# Green hydrogen: Methods of production and its role in the energy mix

HyWaves


Local Green Hydrogen

# ABOUT US

HyWaves is a solar-to-hydrogen technology company based at Cranfield University with a radical approach to the power electronics connection between the solar PV and the electrolyser, driving down the Levelised Cost of Hydrogen.

HyWaves brings unique know-how and expertise to create a competitive advantage in the unexploited market gap.

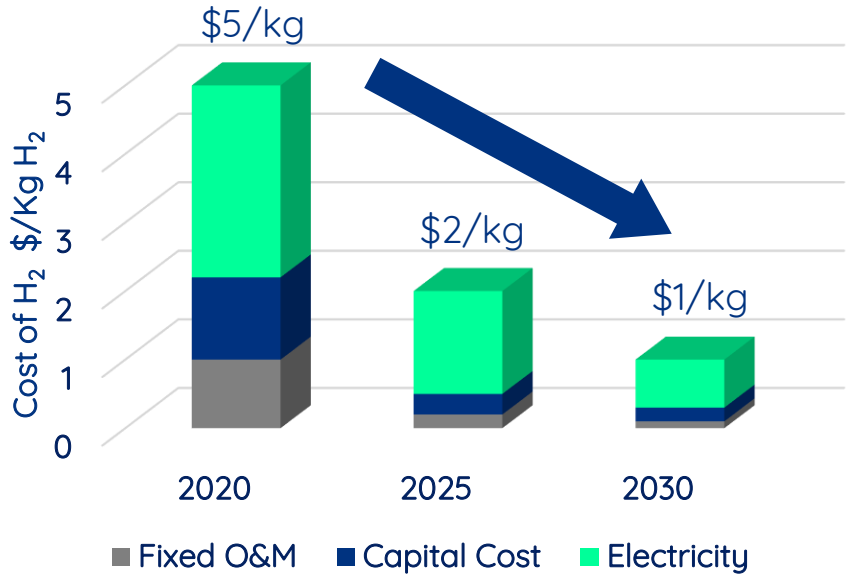

We envision a world where green $H_2$ is produced locally
One step closer to decarbonising the world

# THE CHALLENGE

## Production costs of Green Hydrogen must be driven down

- Globally, a typical solar plant is designed for electricity grid export
- Its architecture is not optimised for Green $H_2$ production, resulting in low efficiency & high-cost

The cost of electrolysers is forecasted to fall dramatically therefore the highest cost of electrolysis will be electricity. Electricity losses must be minimised.



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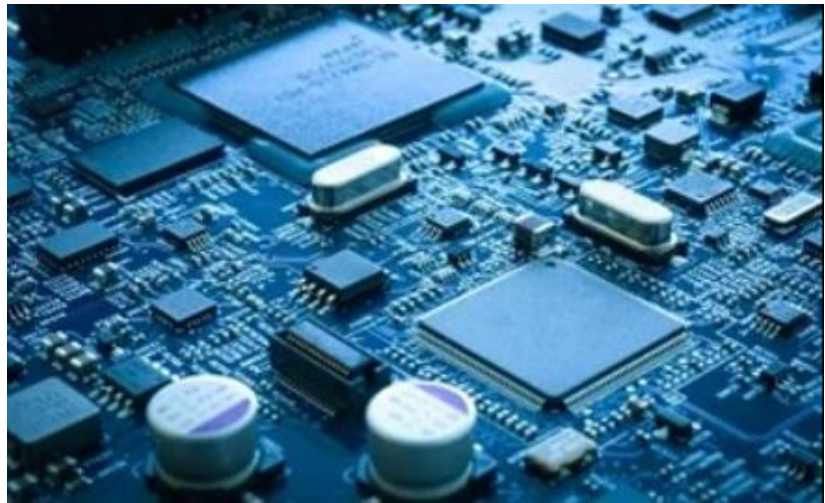
Hydrogen will become a key commodity that is used both as a fuel and a feedstock for industrial processes

- Semiconductor manufacturing is moving to a new process (EUV) being introduced that will require up to 1,000 times more hydrogen than at present with the industry having a need for a supply of high-purity green hydrogen
- The Industry in Taiwan currently consumes an estimated 165K metric tonnes per year of hydrogen!
- Joint Cranfield/HyWaves project over the next 24 months developing a production facility to meet the need for onsite production and management

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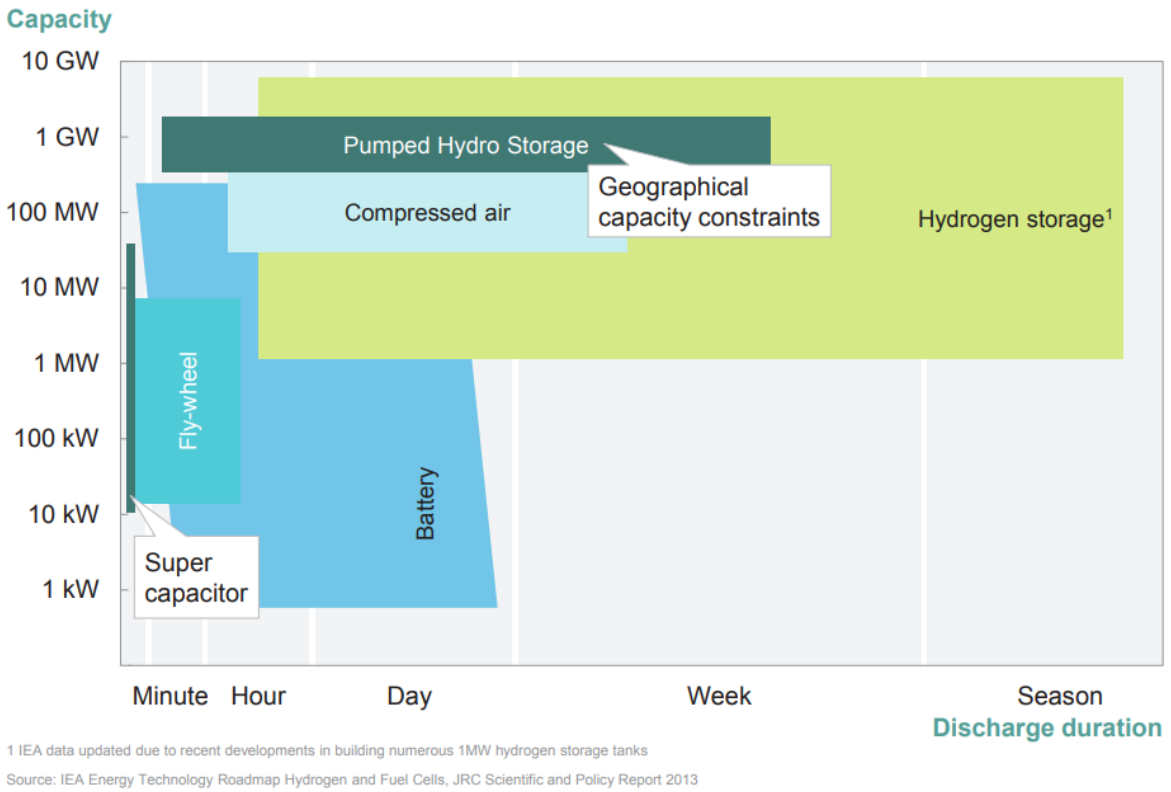
## Hydrogen is going to be a key energy storage method as carbon-based fuel is phased out

- Electrochemical storage (Batteries) are not suited for long-term storage or for were there is a need to transport energy
- Hydrogen can be converted to liquid form or ammonia that can be easily transported using the fully developed global oil and gas network
- Along with supporting the energy transition hydrogen is used in a range of key industries



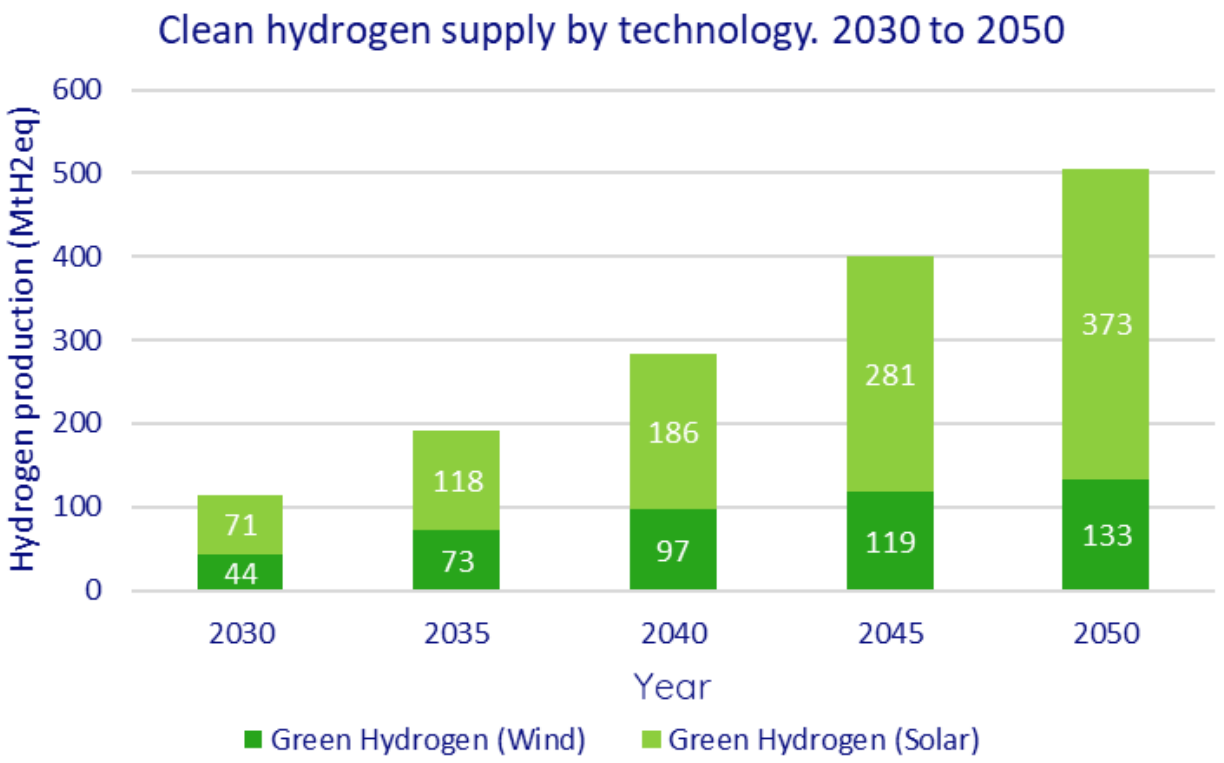

1 IEA data updated due to recent developments in building numerous 1MW hydrogen storage tanks

Source: IEA Energy Technology Roadmap Hydrogen and Fuel Cells, JRC Scientific and Policy Report 2013

Hydrogen Council - How hydrogen empowers the energy transition

# GREEN HYDROGEN LANDSCAPE

- Soon, Green $H_2$ will be primarily produced where the Levelised Cost of Electricity (LCOE) is cheapest
- This will be in sunny climates where solar PV is cheap and abundant, e.g. the Middle East, North Africa, Australia
- HyWaves enhanced electrolyser will reduce the CAPEX balance of systems and almost eliminate electricity losses for solar to hydrogen plants, in these climates

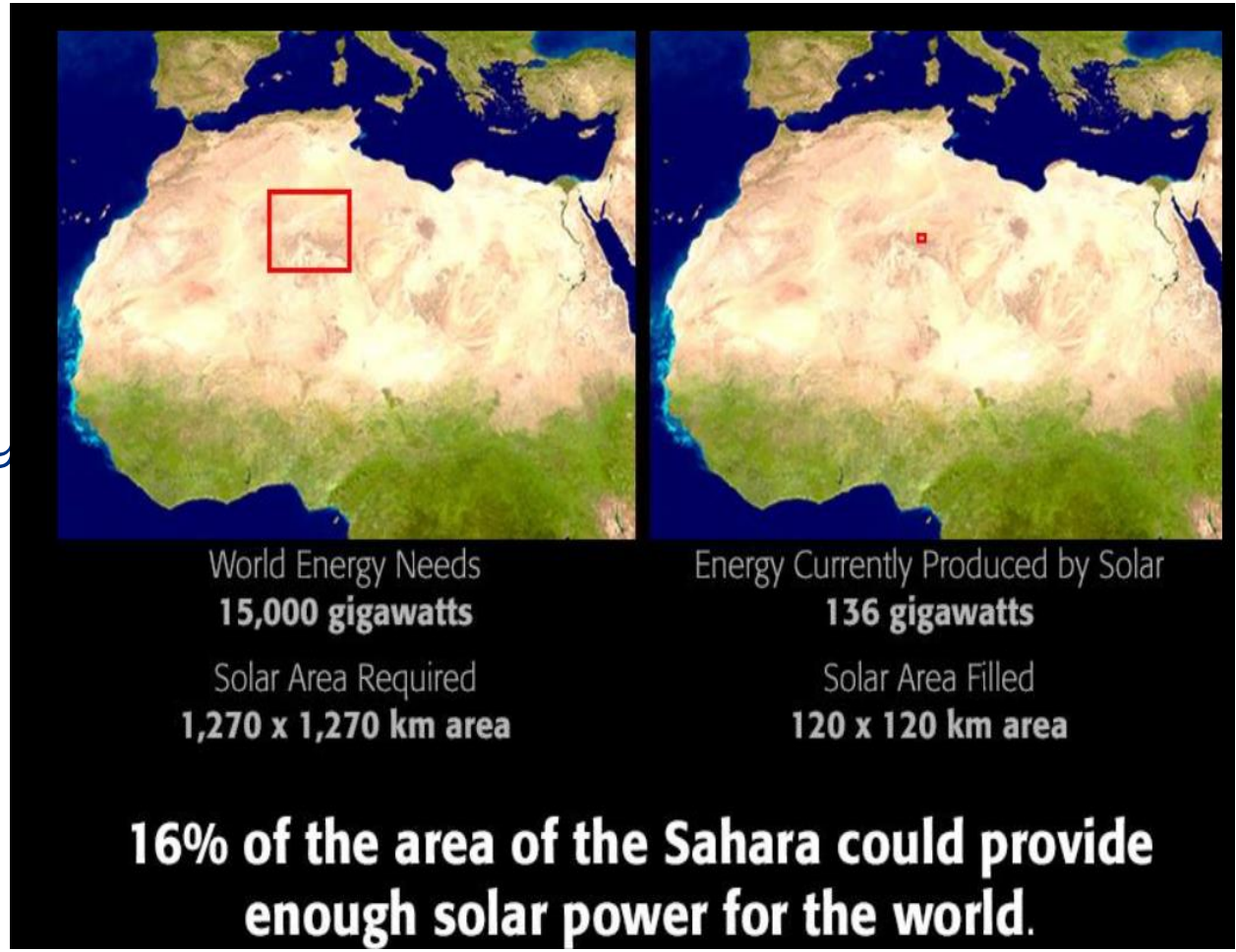



Source: Deloitte's 2023 global green hydrogen outlook

# Green hydrogen: Methods of production and its role in the energy mix

## Solar energy offers a key contributor to meeting global energy demand

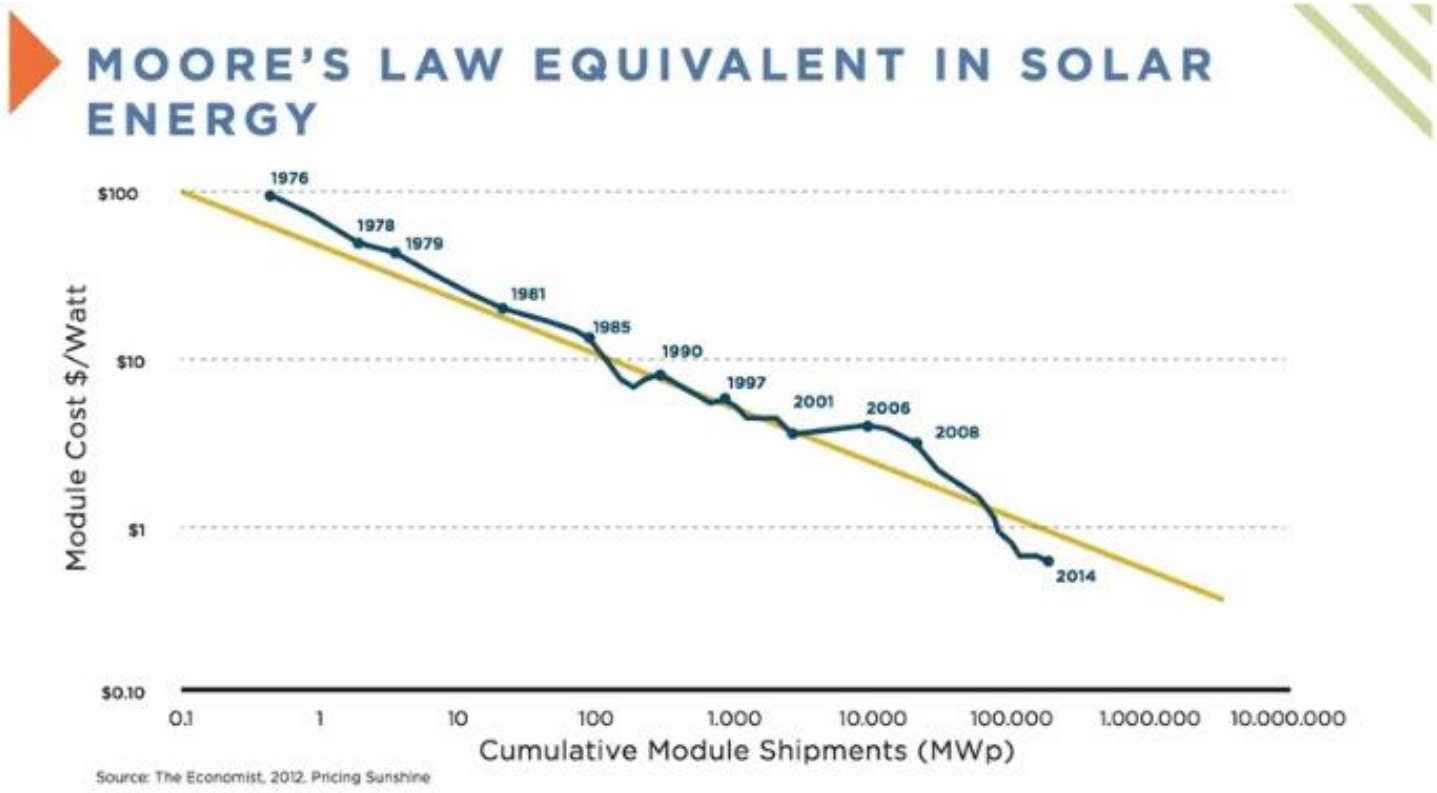
- Just 0.3% of the Earth's surface could generate the full energy demand of the World if covered in solar PV
- Averaged over a year, approximately 342 watts of solar energy fall upon every square meter of Earth (8kWh/day)
- Intermittency and issues with grid connections result in hydrogen becoming a key energy carrier for solar PV




IEE Website Post

# Using the Solar Industry to produce green hydrogen

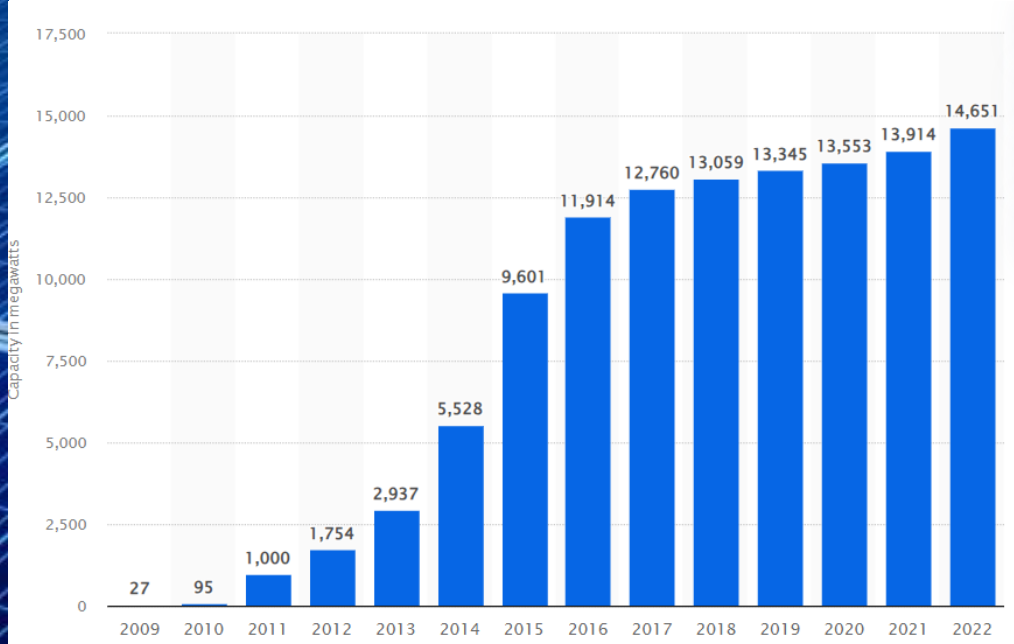
- Solar PV has seen a dramatic cost reduction over time as production is scaled with the wholesale panel cost now less than $0.5/W for a Monocrystalline cell, making it the lowest cost renewable source
- There is, however a problem typical sites are not optimised for hydrogen production and come with a high cost of grid connection!



# GREEN ENERGY HOW HYDROGEN IS NEEDED IN THE PICTURE

## Bring more green power online will require hydrogen

- Adding renewables results in system intermittency requiring energy storage not currently seen in the grid
- Hydrogen grid stabilization is likely to be required for greater solar capacity – 10+ year wait for grid connection is typical for new solar farms!




UK Solar capacity for expansion is limited by grid connection availability

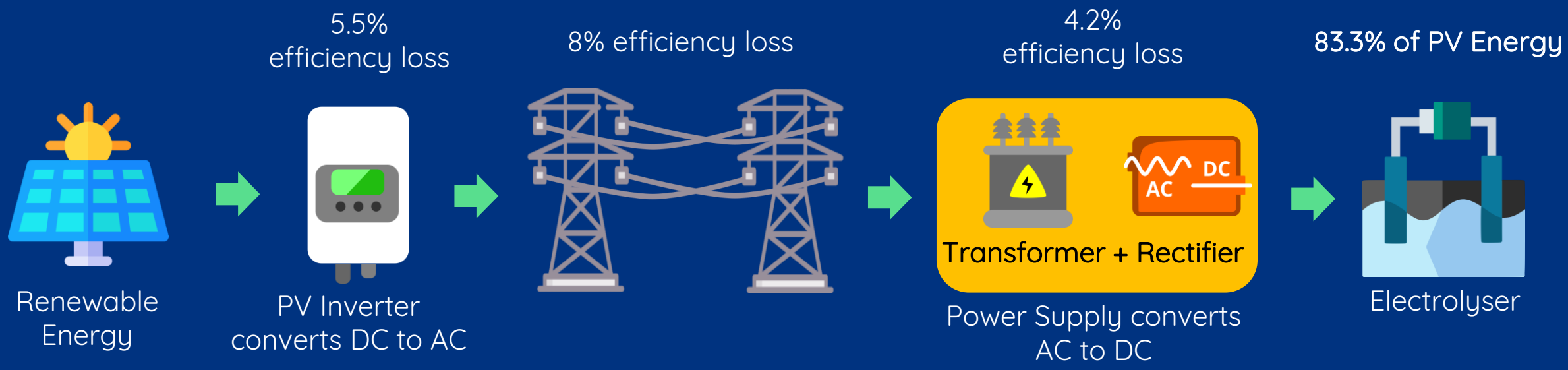
# Solar - What needs to change for Green Hydrogen?

- A typical solar plant in the UK or anywhere around the world is designed for electricity grid export – Up to 14-year waiting list in the UK!
- Its architecture is not optimised for Green Hydrogen production, resulting in low efficiency and high-cost

**HyWaves has a solution to this challenge!**

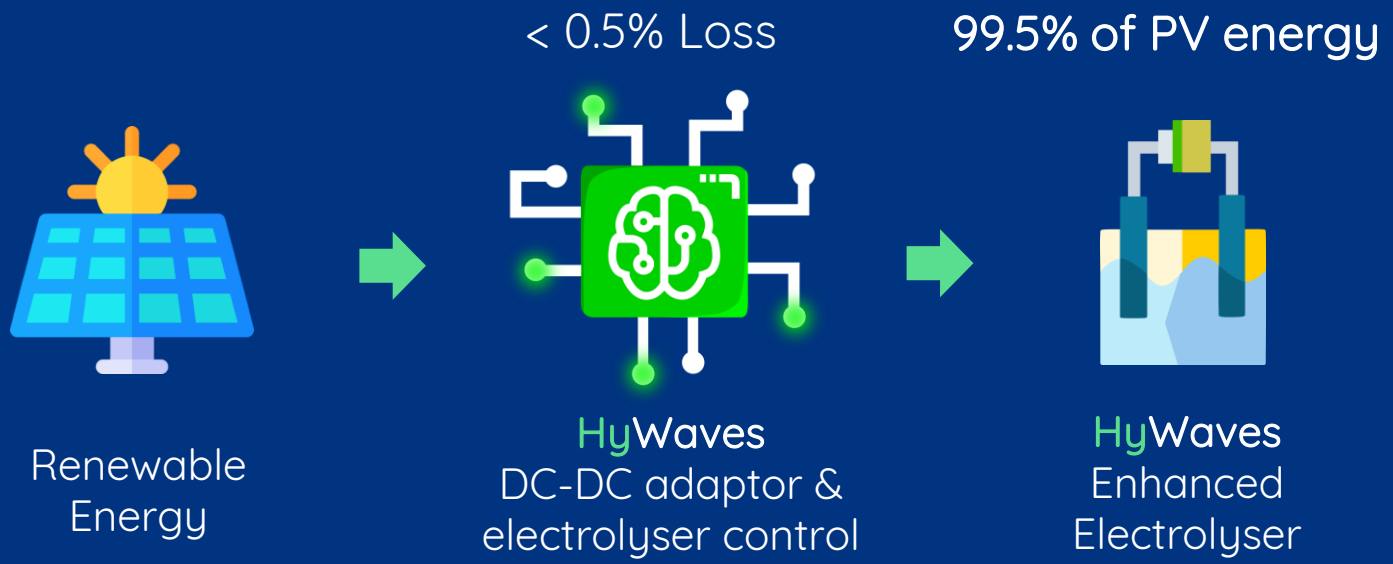
# Problem: Green $H_2$ Production Remains Inefficient, Why?

Current solar to hydrogen plants are sending renewable electricity to the grid even when co-located with the electrolyser resulting in >10% losses




Ref. Losses & Leakages, Parliament

# Solution: DC-based Co-located PV & Electrolyser




- Direct DC-DC coupling → Up to **99.5% of PV energy** to produce green hydrogen
- **10%** more electricity available for hydrogen production
- **CAPEX savings** in PV inverter & electrolyser power supply electronics

# $H_2$ from PV: $H_2$Top Capex Savings and Efficiency Gains

$H_2$Top can **reduce the LCOH up to 25%** for green hydrogen produced from **PV** renewable energy:

a) **10% by improved energy efficiency** of the DC-DC direct-coupling electronics, no power conversion

b) **15% by CAPEX saving on Power Supply** of the electrolyser system, replaced by cheaper H2Top switching electronics

c) **10% to 20% by CAPEX savings in PV Plant**, by removal of 1) MPPT Inverters 2) Grid Connection 3) Other costs associated with Inverters and Grid Connection

**Note**: The exact CAPEX saving impact of b) c) depend from country & relative weight of PV & Electrolyser costs.

# Stage of Development

TRL4

TRL5

TRL6

## Phase 1

Validation of concept at 1kW scale

## Phase 2

Software development for automated switching

## Phase 3

Co-develop enhanced electrolyser with automation (by Q4 23)

## Phase 4

Pilot solar to hydrogen plant. (by Q2 24)

## Phase 5

Compatibility of wind energy source (by Q4 24)

# Cranfield Students Working on a HyWaves Project!

- Over the next 24 months we will be developing a solar-to-hydrogen plant with Cranfield with a focus on delivering a research facility that other companies/universities can become involved
- The facility will have an experimental 50kW BP Lightsource solar array providing a highly capable research flexibility on a modular scale by mid-2024!

HyWaves

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Making Waves in the Hydrogen World