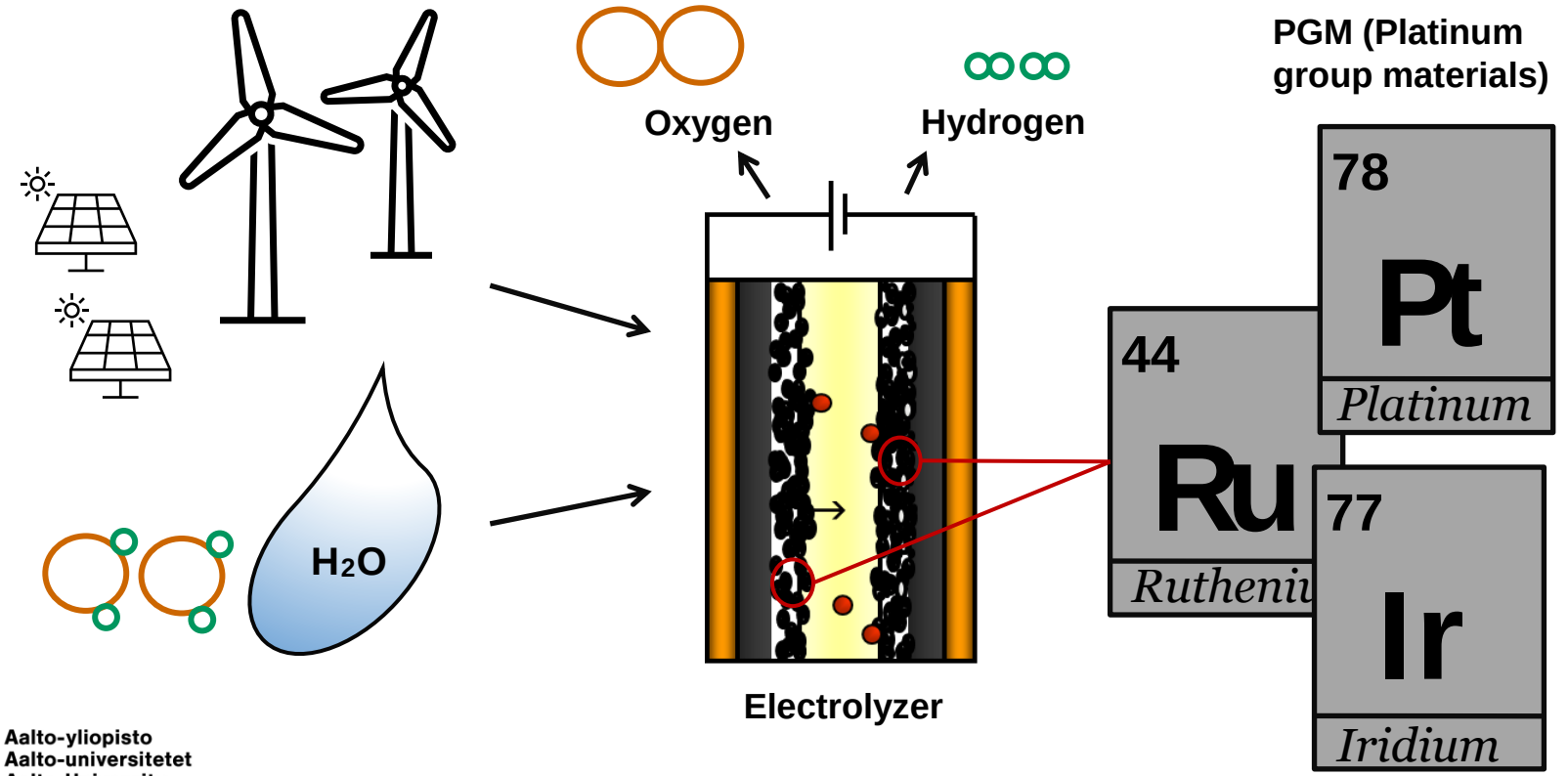
Collaborating partner organizations

(Research forum)

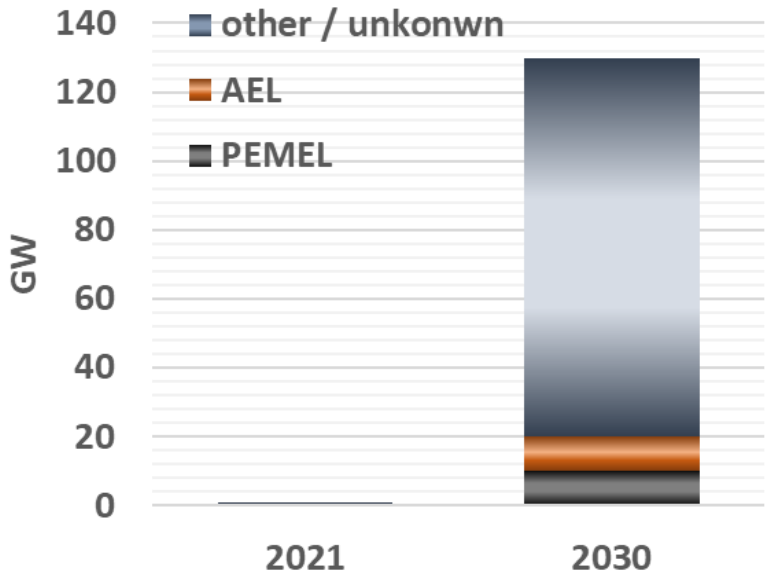
Case study of our H2 related research: New Electrocatalyst materials

Tanja Kallio and her group

Limited amount of electrocatalysts



Global Electrolyzer Capacity Increase ~250 times?



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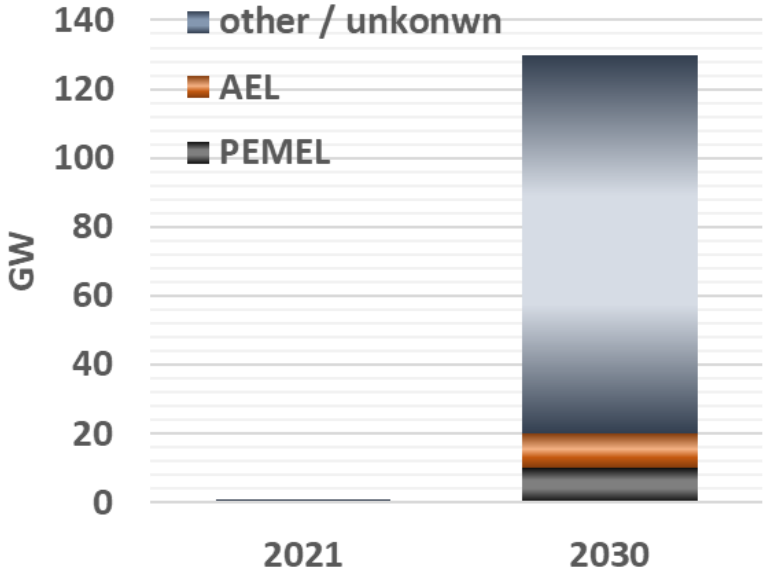
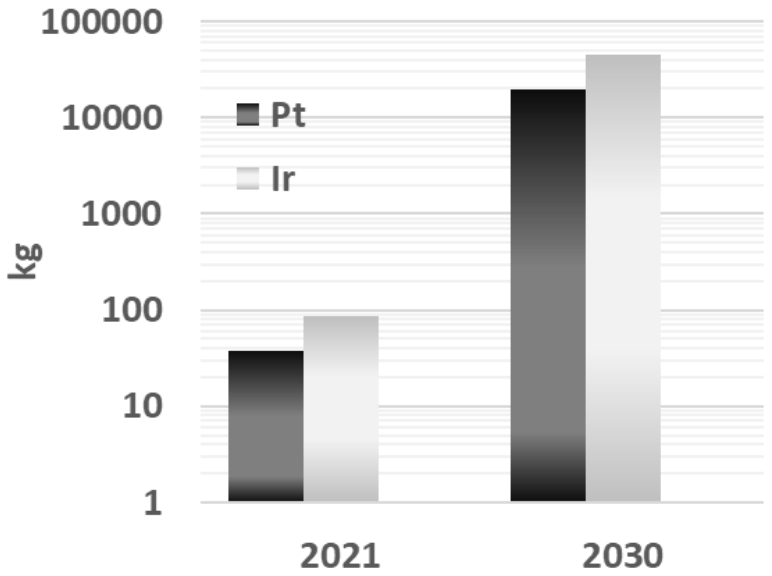
IEA: Global Hydrogen Review 2022
IEA: The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions 2022

Global Electrolyzer Capacity Increase ~250 times?

PGMs demand for PEMEL increase 500 times?





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IEA: Global Hydrogen Review 2022
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Material & Energy Efficient Electrocatalyst

- Reducing inactive material
- Reducing overall losses
- Long lifespan

Alternative Electrocatalysts

- More abundant materials
- Overall losses in electrolyzers?

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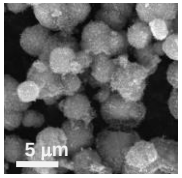
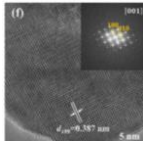
Alternative Catalysts for H_2 and O_2 Generation in PEM and AM Electrolyzers



TM-O$_x$

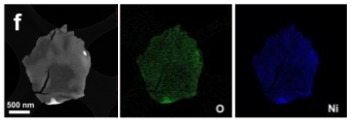
M. Rosenthal et al. in progress



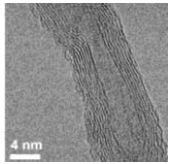
$La_{0.7}Sr_{0.3}Fe_{1-x}Ni_xO_{3-\delta}$

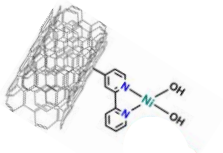
L. Fan et al. Nanoenergy 93 (2022) 106794

QD-NiO$_x$

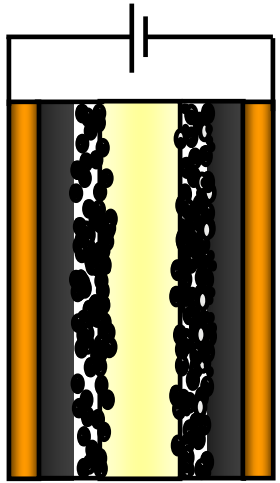


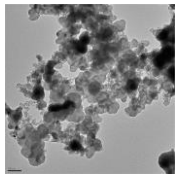
B. Jin et al. submitted





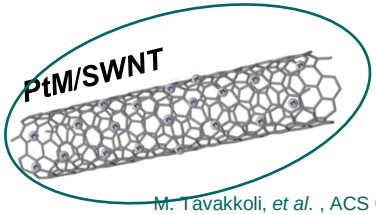
Ni-bipy-MWNT

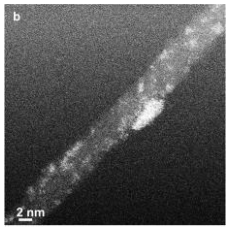




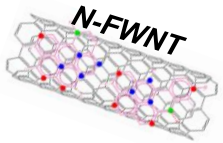
MoC/C

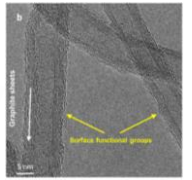
S. Tuomi et al. Journal of Catalysis 334 (2016) 102



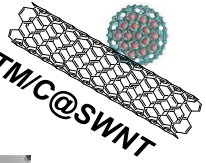


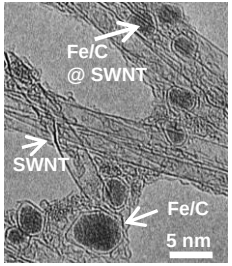
M. Tavakkoli, *et al*. , ACS Catalysis 7 (2017) 3121
T. Rajala *et al*. Applied Catalysis B: Environmental 265 (2020) 118582
F. S. M. Ali et al. Applied Catalysis B: Environmental 315 (2022) 121541





S. Tuomi *et al*. ChemCatChem 2018
F. Davodi *et al*., J. Catal. 353 (2017) 19





M. Tavakkoli *et al*. Angewandte Chemie 54 (2015) 4535.
F. Davodi *et al*. J. Colloid Interface Sci.. 556 (2019) 180.

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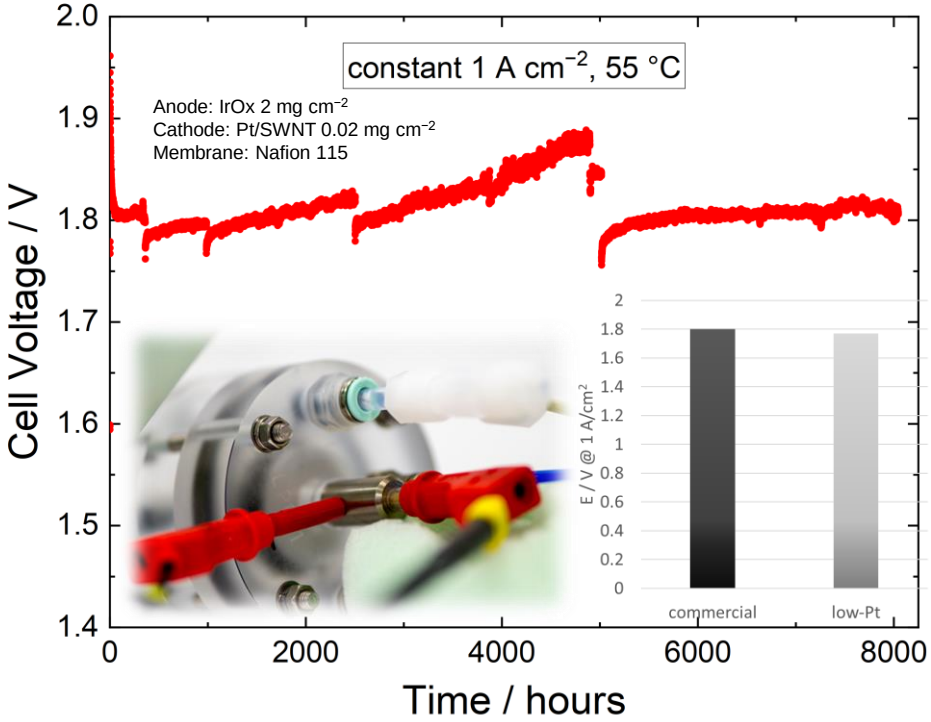
M. Tavakkoli et al. ACS Catalysis 7 (2017) 8033

Successful new Pt/SWNT electrode

SWNT = Single Wall Carbon Nanotube

- PGM loading cut by 90% for H_2 reactions
- 8000 h demonstrated in a lab-scale electrolyzer
- **Selected as a cutting-edge EU-funded innovation**.



T. Rajala *et al*, Applied Catalysis B: Environmental 265 (2020) 118582.

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Next steps for the Center

- **Launch of Hydrogen doctoral school with collaborative topics, first students to start autumn 2024**
- **Enhancing collaboration with other research organizations & industry, including joint doctorates**
- **Event series: Hydrogen Breakfast series (see next slide).**

Upcoming event:

Hydrogen Breakfast series #3 14.2.24

Energy networks for the Hydrogen Economy

Register via the QR code or our website

Our breakfast event series combines perspectives from both Aalto academics & industry, with each event built around one thematic area

14th February 0830-1000, Physical/Online

Hosted by Prof. Markko Hinkkanen, School of Electrical Engineering, Aalto University

Speakers:

Sara Kärki, Senior Vice President, Hydrogen Development, Gasgrid

Janne Seppänen, Professor of Practice, School of Electrical Engineering, Aalto University & Senior expert, Fingrid

Kimmo Karhu, Assistant Professor, School of Science

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Thanks everyone!

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Shaping a sustainable Hydrogen Society

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