

Hydrogen: Help or Hype?

Hydrogen in the Future Energy Supply

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Honorary Fellow of Institute of Physics

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Was Kemi right?

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Badenoch: Net zero by 2050 is impossible

Tory leader drops support for 'unrealistic' target, saying it cannot be reached without bankrupting Britain



973



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"I am not making a "moral judgment" on net zero or debating whether climate change exists, but that the target to reach net zero emissions by 2050 cannot be achieved without a drop in living standards."

targets for electric vehicles, banning fossil fuel cars, mandating heat pumps/banning gas boilers.

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But do people even care?



People do want to leave a better planet

People are prepared to do easy things
.....BUT not turn down heating etc

People do support climate initiatives
.....BUT only if it doesn't cost them anything
.....AND
electrifying ovens leads to circa
10p rise in cost of loaf

SINGLE ACTION SATISFACTION

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But why do we need to do this? A bit of revision:

We need to decarbonise!

- We **could** use green electricity for everything.....
 - Personal Transport - battery powered road vehicles
 - HGV's – battery powered trucks
 - Trains – electric rails
 - Flight – battery powered planes?
 - Central Heating - Heat Pumps
 - Heavy Industry – steel, cement, glass
 - Food production – electric ovens
 - Etc

BUT.....



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The UK's problems

UK can't generate enough electricity

- Currently maximum of ~1kW per person including gas generation (often >50%)
- UK certainly can't generate enough via renewables
- UK infrastructure (the National Grid) installed in 1960s for much lower power flows
- Already many off-shore projects waiting for grid connections



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Let's not be negative.... BUT.....

What about	Hmmm
Lots of wind farms – offshore on East Coast or around Scotland	problems persuading people to accept lots more pylons – planning restrictions
Cable bringing solar power from Morocco	Too many joints so it's very likely to fail repeatedly
Used cooking oil for sustainable aviation fuel	Makes used cooking oil a valuable commodity - more expensive than virgin oil
Microwaves beaming energy from space	Would fry anything that gets in the way – planes, birds
Drax Power Station burning Wood Pellets instead of coal	Creates more emissions in transporting by ship them to UK
Use emission reduction offsetting to mitigate carbon emissions – > Net Zero	Young trees don't absorb enough and may not even survive the rising temperatures

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Question – Can Carbon Offsetting Help

- Is offsetting an affordable way to net zero?

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Case Against Emission Reduction Offsets

- Front loads low-cost emission reduction projects
- Postpones the more expensive /harder projects
- Cuts the cost of achieving net zero now but redistributes it over time
- Relies on predictability of politics and climate
- VERRA analysis says 90% of offsetting projects are worthless

Professor Myles Allen, Oxford

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VERA

PROGRAMS ▾ PROJECTS ▾ RESOURCES ▾ LATEST ▾ ABOUT ▾ CONTACT 🔍

VERIFIED CARBON STANDARD

The world's leading greenhouse gas crediting program

VCS PROGRAM DETAILS →

Professor Myles Allen, Oxford Katingan Peatland Restoration and Conservation Project in Indo

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Why we need like-for-like offsetting

Storage in the **Geosphere** not the **Biosphere** is better because:

- Land is limited – all land that could be used for offsetting cannot be used for something else eg food production
- Surface carbon stores are valuable therefore vulnerable
- Carbon Dioxide injected into rocks is valueless and hence safer.

Professor Myles Allen, Oxford

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Conclusion: offsetting to get to net zero?

Don't rely on planting trees – be cautious about 'offsets'

Need to develop

- Carbon Capture technology
- Geosphere storage rather than biosphere storage

Investment required BUT don't hold your breath....

- There is no silver bullet

.....**BUT hydrogen has to be part of the solution**

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Question: does hydrogen help?

- Does hydrogen help us get to carbon neutrality?
- And can it help overcome “Kemi's Concerns”?
- Is it affordable?

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More Revision: Hydrogen and carbon neutrality

Hydrogen – a light carbon free gas

Can burn in ovens and in gas boilers

Can generate electricity in Hydrogen Fuel Cells for cars, boats, planes, HGV's, trains.....

Totally carbon-free – can help get us to net zero!

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Reminder

**Last time:
I spoke
about H21**

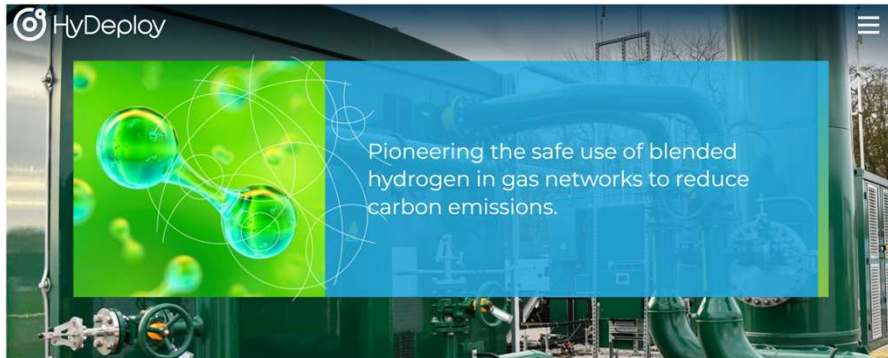
**Leeds CityGate
feasibility study.**

**Confirmed conversion of the
UK gas network to 100%
hydrogen was technically
possible at a realistic cost.**

Northern Gas Networks 2016

14

HyDePloy



2022: Demonstrated how **blended hydrogen** can be used safely.

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Hy4Heat

Hy4Heat Report
Final Progress Report

April 2022 including:

- Safety assessment
- Appliance development
- Meter development



Hy4Heat
demonstrating
hydrogen for heat

Department for
Business, Energy
& Industrial Strategy

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FutureGrid

FutureGrid is an ambitious programme which seeks to build a hydrogen test facility in Northern England

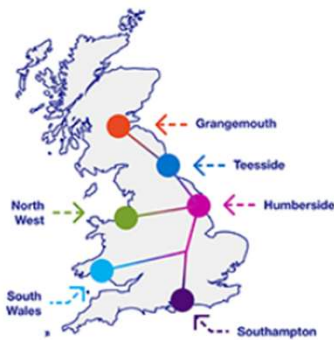
**National Grid
FutureGrid**

First of many steps towards a **full-scale conversion** of the existing National Transmission System (NTS) **to transport** hydrogen.

Hydrogen ‘backbone’ across UK

Hydrogen could be used to decarbonise our industrial clusters.

As the clusters **develop**, we stand ready to **join** them up.



ProjectUnion
Launch Report

May 2022

Project Union National Grid Reported March 2021

Hydrogen Villages



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Reducing heating emissions in Whitby, Ellesmere Port

The UK is on an important journey to make heating more environmentally-friendly. Bringing low-carbon hydrogen to heat homes and businesses is the next exciting milestone.



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Homeowner Professional Search

How to buy Products Advice Support About MyBosch

Excellent ★★★★★ ★ True

Home > Hydrogen



Hydrogen-fired boiler

For the heating and hot water industry, removing carbon entirely is a complex matter, largely because of the existing infrastructure, where the majority of UK homes use natural gas for heating.

Bosch has 17 patents in place for hydrogen appliances.

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Capital Hydrogen

THE CAPITAL HYDROGEN PROGRAMME

Working in partnership to deliver hydrogen for London, the East of England and the South East

Cadent

nationalgrid



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Big News!

Plans for hydrogen to be blended into UK gas network - up to 20%!

.....no change to appliances

.....no reduction in safety

.....***but is there a cost implication?***

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Where does the Hydrogen come from?



Windfarms!
(and imports)

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Night time: Demand < Supply

UK power demand typical summer daytime peak of around **30 GW**
(National Grid)

At night (this) can fall to **17 GW**.

UK has 31.3 GW of "uncontrollable" generation

(23.2 GW renewable generation, plus 8.1 GW of nuclear: BEIS)

<https://physicsworld.com/a/too-much-of-a-good-thing-an-excess-of-uk-renewables/>

physicsworld | 🔍

Magazine 1 Lates

Too much of a good thing: an excess of UK renewables?
31 Oct 2018 Dave Elliott



(Courtesy: Shutterstock/hru)

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How does this work?

Will have local producers around the UK e.g.

- 1st = **Whitelee** on-shore windfarm nr Glasgow – 20MW electrolyser
- **Humber Hydrogen Hub** – H2H Saltend - green & blue hydrogen
- **Hynet NW HPP1** - capacity 350MW hydrogen
- British Gas to supply hydrogen into gas grid
- % will vary by region depending on availability
- gas operators will sell to customers – *Cadent, Northern Gas Networks, SGN (Southern Gas Networks covering Scotland and SE)*

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Can we afford it?

Industry cost challenge
- hydrogen vs electricity.

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Can we afford it?

Electricity from curtailed wind at periods of low usage

transmission uses existing infrastructure (cheaper)

no need for pylons (expensive)

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Domestic Electricity costs in Europe

UK – 37c/kWh

Germany 40.5

Netherlands 38.5

Denmark 37.5

Switzerland 36.5

Serbia 10

Hungary 9

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Domestic Gas costs in Europe

Uk 8.8 c/kWh

Sweden 37.2

Netherlands 18.3

Switzerland 17.5

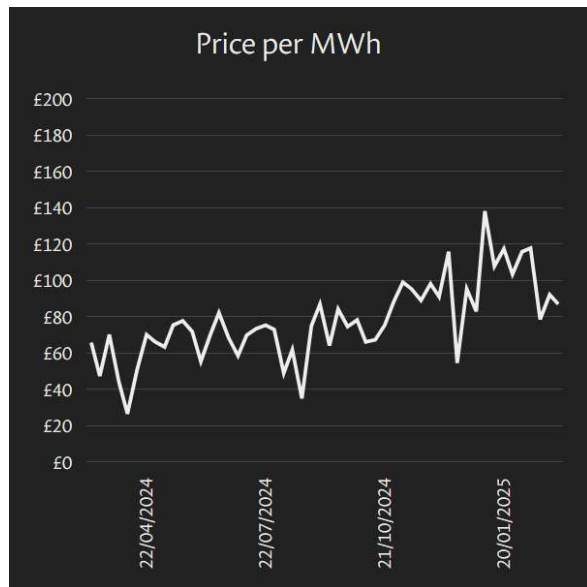
Ireland 12.0

Hungary 2.5

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Pricing

Wholesale price varies



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Future Electricity costs?

Elephants in the Room

Zonal Pricing
And
Nodal Pricing

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Zonal Pricing Pros and Cons

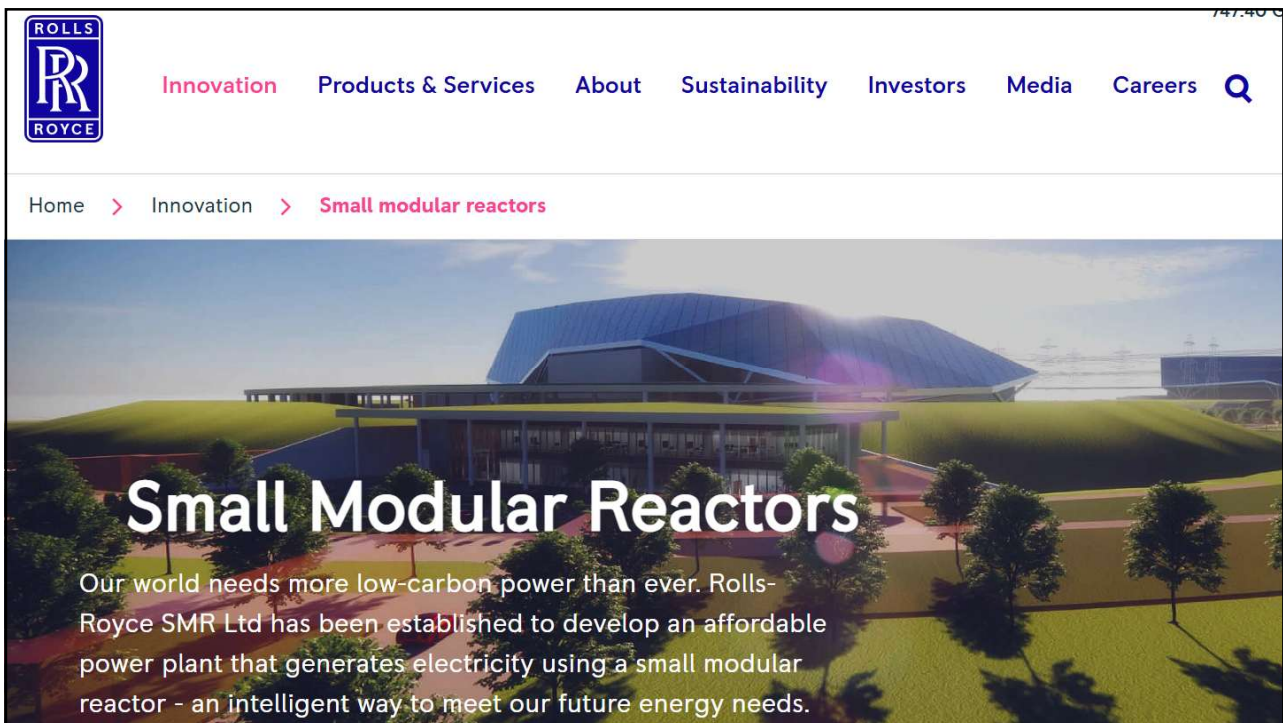
- **Zonal pricing** divides the grid into larger zones with a **uniform price**.
- Zonal price based on aggregated supply and demand across zone.
- Zonal prices are **more stable** and less volatile than nodal prices.
- Helps budgeting and planning for businesses and retail electric suppliers.
- Uniform zonal price does not reflect the true cost of delivering electricity to specific locations, potentially resulting in **inefficient** generation and consumption patterns.

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Nodal Pricing Pros and Cons

- **Nodal pricing**, locational marginal pricing (LMP): prices are determined at specific locations, or nodes where the electricity is injected or withdrawn eg power station
- Nodal pricing depends on electricity congestion costs and demand for transmission pathways.
- Nodal Pricing reflects **real-time** supply and demand conditions at each node.
- Nodal pricing encourages **efficient** generation and consumption of electricity.
- Generators are **incentivized** to produce power where it is most needed, and consumers can adjust their usage based on localized price signals.

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ROLLS ROYCE

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Home > Innovation > Small modular reactors

Small Modular Reactors

Our world needs more low-carbon power than ever. Rolls-Royce SMR Ltd has been established to develop an affordable power plant that generates electricity using a small modular reactor - an intelligent way to meet our future energy needs.

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Is Hydrogen Safe?



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Is it safe?

Hydrogen:

- Existing controls and installation techniques work well
- POLYETHYLENE linings of current gas grid -> impermeable
- no need for changes except a few new gas sensors

(Project Hy4Heat and FutureGrid)

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**Hydrogen
storage –**

Is it safe?

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**Hydrogen
Fuel
Tanks?**

- NOT liquified hydrogen
- NOT at super high pressure
- NOT ultra low temperature
- NOT about to explode

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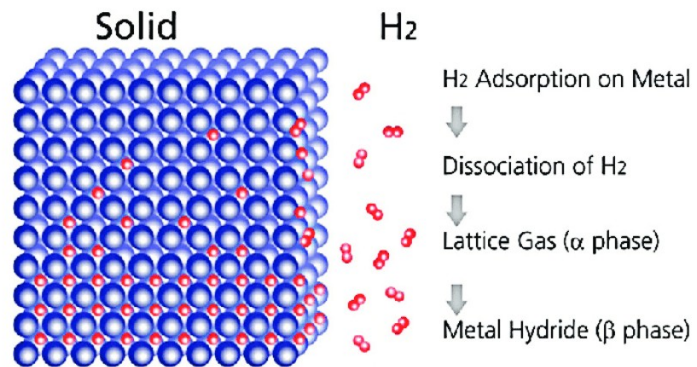
Hydrogen Fuel Tank



- Conventional hydrogen storage tanks are large or high pressure, both of which are safety risks.
- GKN Powder Metallurgy's Hy2Green storage tanks are safe and effective energy stores.

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The clever bit



- Metal hydride powder fills tank (e.g. ALH₃)
- Hydrogen fills interstitial gaps
- Greater H₂ density than if it were a liquid!

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Will Hydrogen Work?

In kitchens

- Research at Tysley Energy Park, University of Birmingham

4 appliances undergoing testing

“astonished at effect of heat in oven

– had to turn down thermostat by 10-15 degrees”

Development Chef:

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Commercial Kitchens

Gas companies developing safety standards and regulations to cover ovens.

Assessment of buildings being published

Insurance companies are on board

Burner manufacturing already in place

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Hydrogen Kitchen – Falcon Foodservice



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Hydrogen Kitchen – Falcon Foodservice

- [YouTube](#)

- <https://www.youtube.com/watch?v=AOX0RQTCZTY>



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It's real!

Tysley Energy Park, Birmingham

- <https://www.youtube.com/watch?v=AOX0RQTCZTY>

“anyone wanting to use the kitchen facility and wanting to discuss separate additional test and development facilities for Hydrogen industrial ovens, then they would need to speak to at Tyseley Energy Park and how to assist in safely installing an industrial hydrogen oven”.

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Question: where do we stand?



are we ahead/behind globally



and why?

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Where do we stand?

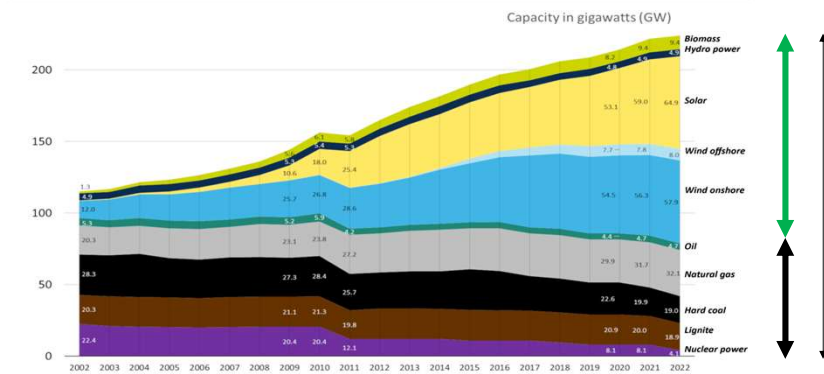
Germany has stated it will not fully electrify

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Germany

Installed net power generation capacity in Germany 2002 - 2022.

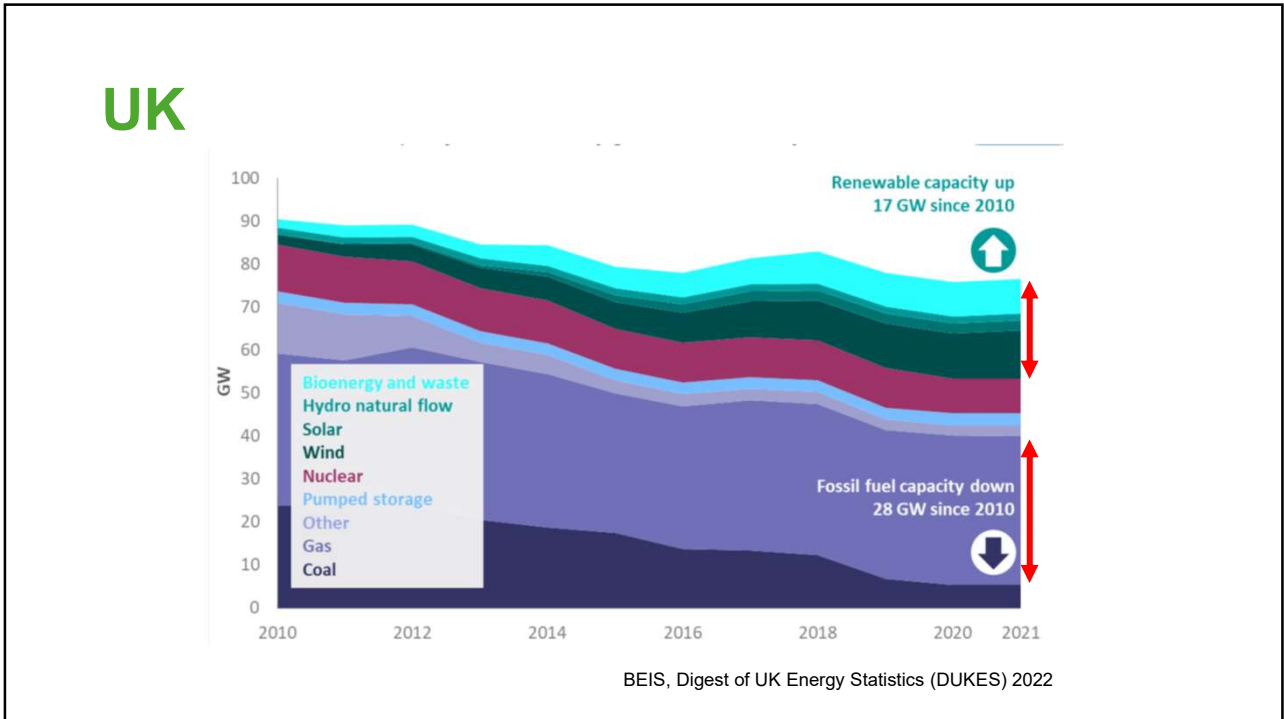
Data: Fraunhofer ISE 2022 (2022 status of 19 December).



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<https://www.cleanenergywire.org/factsheets/germanys-energy-consumption-and-power-mix-charts>

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Hot off the Press....

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How Hydrogen?

- Very much import/export led
- Countries with large land mass investing facilities
- Project Neom (Saudi Arabia) increased from \$4bn -. \$8.8bn

BIGGEST ISSUE

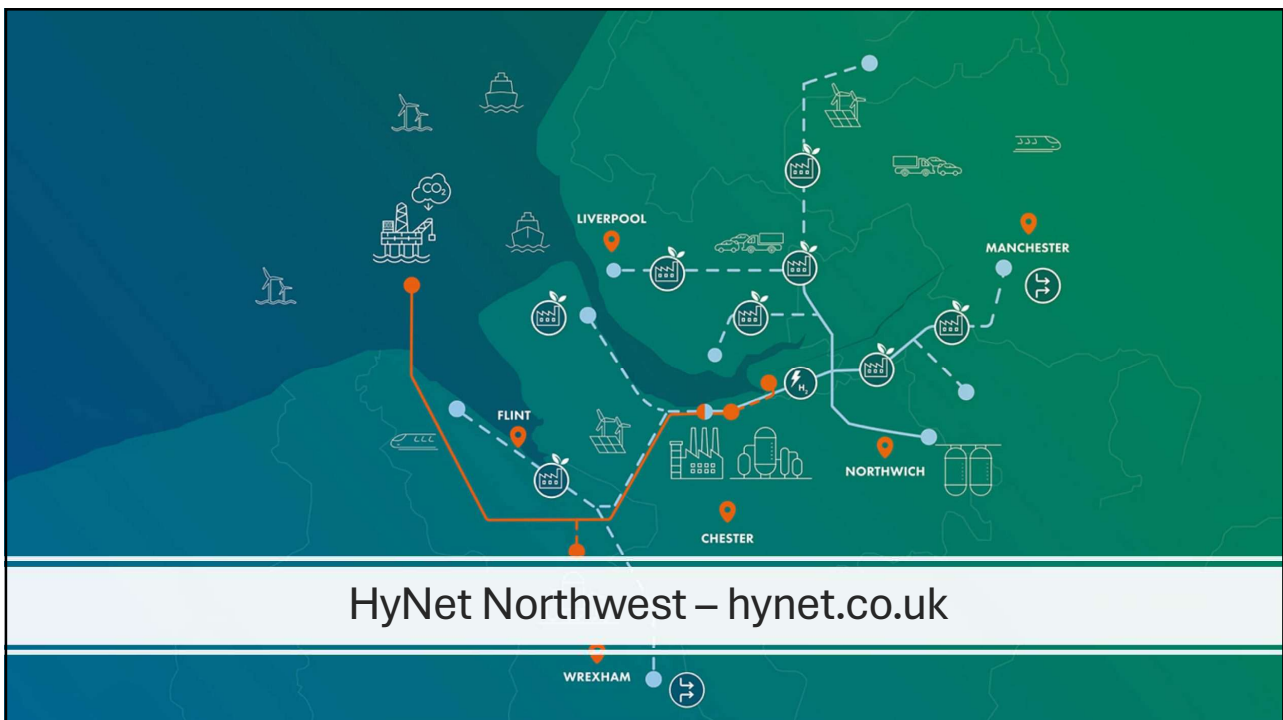
– skilled workforce

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Mystic Meg?.....

- If you were to speak at this event in 5 years' time - would things have changed significantly?

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Hynet HPP1

- HyNet Northwest unlocks a low carbon economy for the Northwest and North Wales
- puts the region at the forefront of the UK's drive to net zero.
- HPP1 will have a production capacity of **350MW hydrogen**
- HPP1 will capture around 600,000 tonnes of CO2 a year – the equivalent to taking around **250,000 cars off the road**.
- HyNet Cluster goal of **developing 4GW of low carbon hydrogen production** for industry across the NorthWest of England to decarbonise operations, protect jobs and drive economic growth.

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Essar Energy Transition - eethydrogen.com



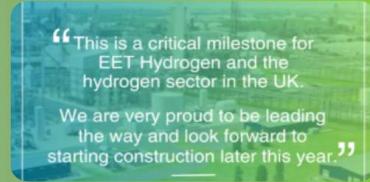
15 JANUARY 2025

EET Hydrogen and ENKA partner to deliver the UK's leading large scale low carbon hydrogen production plant (HPP1)



10 SEPTEMBER 2024

SSE and EET Hydrogen partner on green hydrogen production facility in the North West



8 FEBRUARY 2024

EET Hydrogen to proceed into final negotiations with UK Government to develop low carbon hydrogen plant in Ellesmere

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Keuper Gas Storage - kspg.co.uk



Keuper Gas Storage Limited (KGSL), a wholly owned subsidiary of INOVYN, is planning to develop a new underground hydrogen storage facility and associated development at the southern end of the Holford Brinefield and surrounding area, to the north of Middlewich in Cheshire.

The plans will see the previously consented Keuper Gas Storage Project (KGSP) amended to give the option of storing hydrogen rather than natural gas.

To underpin the UK's efforts to help tackle climate change and reach net zero emissions by 2050 INOVYN is planning the UK's largest hydrogen storage facility.

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carltonpower.co.uk



Hydrogen

Carlton Power are currently developing a number of green hydrogen production facilities around the UK. Three initial projects have been successful in gaining funding support from DESNZ: Barrow Green Hydrogen, Trafford Green Hydrogen and Langage Green Hydrogen.

The UK government aims to support 10GW of hydrogen production by 2030, with at least half from electrolysis, 1GW of which to be in construction or operational within two years of FID.

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INEOS GROUP, INEOS HYDROGEN, INEOS INOVYN

INEOS Inovyn starts customers trials with Daimler Truck AG, using Europe's first...



INEOS INOVYN, INEOS HYDROGEN, INEOS GROUP

INEOS Inovyn supports Daimler Truck AG to trial Europe's first heavy duty liquid...

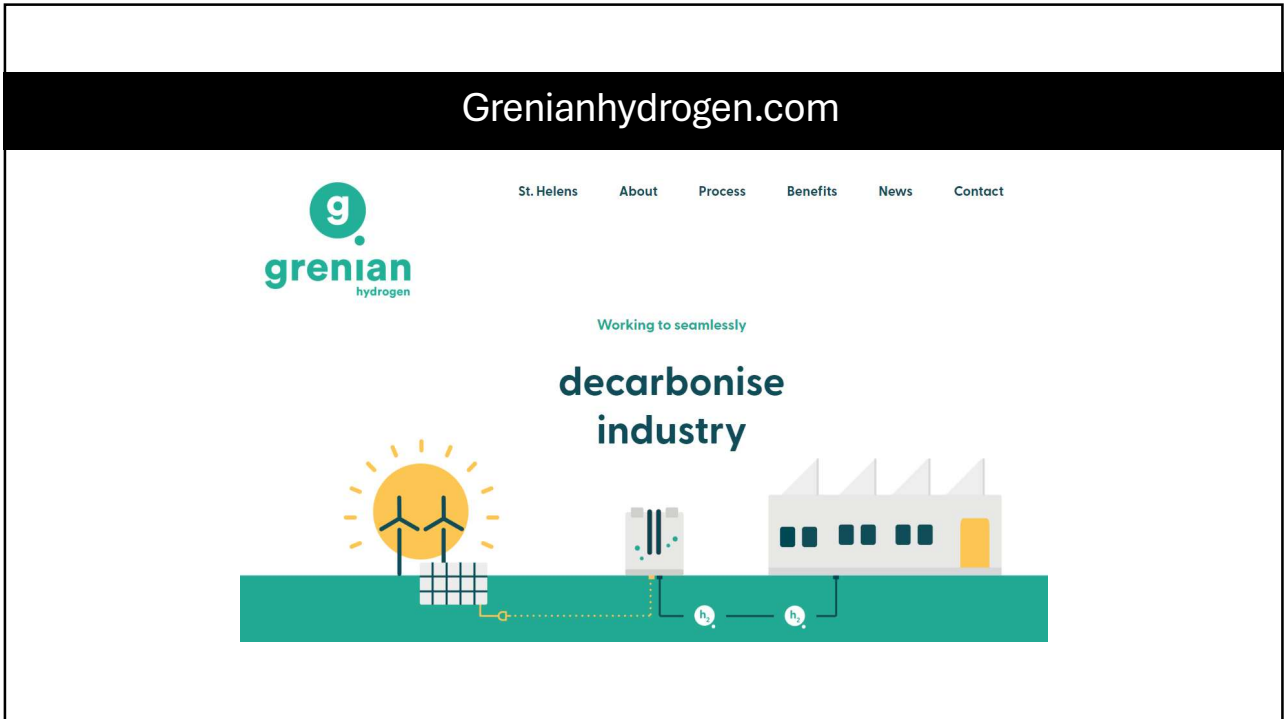


INEOS GROUP, INEOS HYDROGEN, INEOS INOVYN,...

INEOS Inovyn becomes Europe's first green hydrogen ISCC PLUS fully certificated...



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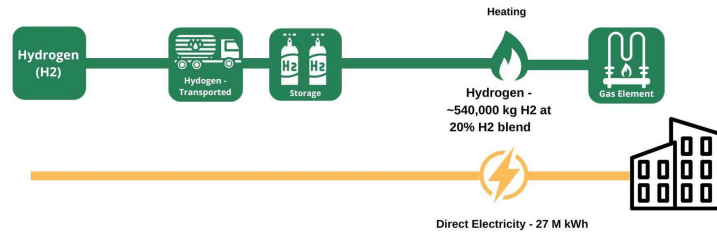
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RWE launches its Pembroke Net Zero Centre to help drive decarbonisation in South Wales

- RWE brings together its expertise to create a focal point for decarbonisation technologies
- The Pembroke Net Zero Centre aims to maximise the potential of hydrogen, floating offshore wind and carbon capture to help decarbonise industry in Wales

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Fully Hydrogen Solution in Food Production



Fuel	Units	FULL HYDROGEN
HYDROGEN		
Hydrogen - Annual	kg	2 700 027
Hydrogen - Month	kg	225 002
Hydrogen - Week	kg	18 750
Hydrogen - Day	kg	1 563
Hydrogen - 3 Days Storage	kg	4 688
CO₂ EMISSIONS REDUCTION		
Emissions from Natural Gas	kg CO ₂ e / kWh	0,183
Co ₂ Emissions Reduction	t CO ₂ / Year	16 470
Carbon Credits	£ / T CO ₂	50

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HydrogenUK



Hydrogen UK is a trade association committed to the development and deployment of hydrogen solutions

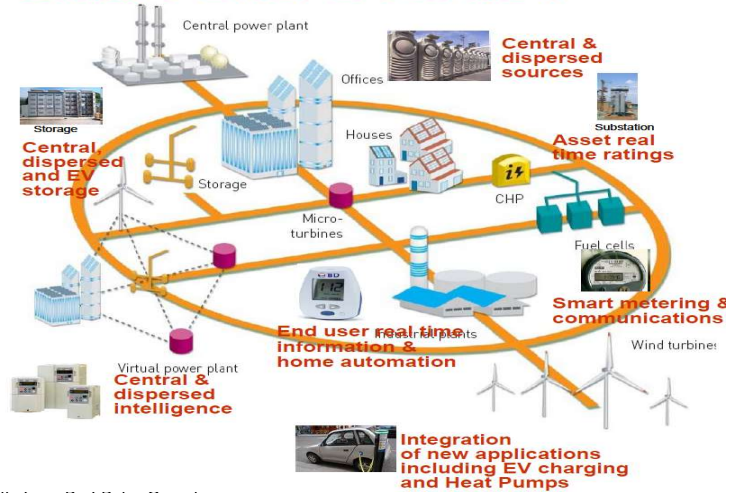
Hydrogen is essential to delivering net zero in the UK

We must act now to scale hydrogen solutions to deliver cost effective deep decarbonisation

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A mixed future

Smart Grid Overview



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One last thought....

- Why is Trump chasing rare earth metals in Ukraine and Greenland?

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