Summary Report

The Future of Green Hydrogen Challenges and Opportunities Workshop

16th January 2025
Online (Microsoft Teams)

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Key resources

- Webinar slides

Overview

This workshop explored Challenges and Opportunities for the future development of the green hydrogen industry, across three key themes:

1. Policy and Marketplace
2. Systems and Technology
3. Community readiness

The concept of green hydrogen was introduced, defined and contextualised in the context of the global transition to renewable energy sources. The FreeHydroCells project was presented as an example of a novel technology aiming to positively disrupt the existing marketplace.

Summary

- Session introduction: Martin Galvin opened the session, setting the stage for discussions around green hydrogen and the FreeHydroCells project.
- Understanding green hydrogen:
  - Explanation of green hydrogen, its differentiation from other hydrogen types, and the mechanisms FreeHydroCells employs for its production.
  - Highlighted hurdles, including policy challenges and societal acceptance, that need to be addressed to facilitate widespread adoption.
- Overview of FreeHydroCells: Dara Fitzpatrick introduced the FreeHydroCells project, outlining its mission to advance green hydrogen production through sustainable and innovative mechanisms
  - Comparison with other renewable energy sources: Contrasted green hydrogen with solar energy, emphasising that solar setups have lower efficiency and degrade over time, whereas FreeHydroCells offers a more sustainable and higher-efficiency alternative.
  - Sustainability and cost-effectiveness: FreeHydroCells electrolysers are designed without using rare or critical raw materials, making them environmentally benign, cost-effective, and sustainable.

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- Multi-pronged: Potential to solve numerous production and storage energy challenges simultaneously:
    - Reducing dependency on the grid, with an off-grid local, distributed, production and storage solution.
    - Avoiding the use of critical raw materials, thus sustainable.
    - Local capability to maintain and operate the solution brings energy security to each community while ensuring we stop doing harm to our planet.
    - The enabling of a localized energy production avoids the need for problematic and costly transportation.
    - Offering a cost-efficient and sustainable alternative to current renewable technologies.
- Hydrogen storage and sharing: An offshoot idea of FreeHydroCells is the development of a sustainable local storage solution for hydrogen, enabling communities to produce, store, and share energy efficiently.
- Broader vision of "positive disruption": FreeHydroCells aims to drive positive disruption by enabling small-to-large scale communities of any size to generate and manage their own off-grid energy production/storage efficiently and at an affordable low cost in a long-term sustainable fashion, fostering decentralisation and independence. The ultimate goal is to democratise energy production, enabling local communities to become self-sufficient and less dependent on the grid. It also brings home to the community the value of harvesting energy and promotes the optimum use of hard-earned energy production and storage, ensuring a more rapid transition and more immediate action to reduce the damage to our environment at the same time.
- Life Cycle Assessment to be conducted later this year in the project, and this workshop can assist our preparations for this activity.

- Breakout discussions: Participants engaged in breakout rooms to discuss key challenges and opportunities to align green hydrogen technology with current market dynamics and societal readiness. Common themes of the discussion are summarised below.

Challenges and Barriers

Policy and Marketplace

- Meeting requirements essential for commercial development (e.g., comprehensive Life Cycle Assessment, certification).
- Must develop a comprehensive understanding of the green hydrogen market, industry perspectives, and current EU policies to align the project's strategies with existing frameworks and future opportunities.
- Understanding current government subsidies and their motivations.
- Incentives favouring existing fossil fuel energy production/integration routes.
- Entrenched lobby groups / politically motivated actors.
- Cost of PV is much less in EU due to LCOE, up to 10 times less expensive.
- EU Net Zero targets not currently being met.
- Global political shifts increase volatility (e.g. US withdrawal from Paris Climate Agreement)
- Need to be clear and specific on where is the incentive / 'profit' to Government to invest and subsidise these systems.

Technology and Systems

- Must provide real clarity and understanding on how technology is different to others. Complex topic, not simple to easily convey.
- Infrastructure designed around existing technologies
- Challenge of 'selling' a novel technology in a way that demonstrates value to investors, policymakers, etc.
- Technology must be rendered easy to use if democratisation in communities to be successful.
- Need an integrated system like PV module, but in modular, deployable form that can be easily scaled as required and maintained locally at low-cost.
- How will system address safety concerns?
- Green hydrogen currently seen as 'product'. Need to change the outlook to 'process'.
- Hydrogen embrittlement (i.e. the loss of ductility that many metals exhibit due to the presence of hydrogen atoms within the metal lattice (Martin et al., 2020)[1]. Storage and production need to go hand in hand. Infrastructure H_2 transfer or transportation affected by hydrogen embrittlement the most – the FreeHydroCells' concept removes the need for the conventional

[1] May L. Martin, Petros Sofronis, Hydrogen-induced cracking and blistering in steels: A review, Journal of Natural Gas Science and Engineering,Volume 101, 2022, 104547, ISSN 1875-5100, https://doi.org/10.1016/j.jngse.2022.104547. (https://www.sciencedirect.com/science/article/pii/S1875510022001378)

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transportation infrastructure, circumventing the problem, as well as the energy and financial cost.

Community and Readiness

- Public awareness/general knowledge based around hydrogen/green hydrogen is limited - on safety, efficacy, cost, ease of use.
- Anticipate potential for resistance due to steep learning curves (highly technical subject matter)
- Communities may not be ready for disruptive effect - readying communities for reality that there will need to be new energy systems and adaptation.
- Challenge in taking innovative ideas from being 'stuck' within the research community to the wider public's attention.
- Public perception of hydrogen as 'dangerous' (e.g. Hindenberg disaster).
- Difficult for people to access existing research and sources of knowledge due to lack of exploration or dissemination in this area by big energy companies.
- Challenge to get people involved / to uptake – time.
- Storage, apparatus, etc? For a young professional, buy house etc. where is the funding?

Opportunities

Policy and Marketplace

- Key question: What is the green hydrogen market and what is the current understanding amongst industry?
- Key Market Forecasts:
    a. Green Hydrogen Market: Global Forecast to 2030
    b. Hydrogen Storage Market: Global Forecast to 2030
- Opportunities to work with oil and gas industry, not against.
- Scope for collaboration with major players in the gas market, due to existing infrastructure and supports. e.g.:
    a. European Gas Research Group
    b. Gas Networks Ireland
- Supportive policy environment, e.g.
    a. EU push for Net Zero 2050 targets
    b. UK govt's Clean Power 2030 Action Plan
- Legal frameworks - green hydrogen policy key role in EU transition. Voluntary certification scheme.
- Sustainability certifications, e.g. the Green Mark (UK). Understand what it is, who is operating it, how decisions are made, etc.
- Availability of funding (e.g. EU Innovation Council green hydrogen portfolio).

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- Tackling energy poverty by empowering communities with innovative systems represents an added opportunity for policymakers.
- Easy to find cost of hydrogen since disconnected from mix of powers sources on the grid.
- Appetite from investors: 75 major multibillion-dollar companies.

Technology and Systems

- Disruptiveness of the technology is a strength (e.g. for investors).
- USPs (Unique Selling Points) in comparison to other technologies (e.g. No use of critical raw materials, avoiding noble metals (≠PV + EC).
- Ability to look at production and storage simultaneously.
- Future-facing: In future, hydrogen likely stored not as gas, but in organic frameworks. Get ahead of trends.
- Embracing Artificial Intelligence in design: A path to AI or algorithmic control over the best use of the energy or sharing between clusters depending on need. AI could be used for safety aspects.

Community and Readiness

- Public appetite for sustainable technology that will be safe and benefit communities.
- Younger generations in particular are more engaged around sustainability, technology and embracing transformation – leverage social media.
- Engaging communities and stakeholders is key to foster acceptance and influence perception. Learn lessons from, for example, how the cause of Hindenburg disaster was communicated (Hydrogen was always blamed as the cause, but recent study and newly-found footage assists in the evidence that a capacitive effect caused the disaster, not the hydrogen. Also, there were many uninjured survivors – seen in the footage – due to the properties of hydrogen as opposed to today's aviation fuel – most would not have survived had such fuel been used).
- Geopolitical and Environmental instability having effect of people becoming more 'tuned in' to environmental issues.

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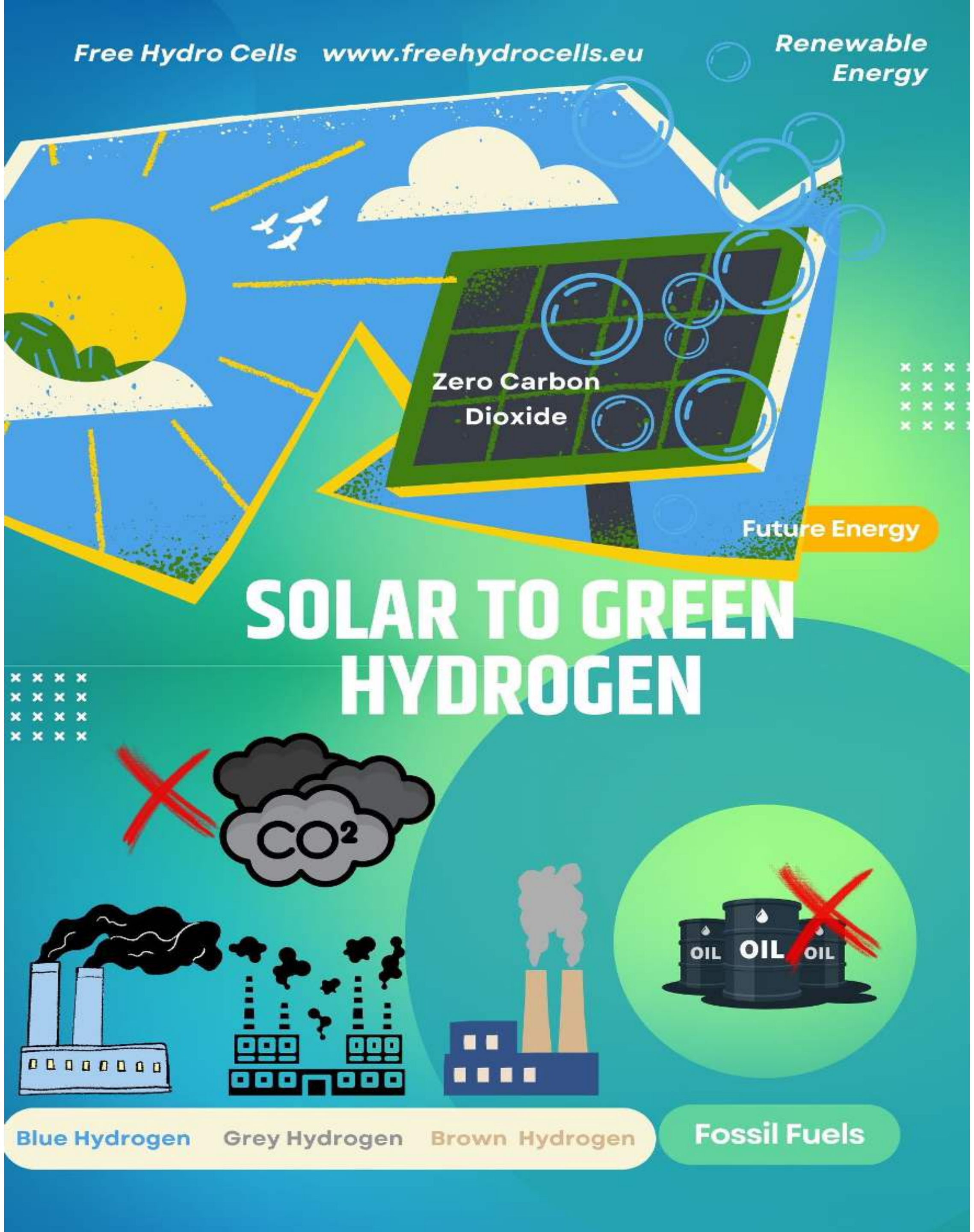
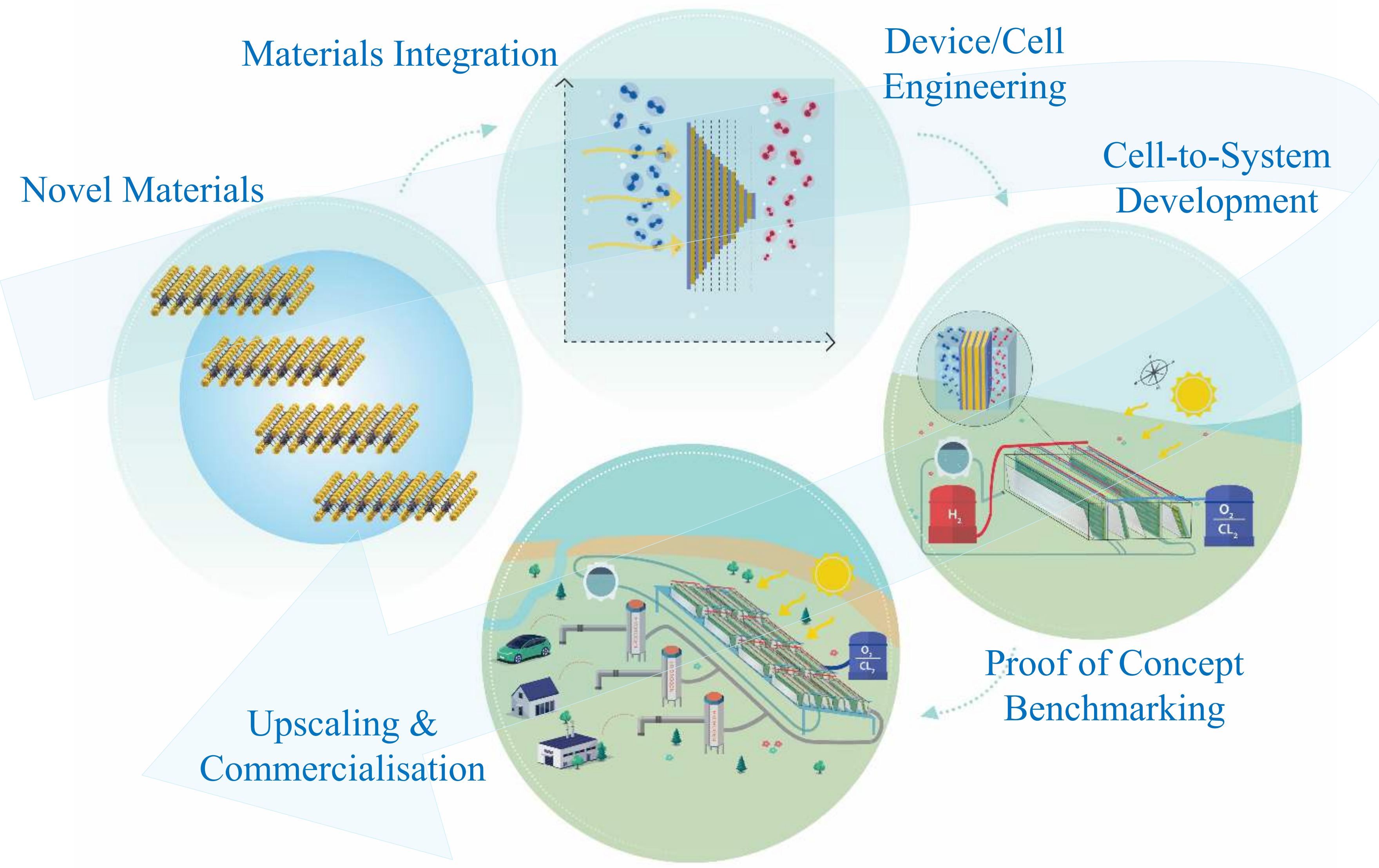
- **Renewable energy:** energy production that does not deplete our natural resources or pollute our environment
- **Carbon dioxide:** CO_2 is damaging to our atmosphere when it is beyond certain concentration amounts
- **Fossil fuels:** Hydrocarbon-based organic matter (e.g. coal, methane, peat, wood) burned by humans to produce energy and heat but also pollutants for our atmosphere/environment
- **Green Hydrogen:** Renewable H_2 production with no pollutant by-product, does not deplete our natural resources
- **Electrolysers:** Electrochemical systems that split water to produce H_2. Unfortunately, these systems deplete our natural resources (e.g. platinum is needed in high quantities). Green, low power, electrolysers are needed!
- **Solar-to-Green Hydrogen:** This can be solar panels driving green electrolysers to make H_2, or other green solar energy-absorbing systems to make H_2, like *FreeHydroCells*
- **Hydrogen from Wind/Water:** Wind turbines & hydroelectric dams can drive electrolysers for H_2
- **Blue/Grey Hydrogen:** Steam methane reforming (SMR) to H_2 with different levels of CO_2 pollutant release (50-90 %?)
- **Brown/Black Hydrogen:** Coal gasification to H_2 & CO_2



The *FreeHydroCells* Project



Novel Materials
- Environmentally-benign
- Cost-effective & sustainable
- Good light absorbers

Materials Integration
- Make multilayer junctions
- Max. energy retention, min. losses

Device/Cell Engineering
- Transfer energy to split water→H_2
- Photon energy to chemical energy

Cell-to-System Development
- Large volumes of H_2 needed
- System efficiency key

Upscaling & Commercialisation
- Modular expansion possible
- Good life-cycle predictions
- Commercially competitive

Proof of Concept Benchmarking
- Operationally efficient & low cost
- Viable for Green H_2 gas production
- Durable with long service life
- Green H_2 efficiency benchmark