ECONOMIC ANALYSIS AND FORECAST OF THE LEVELIZED COST OF GREEN HYDROGEN IN SCOTLAND WITHIN THE PERIOD 2025 – 2050 USING A MONTE CARLO APPROACH

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Background

- The legally binding commitment of the UK towards Net-Zero 2050 implicates a total transformation of energy production and consumption. Therefore, the substitution of traditional fossil fuels with Hydrogen-based fuels will play an important role in this transformation.
- This study assesses the economic feasibility of the deployment of off-grid stand-alone Proton Exchange Membrane electrolyzers in Scotland given its affinity with Renewable electricity, for water electrolysis Hydrogen production purposes.
- A total of 60 different scenarios are considered:
  - For the years: 2025, 2030, 2035, 2040, 2045, and 2050.
  - 2 renewable energy sources: Onshore and Offshore Wind electricity.
  - 5 Scottish regions based on NUTS-2 classification.

Methodology

Deterministic Model

Levelized cost of hydrogen is used as metric for determining the Scottish NUTS-2 in which, in a given year and with a specific renewable electricity source, is most cost-effective to place a water electrolysis plant in.

The mod … ost of the electroly… or (CRF),

$$LCOH = \frac{(C_{CC} * CRF) + C_{O\&M} + C_{REP}}{M_{H_2}}$$

Operation and maintenance costs (), electrolyzer replacement costs (), and the hydrogen mass produced per year ().

Probabilistic Model

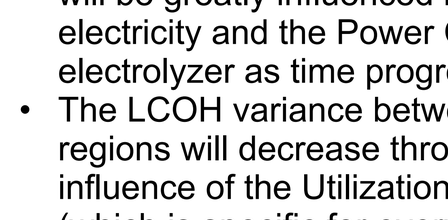
MC simulation assuming: Cost of electrolyzer, Electricity prices, and Power Consumption of electrolyzer (Beta-Pert Distribution). Water Prices, and Interest rate (Triangular Distribution).

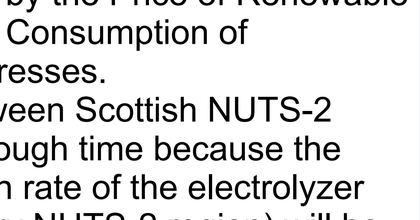
LCOH Tornado Charts

LCOH £/Kg H2 Onshore Wind (2022 real Prices)					
Year	UKM5	UKM6	UKM7	UKM8	UKM9
2025	3.88	3.77	3.96	3.91	3.91
2030	2.94	2.89	2.97	2.95	2.95
2035	2.72	2.68	2.75	2.73	2.73
2040	2.59	2.56	2.62	2.6	2.6
2045	2.44	2.42	2.46	2.45	2.44
2050	2.32	2.3	2.33	2.33	2.33

LCOH £/Kg H2 Offshore Wind (2022 real Prices)					
Year	UKM5	UKM6	UKM7	UKM8	UKM9
2025	4.06	3.98	4.11	4.08	4.08
2030	2.9	2.87	2.93	2.91	2.91
2035	2.55	2.52	2.57	2.56	2.56
2040	2.29	2.26	2.3	2.3	2.29
2045	1.94	1.92	1.95	1.94	1.94
2050	1.68	1.67	1.69	1.69	1.69

Onshore 2025: 2050:





Conclusions:

- In all the periods, the lowest LCOH will be found in Scottish Highlands and Islands (UKM6) regardless whether the PEM electrolyzers are fed by Onshore or Offshore Wind electricity.
- For all periods, except in 2025, the PEM electrolyzers fed by Offshore Wind energy will have the lowest LCOH's for all Scottish NUTS-2 regions.
- By 2025, the minimum LCOH will be of 3.77 ; by 2050, the minimum LCOH will be of 1.67 .
- Although in 2025 the Investment Cost of the electrolyzer will be the factor that most greatly will contribute towards the LCOH, by 2050 the LCOH will be greatly influenced by the Price of Renewable electricity and the Power Consumption of electrolyzer as time progresses.
- The LCOH variance between Scottish NUTS-2 regions will decrease through time because the influence of the Utilization rate of the electrolyzer (which is specific for every NUTS-2 region) will be relatively lower compared to the Electricity Prices and Power Consumption.

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