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REALISING HYDROGEN

TECHNOLOGIES

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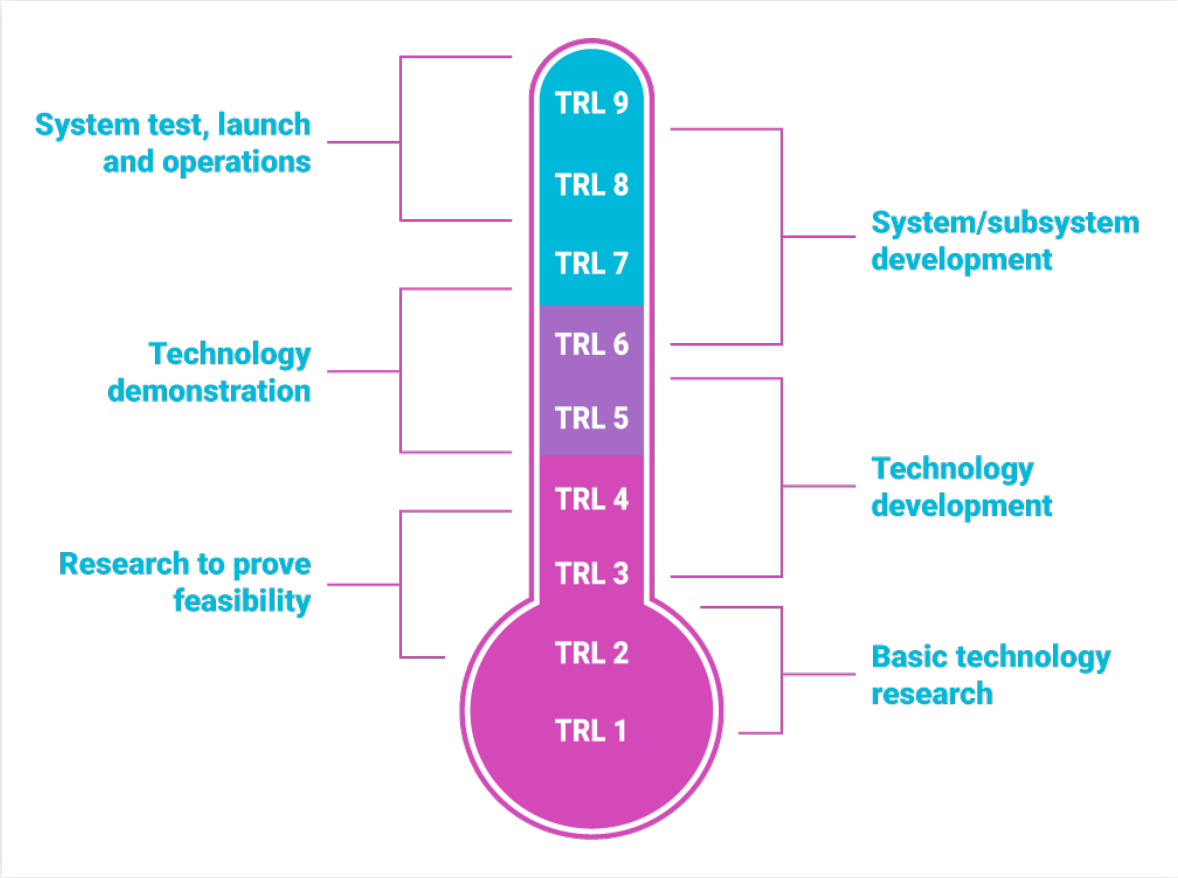
FROM RESEARCH TO IMPACT

- Research institutions work heavily at TRL 1 and 2
- This work helps establish new technology options

HOWEVER

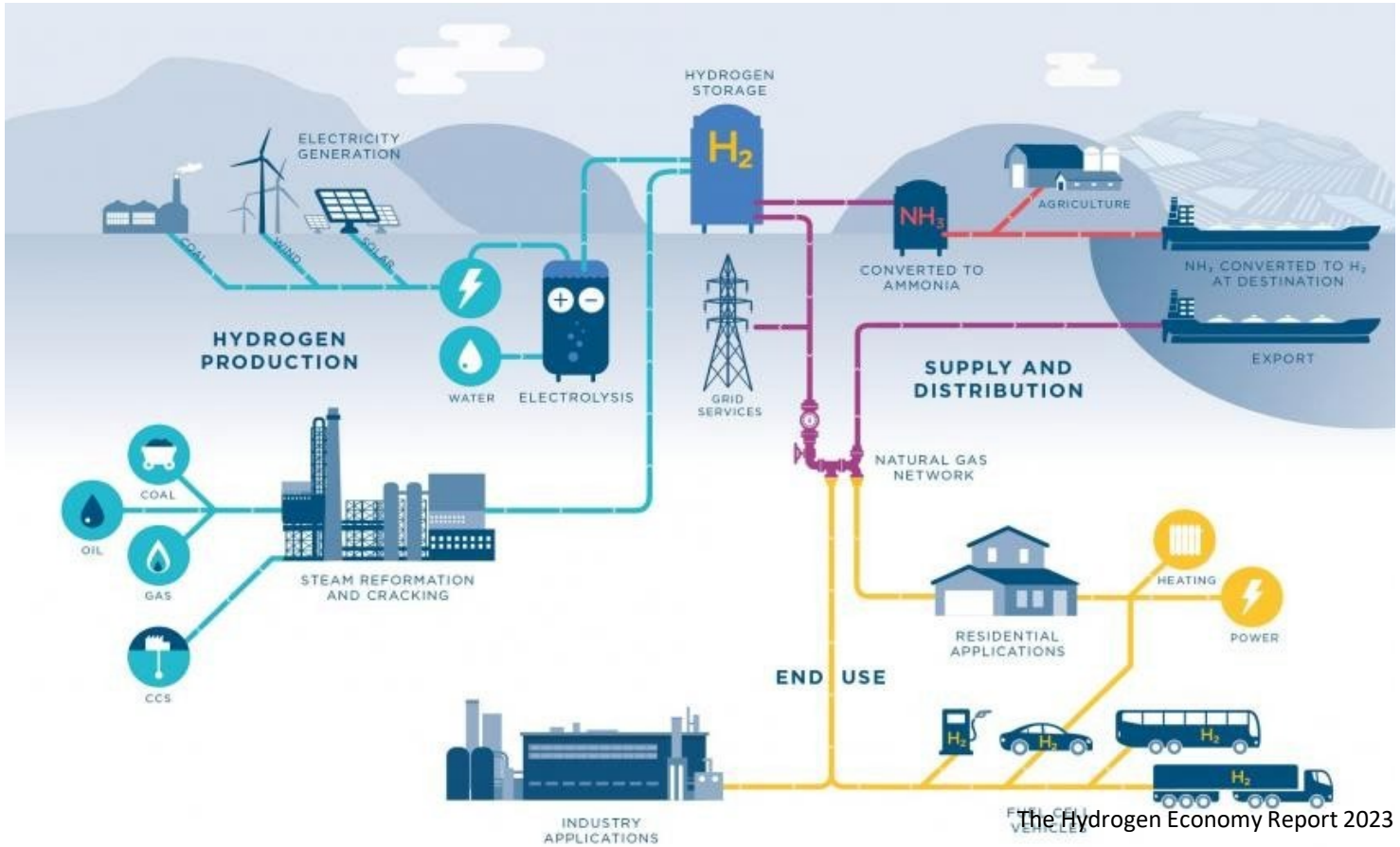
- To be commercially viable a technology must transend the lab and become:
  - **Affordable**
  - **Reliable**
  - **Manufacturable**
  - **Proven**

- There is a large chasm to cross getting from TRL3 to TRL 5



THE VISION OF HYDROGEN ECONOMY

- We are all now bombarded with several versions of the hydrogen vision
- Most include
  - **Green Hydrogen production**
  - **Pipeline distribution**
  - **Storage**
  - **Domestic Delivery (heating etc)**
  - **Electricity generation/storage**
  - **Transport**



The Hydrogen Economy Report 2023

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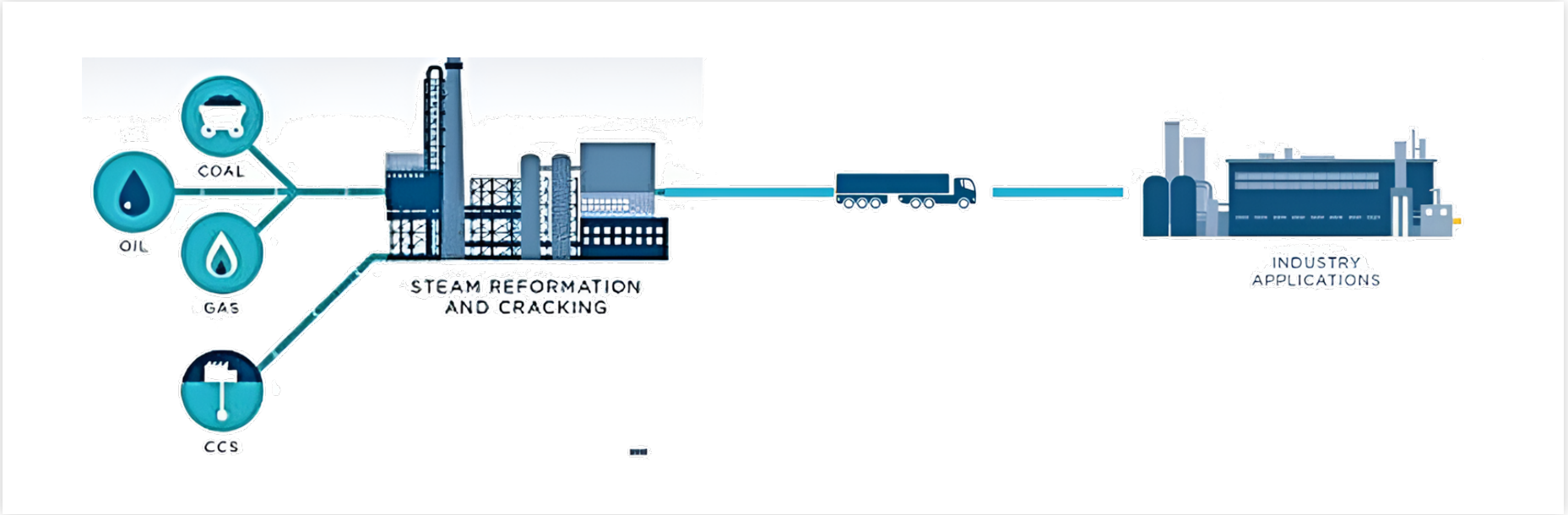
THE CURRENT HYDROGEN ECONOMY



In 2022 our global demand was **95Mt of Hydrogen**. [1]

For comparison 2022 had a demand of **~5400 Mt of Natural Gas**. [2]

This is mostly industrial and refining applications

Primarily from **Blue** or **Grey**

Only 0.7% **Green** Hydrogen.

[1] Global hydrogen Review 2023
[2] Statista

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SO HOW DOES NEW TECHNOLOGY ENTER THE MARKET?

[3] BloombergNEF 2023

Barriers to entry:

- New technologies are hard to make cost competitive
  - Levelised cost of Blue Hydrogen is currently **59% cheaper than Green.** [3]
  - It is hard to generate a pull from industry.
- We lack an accessible market.
  - Demand hasn't yet diversified.
  - Energy projects typically require proven technology

Considerations to address this:

- ✓ Funding availability and focus

  Bridging the gap before commercial profitability
- ✓ Existing Markets
- ✓ Developing Markets
- ✓ Business Model - Ongoing income streams
- ✓ Policy and upcoming policy

A new technology must therefore consider its initial Use Case carefully.

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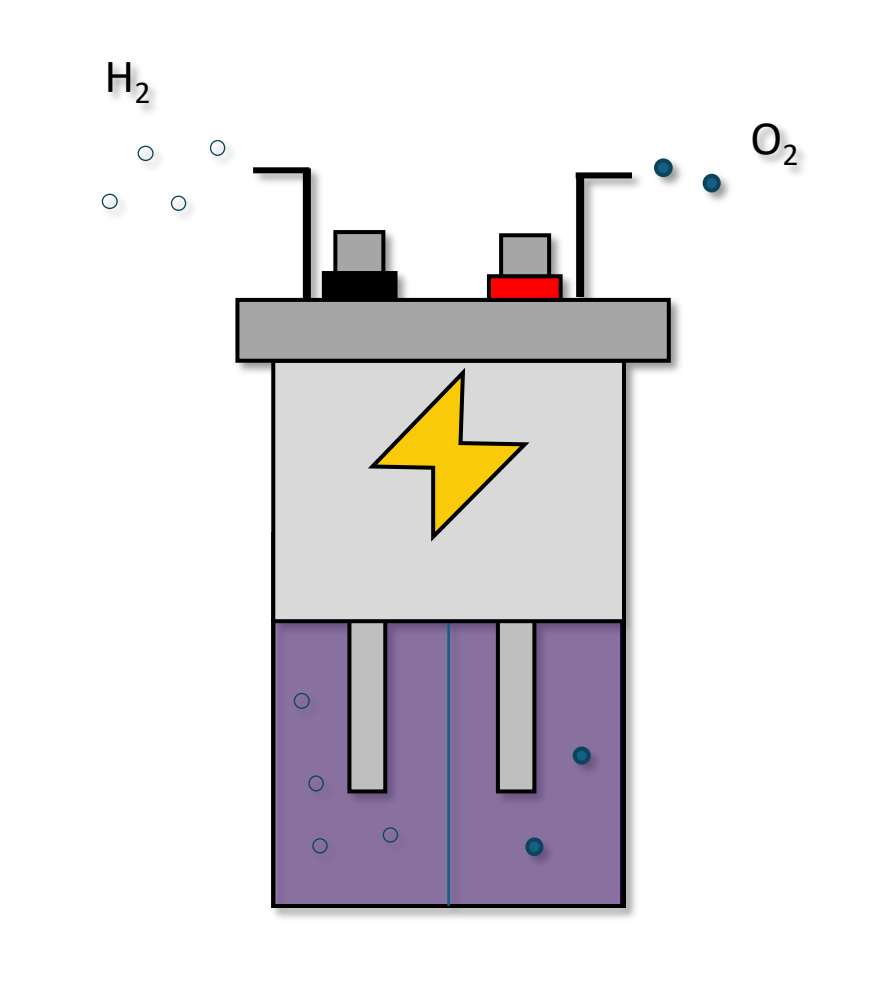
CASE STUDY: BATTERY-ELECTROLYSER

LEAD ACID BATTERY technology allows the cell to charge and discharge as a battery.

ELECTROLYSIS occurs when the cell is over charged – splitting water from the electrolyte into H2 and O2 gas.



HYDROGEN is collected at the negative electrode as a method of chemical energy storage during excess renewable energy production

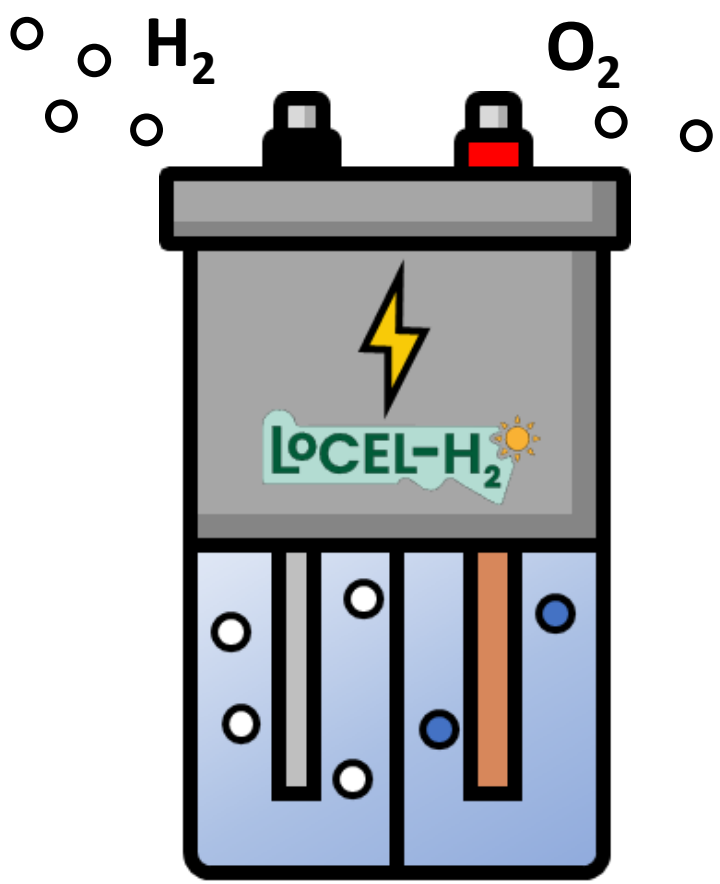
RENEWABLE ENERGY is stored either as electrical energy in the battery or as hydrogen.

HOW WE GOT STARTED

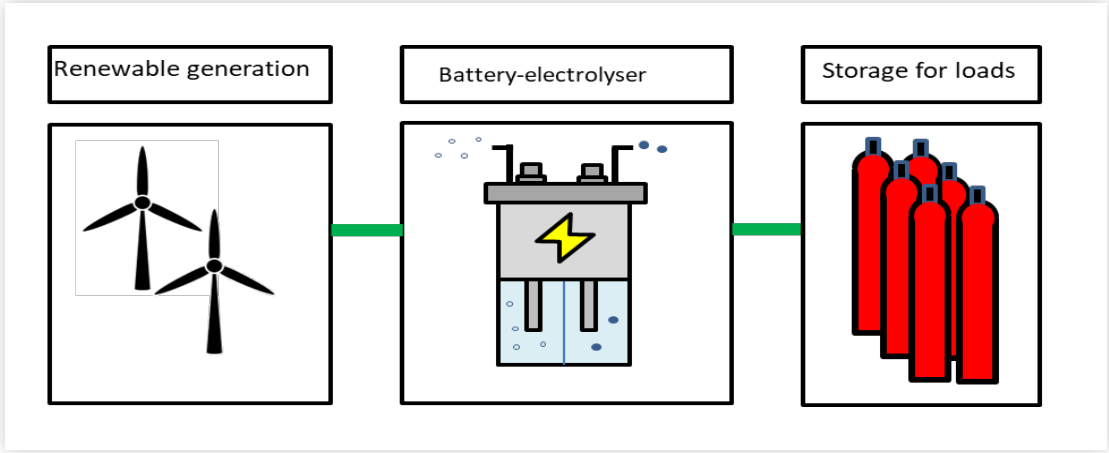
- TRL 1 small scale lab cells
  - Based on off the shelf lab equipment
- Developed small scale prototypes
- Redeveloped prototypes to match manufacturable techniques
- Successful **Proof of Concept**
- Built applicable industrial **partnerships**

CASE STUDY: BATTERY-ELECTROLYSER

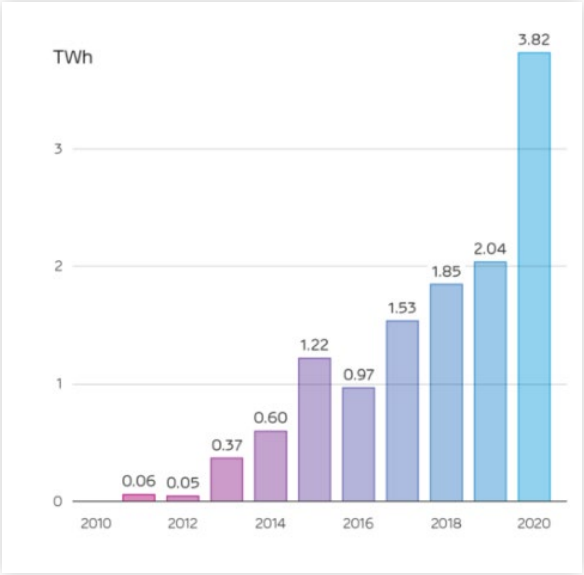
- To progress up the TRL scale we must focus on an **accessible use case** to reach demonstration scale:
  - **Initial territory**
  - **Initial market**
  - **Funding route**
  - **Initial use case**
- Our goal is to reach a **TRL level (6 - 8)** where the technology is sufficiently proven for industrial uptake.
- Accessing development funding bodies such as Innovate and Horizon.



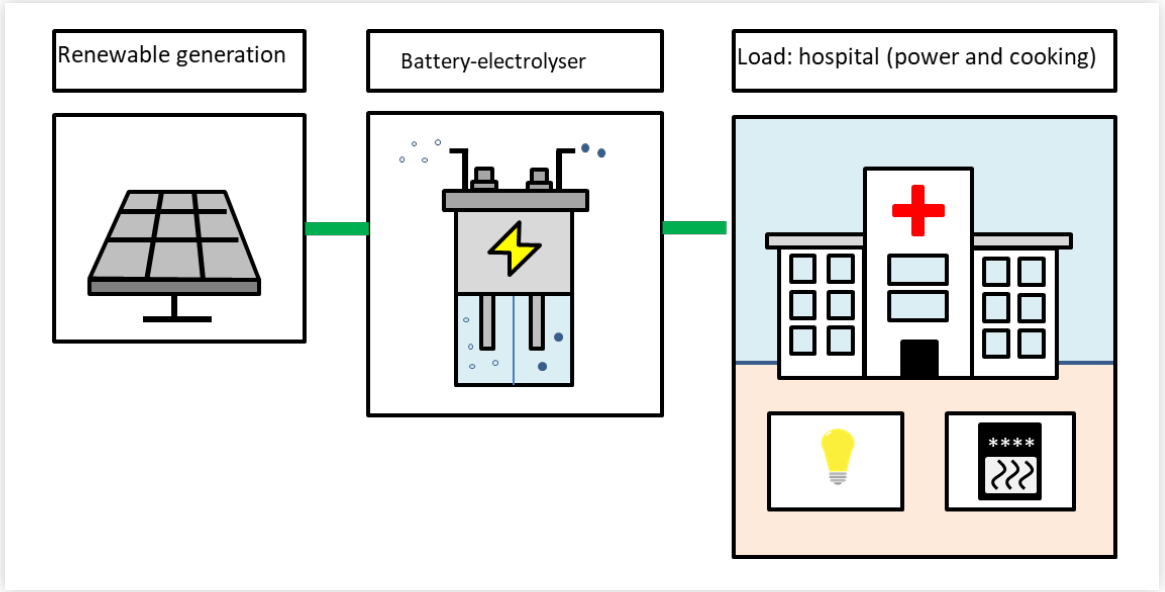
USE CASES



USING EXCESS WIND TO GENERATE GREEN HYDROGEN



TWh curtailment [5]



USING EXCESS SOLAR TO GENERATE GREEN HYDROGEN FOR COOKING IN DEVELOPING COUNTRIES

This use case is more accessible to us.

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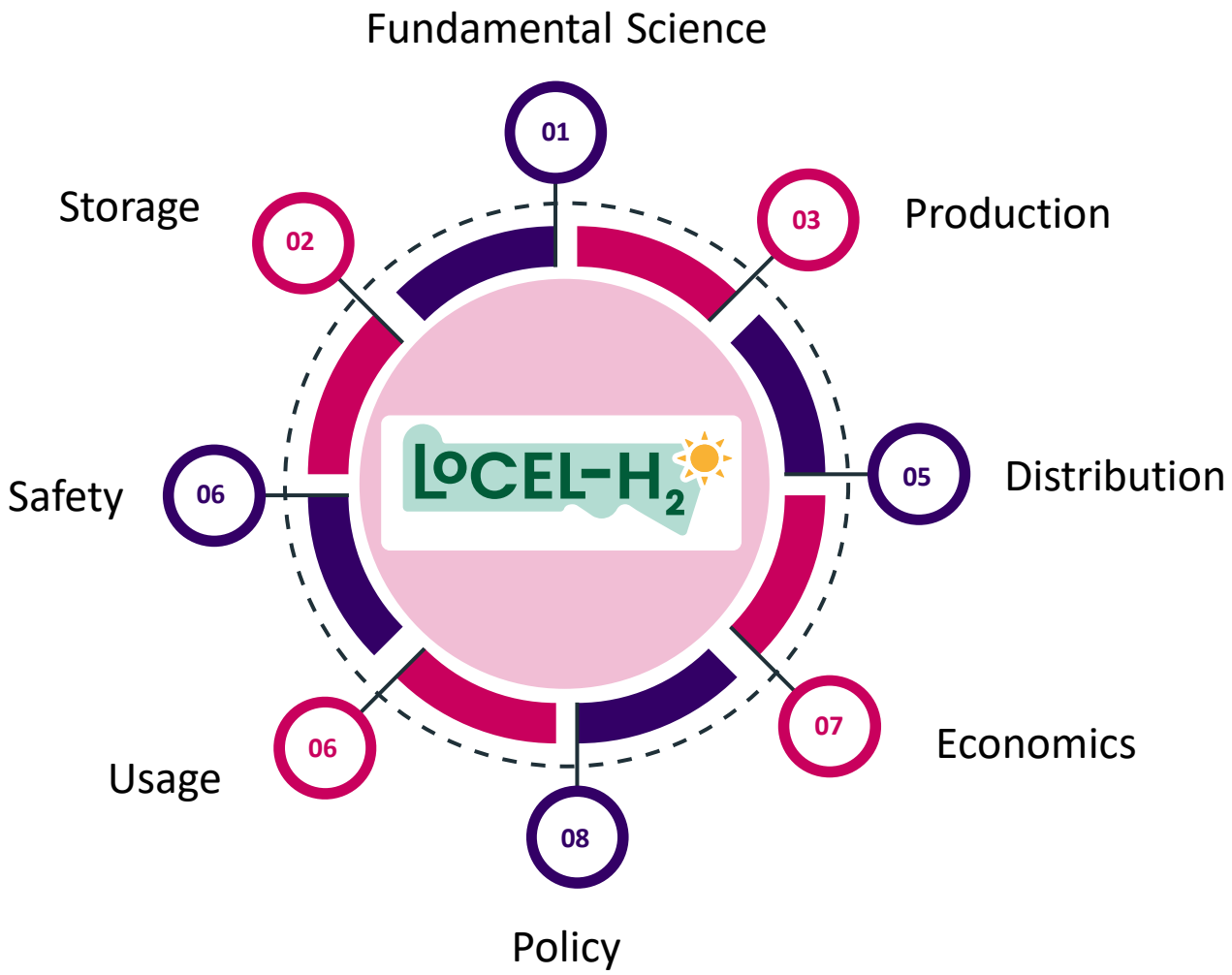
LOCEL–H2 PROJECT

LoCEL-H2 will generate renewable energy, storage, and clean fuel for deployment in isolated and remote regions of Africa, to support communities that cannot connect to an electricity grid.

- Horizon funded project
  - ~ € 9.8m
- Deploy 2 prosumer microgrids in Africa
  - The Battery Electrolyser at the heart of the system.
- Progress the Battery-Electrolyser to TRL 8
- Develop Balance of Plant
- Develop a Minimum Viable Product

MULTIDISCIPLINARY APPROACH



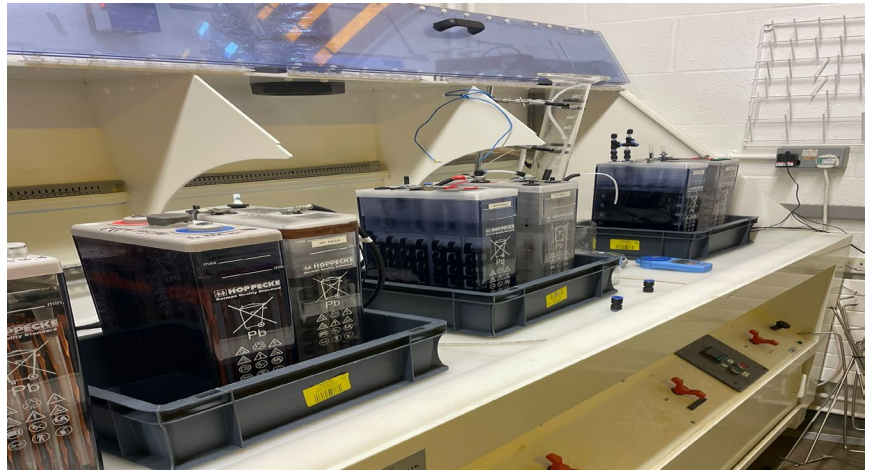
LOCEL–H2 PROJECT

- ✓ Funding availability and focus
  - Horizon – Sustainable Development Goals
  - UN official development assistance (ODA) countries
- ✓ Market
  - Develops a new market for H2 Technology
- ✓ Business Model - Ongoing income streams
  - Includes Generation, Storage and Usage.
  - Removed reliance on H2 economy
- ✓ Policy and upcoming policy
  - Partners specilising in the local regions, government and social acceptance

Addressing all aspects of the H2 distribution chain increases the project complexity resulting in a large number of partners required.

PRODUCT DEVELOPMENT

- The **LOCEL-H2** project has allowed the refinement of a manufacturable product.
- In house manufacturing processes are being deployed for **1000-5000** cell scale
- This lowers the barriers and costs for continuation projects.



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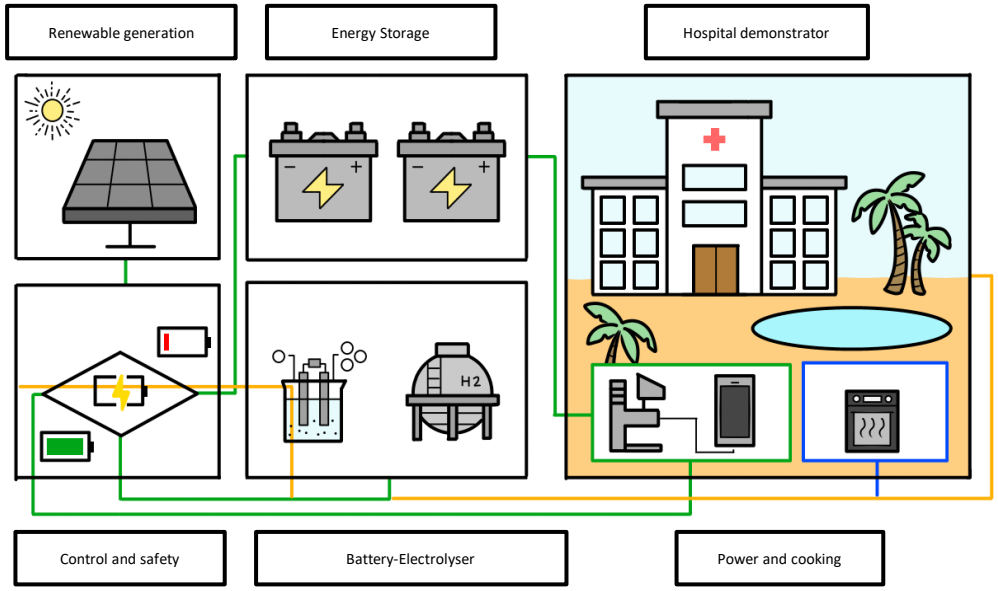
EXPANDING THE USE CASE

- Once a project has **ESTABLISHED** traction we can reutilise the learning, efficiency gains and TRL advancement to deploy **additional use cases**.

- A new Innovate UK project **DEPLOYING** a Battery Electrolyser as a reliable energy source for Malawian hospitals.



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PROJECTS AND FUNDING TIMELINE

OCT 2021 | JAN 2022 | APR 2022 | JUL 2022 | OCT 2022 | JAN 2023 | APR 2023 | JUL 2023 | OCT 2023

Seedcorn grants
(EPSRC £25k, Oct 2021-Apr 2022)

Blog-H
(EPSRC £150k in £250k,
Oct 2022 – Mar 2024)

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MASBAH
(Innovate UK, £118k in £350k,
Oct 2021 – Oct 2022)

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LoCEL-H2
(EU £1.7m in €9.8m, Jan 2023 – Dec 2026)

CÔTE D'IVOIRE

ZAMBIA

LoCEL-H2

Canada exchange (NERC £12k,
Mar 2023 – Jul 2023)

CDICE
(Hydex, £21k in £30k)

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MESCH
(Innovate UK,
£315k in 1.5m,
Jan 2024

MALAWI

KTP
(Innovate UK,
£200k, Feb
2024)

UK

PARTNERS

CBI, Hoppecke, CEA, LUMS, Gabes, UNINA, H&V,
Fibre Tech, SSE, Arenko, Strathclyde University, Cranfield University, MONBAT,
INFLO, Ultima Forma, Renew'N'Able Malawi

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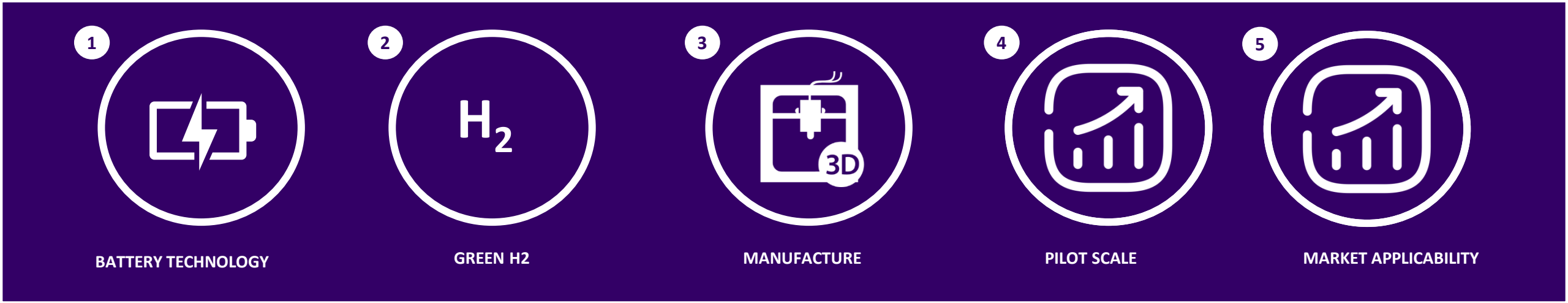
CONCLUSIONS



BATTERY TECHNOLOGY
Using lead acid battery technology, we have successfully developed a combined battery and electrolyser.

MANUFACTURE
We have developed the cell design from lab scale to product scale, using off the shelf and bespoke 3D printed parts.

PILOT SCALE
We are now in the process of testing the next 20 cells for testing, before deploying 160 cells in Zambia and the Ivory Coast.

STRATEGY
We have targeted developing nation funding as a new market where we can address the entire Hydrogen value chain.

MARKET ENTRY
With data proving long term reliability and a demonstration at TRL 6 or 7 the technology becomes attractive to large entities.
These will be with new use cases but now proven technologies.

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THANK YOU