Defossilising Gas - Net Zero Gas Mains

The role of hydrogen in a decarbonised energy system

18 May 2021

Introduction to LCP

LCP INSIGHT CLARITY ADVICE

- Financial services consultancy, offering independent advice across the pensions, investment, insurance and energy sectors
- 800 staff and partners
- LCP Energy Analytics focusses on the GB and Irish electricity markets, providing detailed short and long term forecasting and analysis
- We offer a unique combination of energy market expertise, mathematical modelling and new technological approaches
- We work closely with industry and decision makers
- We provide a range of services, from modelling support to market insight

We advise half of the FTSE100 firms

LCP Energy Analytics

We have provided the modelling framework for a number of key decision makers…

Long term investment and dispatch forecasting

Department for Business, Energy & Industrial Strategy

Price and renewables forecasting

LOW CARBON CONTRACTS COMPANY

Security of supply modelling

nationalgrid

Assessing network charging reforms

ofgem

The role of hydrogen in a decarbonised energy system

Government targets

Capture 10Mt of CO2 per year

Establish a at least one power CCS project

Establish four low-carbon industrial clusters

Aim to bring at least one largescale nuclear project to FID

Build 40GW of offshore wind capacity, and 1GW floating

5GW of low-carbon hydrogen production capacity

Jet Zero and Green Ships

Decarbonisation of industrial processes

End installation of new gas boilers, and roll out 600k heat pumps each year

Ban sale of new petrol and diesel cars and vans

The role of hydrogen in a decarbonised energy system

Background and types of hydrogen production

Blue Hydrogen

Blue hydrogen requires natural gas to be split to separate the hydrogen and CO_2 through a process called Steam Methane Reformation (SMR) or Auto Thermal Reforming (ATR).

The hydrogen can be stored or transported for use.

The CO_2 must then be captured, transported and stored.

Industrial clusters would also use the transportation and storage infrastructure to remove CO_2.

Green Hydrogen

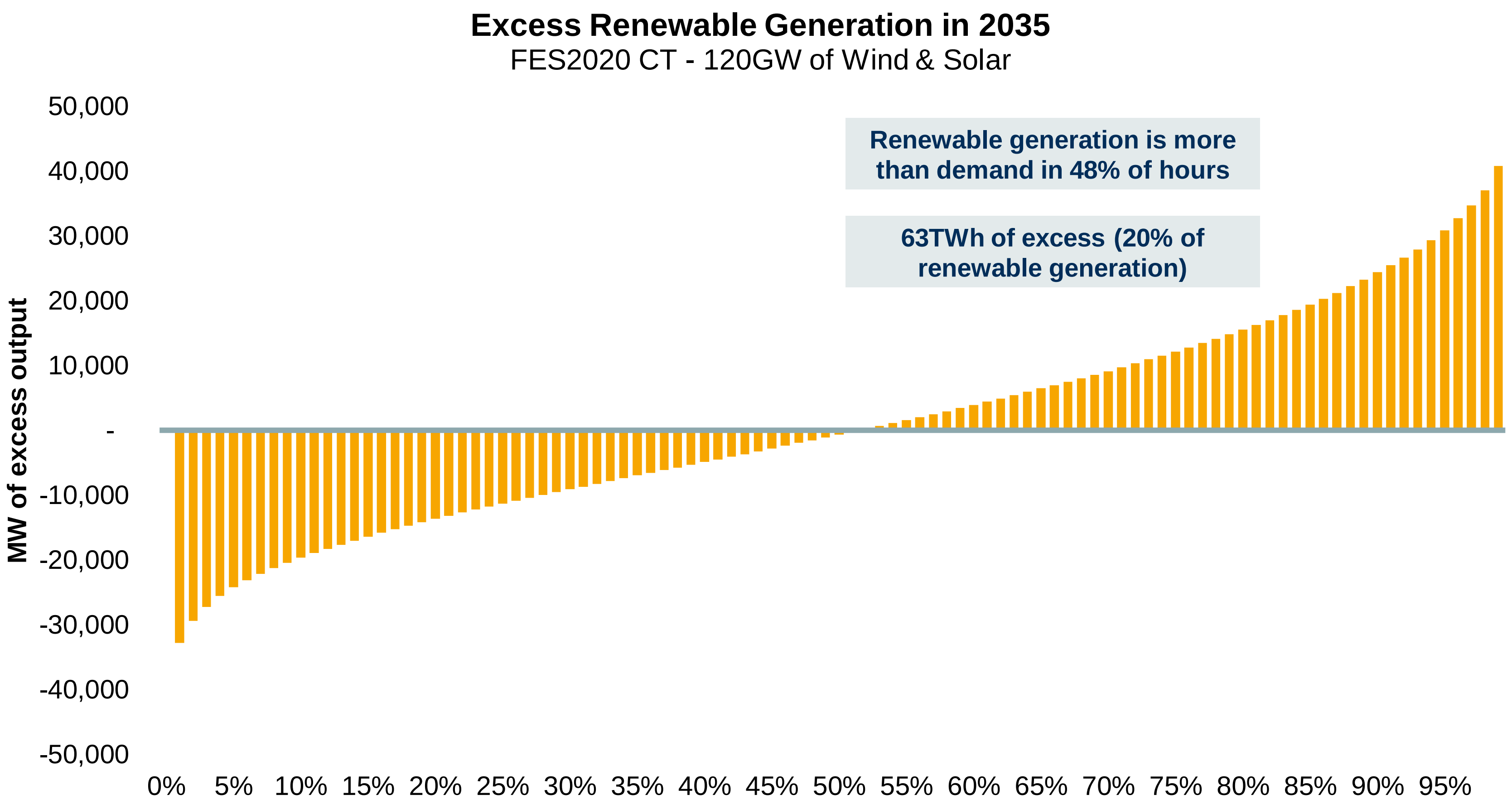
Green hydrogen is produced by splitting water using electrolysis. This produces hydrogen which can be stored or transported for use and oxygen.

The electrolysis process can be powered with either:

- Electricity imported from the grid
- Electricity produced from onsite assets (renewables or nuclear)

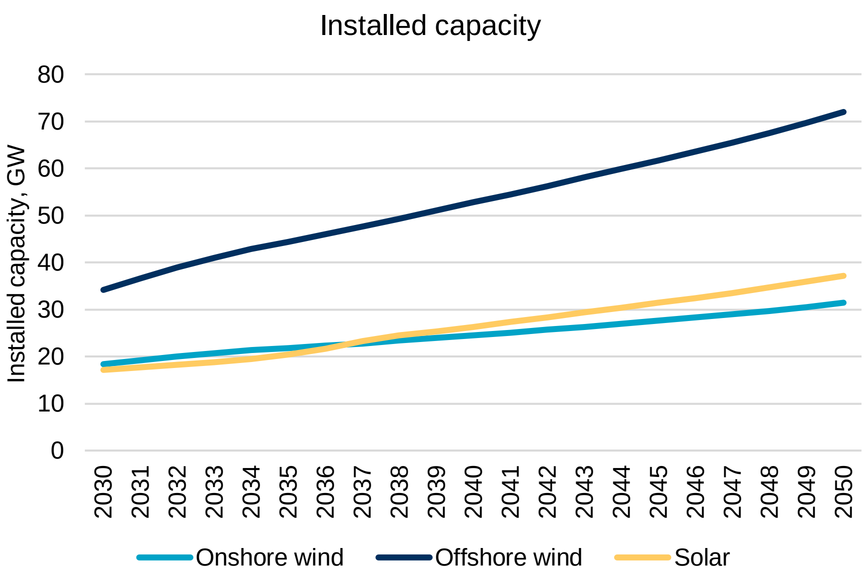
Opportunities from excess renewables

FES2020 Consumer Transformation, projects 120GW of wind & solar capacity by 2035. Large amounts of flexibility required, but zero prices & significant is curtailment unavoidable without great expense.

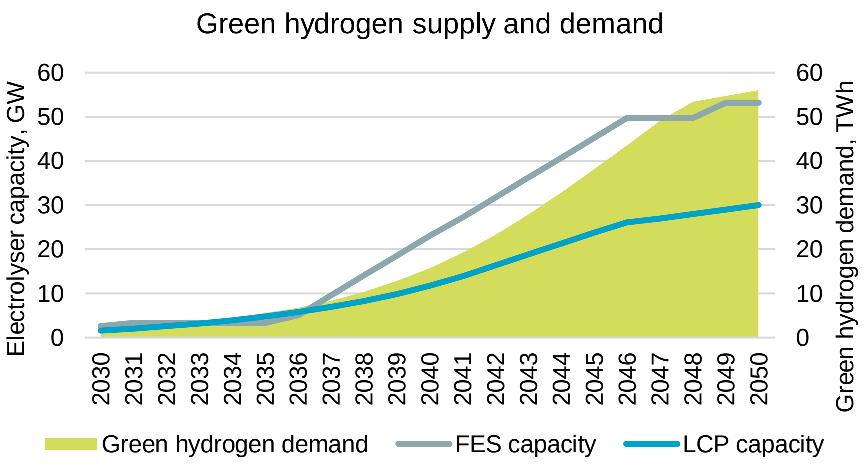


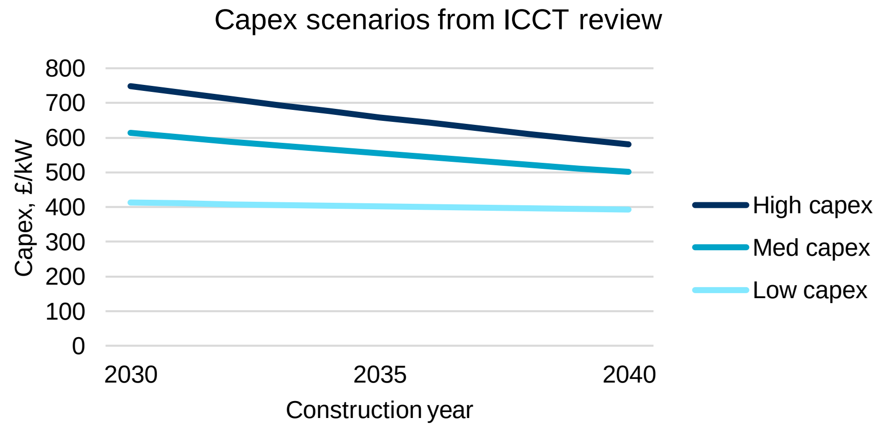
The investment case for electrolysers

Evaluating a marginal 1GW of electrolysers



- Our background capacity mix is based on LCP's Net Zero Central assumptions
- Hydrogen demand assumptions are from NGESO's Future Energy Scenarios 2020, System Transformation
- We have reduced the level of electrolyser capacity in our modelling to match the demand for green hydrogen, assuming electrolysers consume excess renewables.
- Capex and Opex assumptions are taken from a literature review by the International Council on Clean Transportation (ICCT).

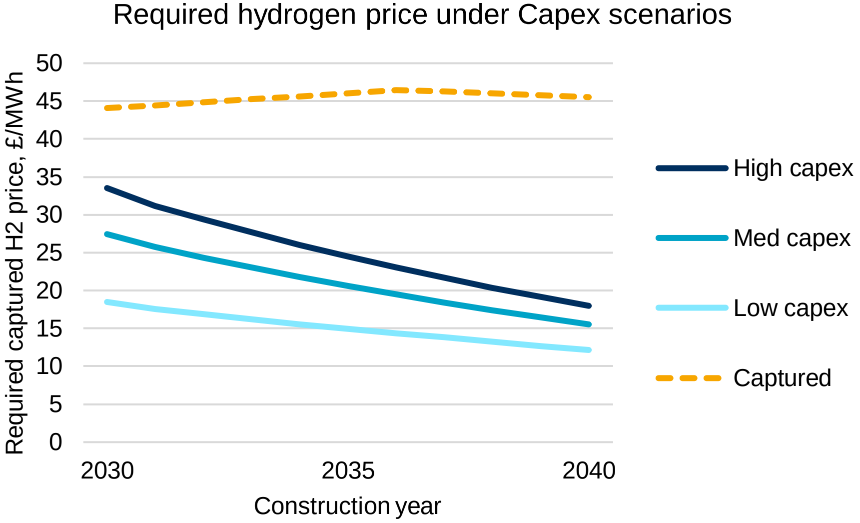


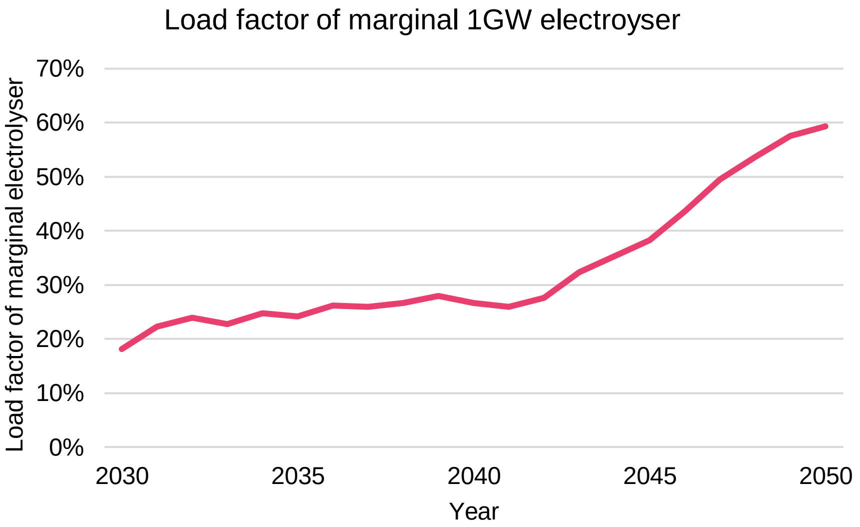


ICCT paper: https://theicct.org/sites/default/files/publications/final_icct2020_assessment_of%20_hydrogen_production_costs%20v2.pdf

The investment case for electrolysers

Evaluating a marginal 1GW of electrolysers





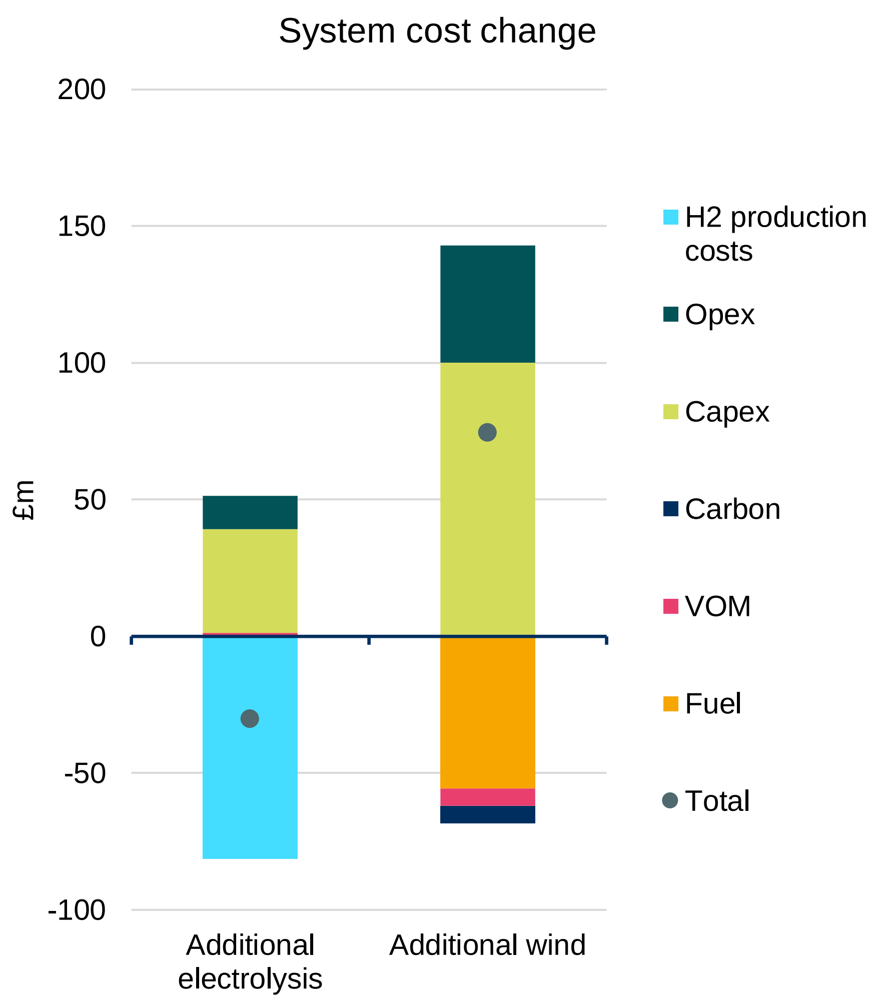
- We examined the **first 1GW** of electrolyser capacity built and looked at its performance between 2030 and 2040.
- The chart compares its levelised costs against an estimated captured price of hydrogen for its lifetime.
- This analysis shows that under all capex assumptions, the captured price is adequate to cover the levelised costs
- This suggest that there is a strong investment case for small amounts of electrolyser capacity.
- The chart below shows the load factor of the first 1GW built in 2030.

Key assumptions

- Capex assumptions sourced from literature review by ICCT
- Hydrogen price estimated assuming marginal SMR CCS (Comes out at roughly double the gas price)
- Both the captured price and levelised costs do not include transportation costs of hydrogen

The investment case for electrolysers

System cost impacts of marginal 1GW electrolysers

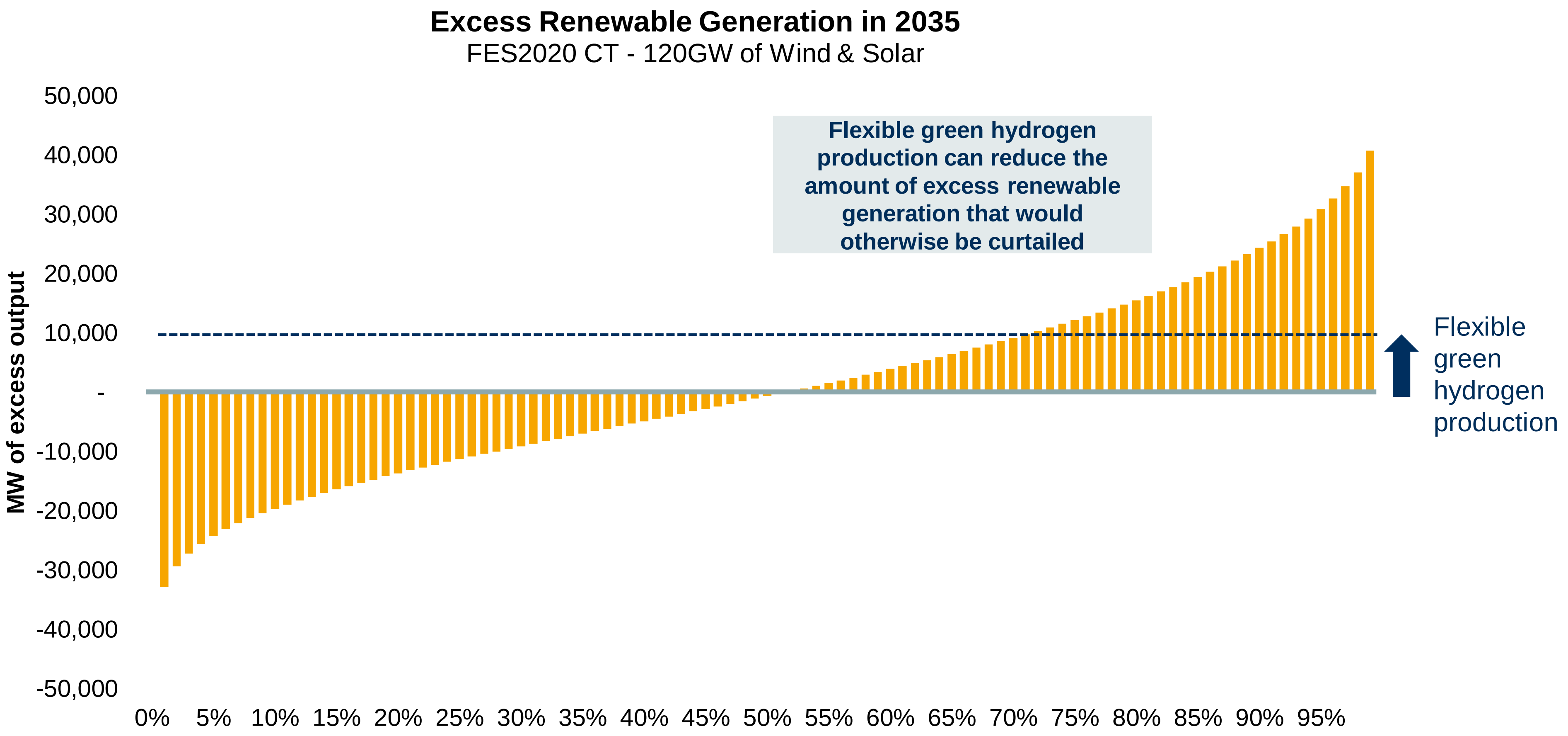


- We evaluated the system cost benefits in the power sector of **the first 1GW of electrolysers in 2040**.
- We compared against building additional offshore wind to reach the same overall renewable generation use **(1,066MW)**
- With no other electrolysers on the system, the first 1GW has a high load factor. Additional wind capacity reduces the load factors of other renewables, so a large amount is required to match overall renewable generation use.
- As before, building additional wind reduces variable costs of dispatchable generation
- The electrolyser has a significant impact on the system costs of hydrogen production by displacing blue hydrogen.
- Overall, this suggest that there is a system cost benefit to building the first few units of electrolysers.

Other assumptions

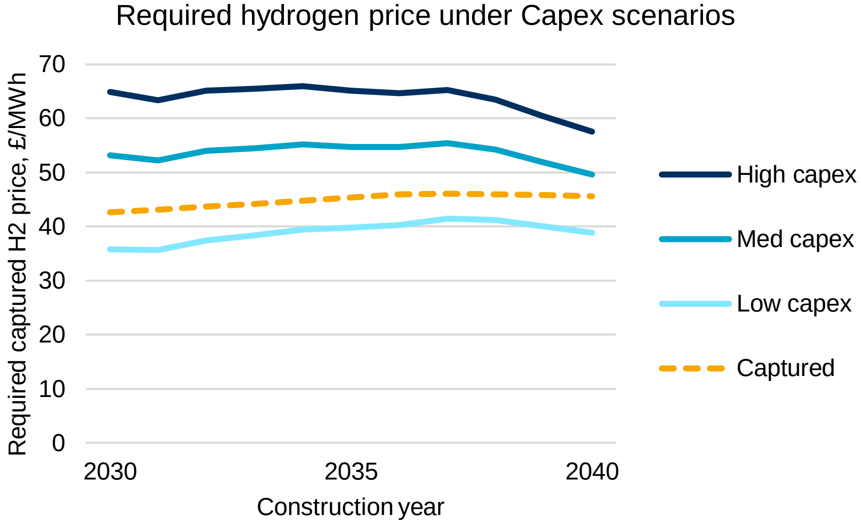
- We have not considered the impact on capacity adequacy as both wind and electrolysis as assumed to provide minimal system security in 2040.

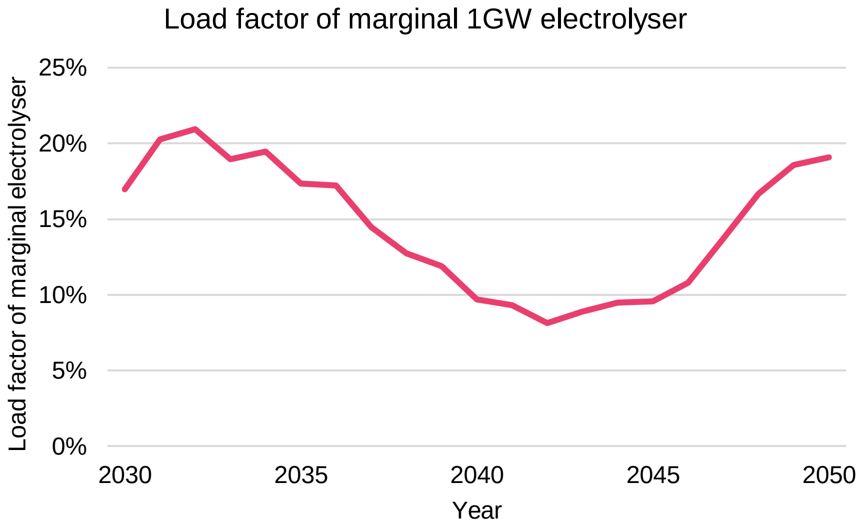
The energy sector in 2030s and beyond



The investment case for electrolysers

Evaluating a marginal 1GW of electrolysers





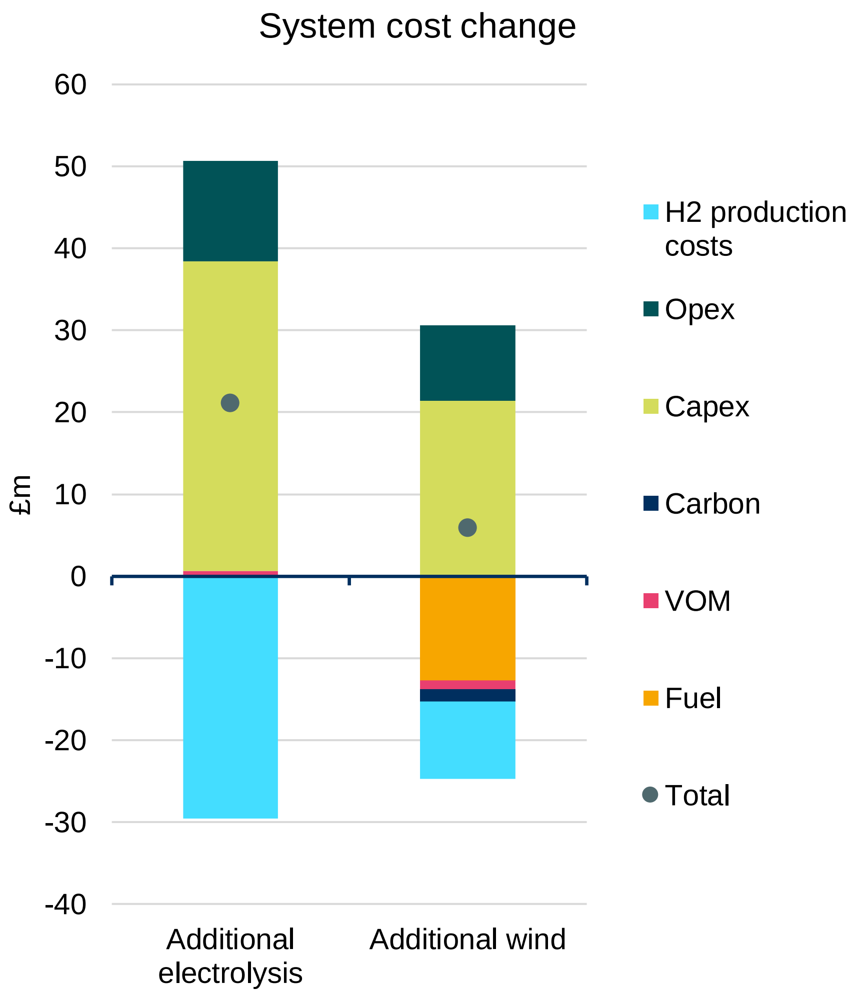
- We examined the **last 1GW** of (the 11th GW) electrolyser capacity built and looked at its performance between 2030 and 2040.
- The chart compares its levelised costs against an estimated captured price of hydrogen for its lifetime.
- This analysis shows that under low capex assumptions, the captured price will cover costs. However, at higher capex cost assumptions, support would be required.
- The levelised cost is very dependent on the load factor of the marginal 1GW electrolyser. The chart below shows the load factor of the final 1GW built in 2030.

Key assumptions

- Capex assumptions sourced from literature review by ICCT
- Hydrogen price estimated assuming marginal SMR CCS
- Both the captured price and levelised costs do not include transportation costs of hydrogen

The investment case for electrolysers

System cost impacts of marginal 1GW electrolysers



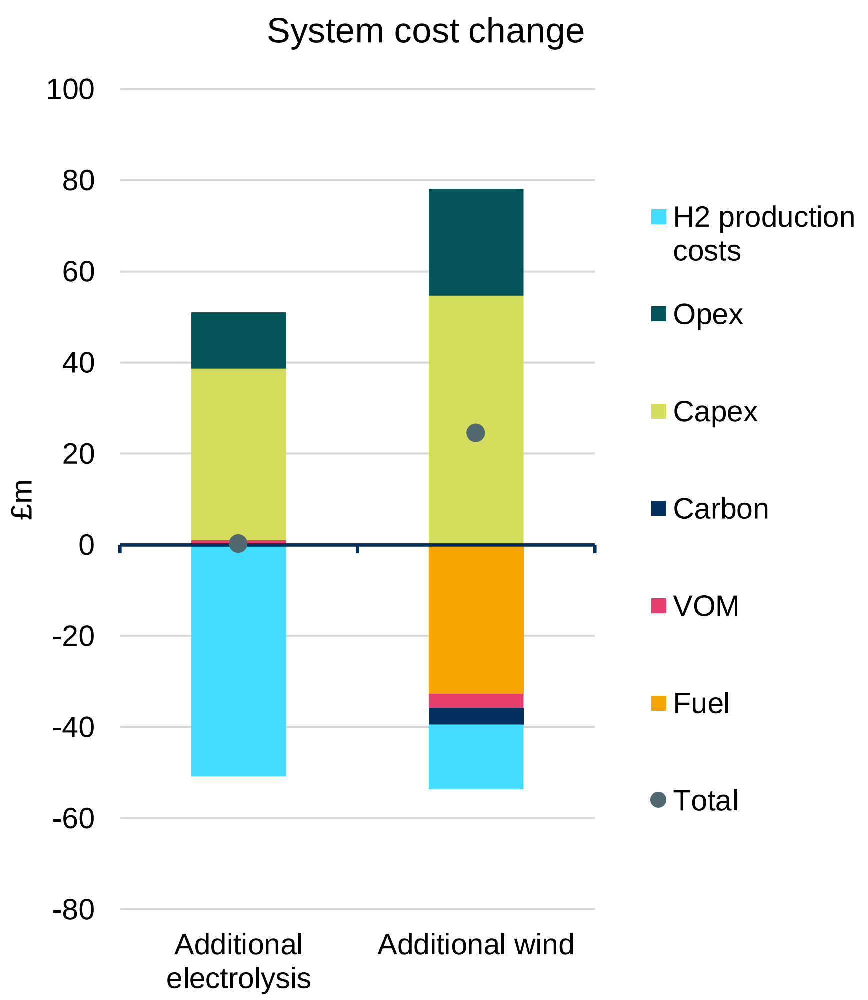
- We evaluated the system cost benefits in the power sector of **the last 1GW of electrolysers in 2040**.
- We compared against building additional offshore wind to reach the same overall renewable generation **(229MW)**
- The last 1GW of electrolysers do not replace much offshore wind, so the capex and opex costs incurred are much higher.
- Building additional wind capacity provides generation capacity, which electrolysers do not. Therefore, the additional wind reduces the load factors of dispatchable generation, reducing variable costs.
- In both cases, some blue hydrogen production costs are offset, more so for additional electrolysers.
- Overall, this suggest that at this level of build, the last 1GW of electrolysers should be replaced by wind.

Other assumptions

- We have not considered the impact on capacity adequacy as both wind and electrolysis as assumed to provide minimal system security in 2040.

The investment case for electrolysers

System cost impacts of marginal 1GW electrolysers



- We evaluated the system cost benefits in the power sector of **the central 1GW of electrolysers in 2040, i.e. the 6th GW of 11GW**.
- We compared against building additional offshore wind to reach the same overall renewable generation **(584MW)**
- In this case, the system cost benefit of the electrolyser is relatively neutral and it is still preferred to additional wind build.
- This suggests shows that there is a place for significant investment in electrolysis and that it can be used as a preferable alternative to building additional renewables.

Other assumptions

- We have not considered the impact on capacity adequacy as both wind and electrolysis as assumed to provide minimal system security in 2040.

The role of hydrogen in a decarbonised energy system

Electrification or hydrogen

More electrification — *Less electrification*

Domestic vehicles and heavy goods

Power Generation

Industrial processes

Long distance aviation and shipping

Deployment of heat pumps

Hydrogen boilers

Short haul aviation and shipping

At LCP we combine in-depth knowledge of the energy sector with modelling expertise to help our clients make informed decisions.
Our products and consultancy services have developed over many years of close engagement with government and industry, and are used by policy makers, strategists, investors, operators and traders in the UK and Ireland