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HyDEX

Creating a new hydrogen economy in the Midlands

Hydrogen: the case for UK-EU collaboration

Funded by UKRI Research England

Delivered by ERA Energy Research Accelerator

Contents

The UK has **huge onshore geological capacity to store hydrogen** and could operate as the hydrogen lungs of Europe

Summary

The UK and the EU both see hydrogen as essential to achieving net zero and both have extensive and well-funded policies to support it.

Yet progress is far too slow.

Green hydrogen represents less than 1% of total production and still costs 6-14 times more than grey hydrogen. Only a tiny fraction of green or blue hydrogen projects have reached final investment decision (FID). Some 2030 targets look set to be missed in both the UK and EU.

In many proposed applications, hydrogen is being eclipsed by electrification. But in other areas, hydrogen and its derivatives still seems like one of the best, or possibly the only option, such as in fertiliser production, shipping, jet aviation and long-duration grid balancing.

What's more, regardless of the higher production costs of cleaner forms of hydrogen, its system benefits in terms of greater energy security and lower overall energy system costs still look potentially enormous.

It is therefore time to take stock. Both the UK and the EU need to ask what their policy is getting wrong and whether they could make faster progress, and at lower cost, by working together.

In 2024, HyDEX (Hydrogen Development and Knowledge Exchange) and ERA (Energy Research Accelerator) held a series of summits in Brussels and London where academics, policymakers and industrialists agreed the arguments in favour of greater collaboration look strong:

- **The potential system-level benefits should be larger for the UK and EU together than apart**
- **North Sea depleted gas fields, platforms and pipelines could be repurposed for hydrogen storage and transport**
- **The UK has huge onshore geological capacity to store hydrogen and could operate as the hydrogen lungs of Europe – to the benefit of both sides**
- **The EU and some member states have signed hydrogen supply memoranda with countries as far afield as Kazakhstan, Saudi Arabia and Indonesia, but the European Court of Auditors' review of hydrogen policy recommended the EU should "make strategic choices without creating new strategic dependencies"**
- **The new British government is looking for ways to improve relations with the EU short of rejoining and hydrogen could be a relatively contained and mutually beneficial area**
- **Now the UK is back in the Horizon programme there is a well-established and well-funded framework for research and technical collaboration**

We therefore propose that the UK and EU should set up a Hydrogen Taskforce to investigate the potential benefits of working together and produce a draft Hydrogen Agreement.

The Taskforce would identify areas and cross-border projects where the two sides could pool resources for mutual benefit, plan a hydrogen market, analyse how to clear barriers in financing, agree common standards, and devise a platform through which to share best practice. The Agreement would codify the conclusions and provide a framework for putting them into practice.

The Taskforce would be led by representatives of the UK government and the European Commission, and include members from industry, grid operators, trade associations, energy traders and universities. Working groups would include policy, safety, public acceptance, decarbonisation, whole-system modelling, markets and financing.

In particular, we think the UK and EU should consider a cross-channel hydrogen pipeline and storage facility linking UK with the planned European hydrogen grid. Britain has already discussed with Germany the idea of building an export pipeline to supply that country's industry.[1] We fear that bilateral deals risk slowing progress and think an overarching agreement between the UK and the EU would be more effective. Any agreement should consider two-way transport of hydrogen so that potentially huge UK storage capacity can be integrated with the wider European Hydrogen Backbone. Any such project would require the UK and EU to develop a joint hydrogen market, and to resolve any issues around hydrogen types, carbon trading schemes and the Carbon Border Adjustment Mechanism.

The precise contents of the Agreement are for the Taskforce to decide, but we believe they should include: common safety standards, joint support for UK-EU cross-border pipeline and storage projects, a UK-EU hydrogen market, support for modelling of whole-system benefits, and a platform through which to share best practice – perhaps building on the EU's Hydrogen Valley programme.

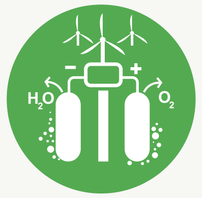
Together the Taskforce and Agreement could release strategic and economic benefits generated by system efficiencies at the UK-EU level; accelerate development in areas where hydrogen has clear advantages; set up a joint hydrogen market to help bring prices down; ensure that the development of hydrogen applications and infrastructure genuinely helps reduce CO_2 emissions; establish common safety and skills standards; and support a just transition by providing opportunities for former oil and gas workers.

If successful it could solve some of the biggest challenges of energy security and cost presented by net zero.

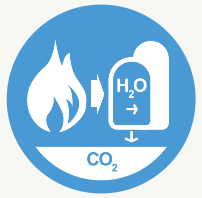
We propose that the UK and EU set up
a Hydrogen Taskforce
to investigate the potential benefits
of working together

BOX 1: **Hydrogen terminology**

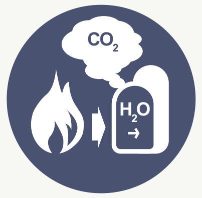
The different types of hydrogen production are widely described, although loosely defined, as colours:



- **Green hydrogen** is produced by electrolysers powered by renewable generation and regarded as emitting no greenhouse gases.

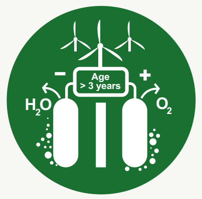


- **Blue hydrogen** is produced by steam reforming of natural gas and most of the carbon dioxide is captured and sequestered (CCS). The size of the remaining emissions is contested, however, in part because of leaks upstream in the methane supply. A recent study in the US has found these are four times higher than previously estimated.[2]

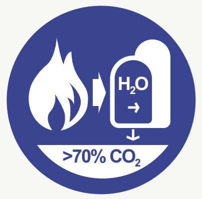


- **Grey hydrogen** is produced from natural gas without CCS meaning all the carbon dioxide is dumped to the atmosphere.

The EU's terminology is more precise.



- It refers to **"renewable hydrogen"**, which equates to green but with strict conditions: the electrolyser must either be directly connected to (say) a wind or solar farm built less than three years previously or, if grid-connected, secure a power purchase agreement that matches electrolyser output to renewable generation on an hourly basis.



- In EU terms, **"low-carbon hydrogen"** is similar to blue but more tightly defined as hydrogen produced from fossil fuels that nevertheless reduces lifecycle CO_2 emissions by 70% – implying the use of CCS. The EU has not yet legislated a methodology for measuring those lifecycle emissions to determine which projects qualify.

Introduction

After many cycles of hype and disappointment, hydrogen is at the cross-roads.

The dream of an all-encompassing ‘hydrogen economy’ has long faded. Many of the proposed applications for hydrogen, in areas such as road transport and railways, have been eclipsed by electrification.

However, in other areas, clean hydrogen still looks like the best or possibly only option.

Hydrogen is an unavoidable component of fertiliser, for example, without which much of the world would starve.

Only hydrogen or its derivatives seem likely to pack enough energy to keep airliners aloft or fuel long-distance container shipping.

And for the same reasons, hydrogen looks the best means of storing huge amounts of energy for long periods to balance annual and even decadal variation in renewable generation *(see Box 1 and Box 5)*. Using hydrogen in this way is likely to produce huge system-level efficiencies that reduce the overall cost to society and provide invaluable levels of energy security.

Separating these unavoidable and strategic applications of hydrogen from others where there are apparently cheaper and better alternatives has taken far too long.

In fact, making any progress is taking far too long, as the International Energy Agency concludes in its most recent annual review.[3]

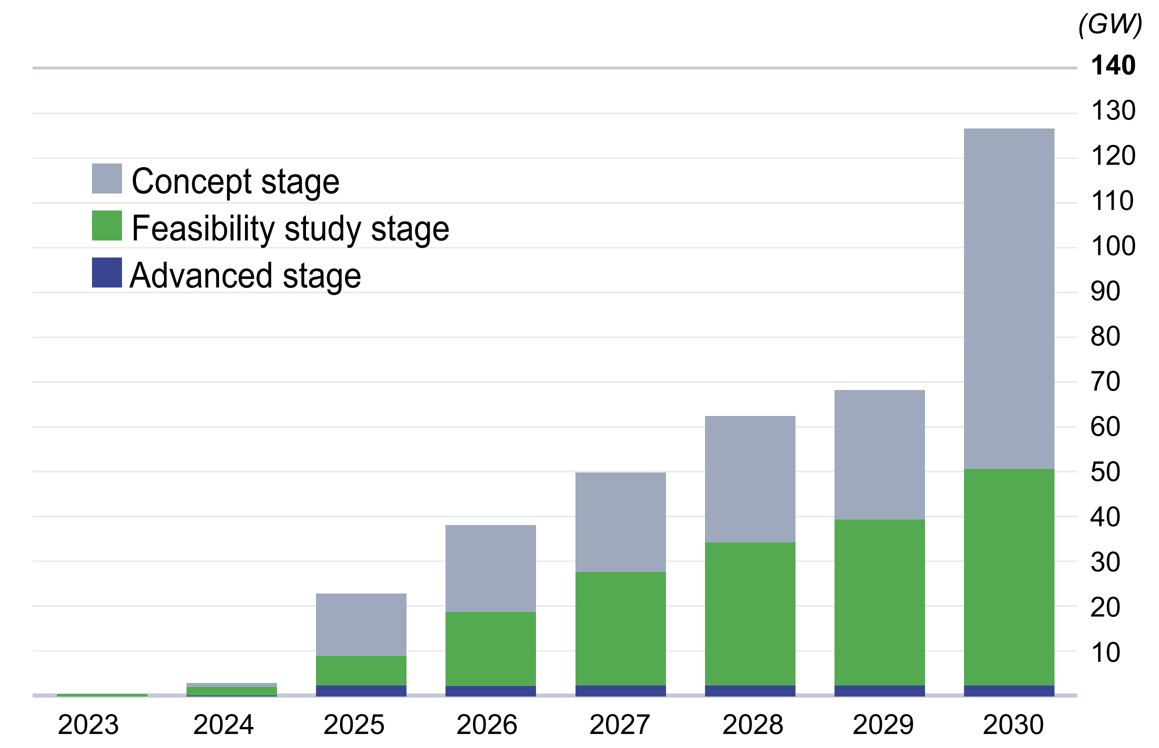
After years of work, **green hydrogen production represents less than 1% of the total** and will have to grow 100-fold by 2030 to match the IEA’s net zero pathway.[4]

Only a tiny fraction of proposed hydrogen projects have reached final investment decision (FID) both in Europe *(see Figure 1)* and worldwide. Electrolyser manufacturers had the global capacity to produce more than 54GW in 2024 but are forecast to ship just 4GW.[5] All but one are loss-making.

Progress is slow but time is short. Hydrogen clearly has a vital net zero role at the system level, and we need quickly to scale up production, transport and storage. Neither EU nor UK policy has yet cleared the fundamental barriers, yet there is a wealth of resources and capabilities on both sides.

The obvious question is whether we can realise the potential of hydrogen more quickly and at lower cost by working together than apart.

FIGURE 1: Electrolyser capacity of projects announced (cumulative, in GW) by stage and projected year of entry into operation (as of October 2023).



Note: Advanced stage includes projects that are operational, or where the stage is "under construction", or for which a final investment decision has been taken.

Source: European Court of Auditors[6]

At the system level
hydrogen has a vital net zero role

Hydrogen: the case for UK-EU collaboration

Barriers

The slow development of hydrogen is not due to any shortage of policy making. Both the UK and the EU have extensive programmes to support the development of hydrogen (see sections below). But so far, neither has overcome two fundamental barriers.

The first is a widely recognised chicken-and-egg problem.

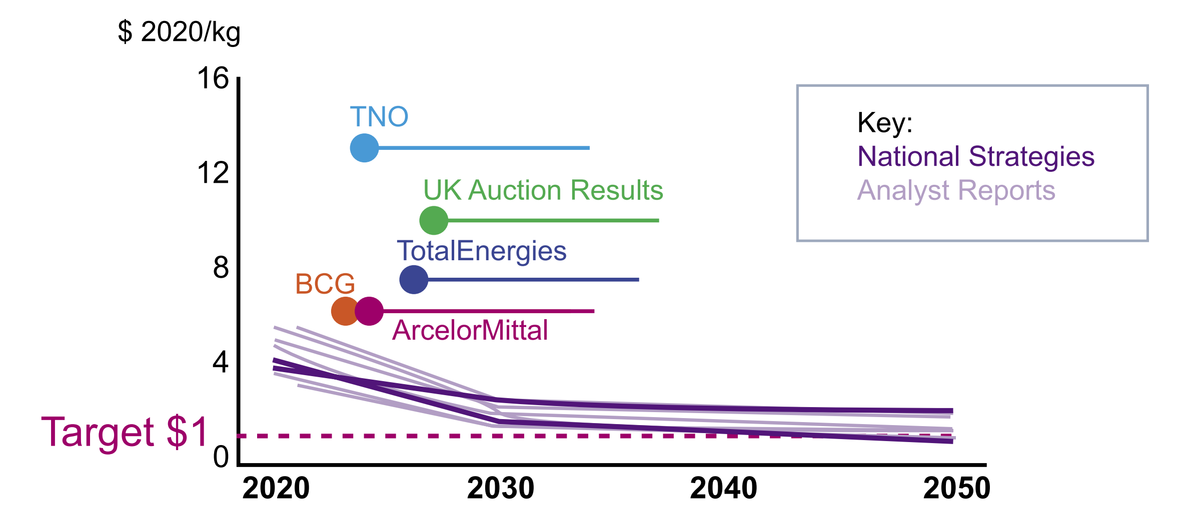
Electrolysers are expensive to build. To justify the investment project developers need to charge a high price for their output and persuade potential customers to commit long term (10-15 year) take-or-pay offtake agreements. Many of those cannot afford the price or risk the commitment.

No offtake agreement means no electrolyser. That in turn means green hydrogen stays scarce and expensive, and potential demand-side projects are stymied.

Policymakers want to reduce the price of green hydrogen to $1/kg – to match the market price of grey hydrogen. But the few electrolyser projects that have managed to reach FID have set green prices anywhere between $6/kg and $14/kg *(see Figure 2)*.

Given the cheapness of natural gas and the high cost of electrolysers, it seems unlikely that green hydrogen will ever match the grey price without subsidy. Nor will enough electrolysers get built without some kind of policy support that gives new hydrogen offtakers the confidence to commit to long term contracts.

FIGURE 2: Green hydrogen cost – hydrogen strategies vs out-turn



Source: Liebreich Associates[7]

A second barrier is that some uses of hydrogen, such as long-duration energy storage and grid balancing, are strategic, social goods, and never likely to have a purely commercial justification, even though they would provide invaluable energy security and reduce system costs. For example, a report for the Royal Society into multi-decadal grid balancing in the UK found that the cheapest option would be hydrogen stored in salt-caverns, at an investment cost of £100 billion (*see Box 2 for detail*).

Clearly it is time for policymakers to reassess and perhaps regroup. Should each country or bloc try to tackle these issues alone, risking further delay as everyone makes the same mistakes? Or, as the IEA recommends, should they work together?

Electrolysers on redundant North Sea oil and gas platforms could **convert offshore wind power to hydrogen**

BOX 2: **Energy security and system benefits of hydrogen**

Although many proposed distributed applications of hydrogen are apparently being eclipsed by electrification, it is widely recognised that in a largely renewable powered energy system, hydrogen could still play a crucial role.

When renewable generation outstrips demand, for example, electrolysers could use the excess energy to produce hydrogen. This could then be stored until demand exceeds supply, when the hydrogen would power turbines or fuel cells to make good the shortfall.

Hydrogen has greatest energy storage potential by mass of any fuel and so could be used to store huge amounts of energy from summer to winter – or even for years and decades (*see Box 5*).

Electrolysers producing green hydrogen might be more expensive than plants producing blue hydrogen from natural gas with CCS, but they offer wider benefits to the energy system, according to researchers from Imperial College London.

Not only could they help shift energy from one time to another, but also provide valuable grid services such as frequency regulation. They could also reduce the cost of compensation payments to wind farms that would otherwise be forced to stop generating when demand is low.

Electrolysers could even be built on redundant North Sea oil and gas platforms, where they would convert offshore wind power into hydrogen, which could then be transported to shore through disused hydrocarbon pipelines. Compared to siting the electrolysers onshore and laying new electric cables, researchers believe this could save almost $40 billion in electricity grid costs.[8]

Others have proposed that nuclear plants could be built to power hydrogen electrolysers all year round except in periods of electricity shortage, when the nuclear plants would switch to supplying the grid.

The benefits of hydrogen at the level of the entire energy system are so great, argues Imperial, that it would be £5 billion cheaper each year to heat Britain's homes with hydrogen boilers (£86 billion) than with heat pumps (£91 billion).[9]

This is a surprising finding since the overwhelming majority of studies find electrification to be the cheapest pathway.[10]

However, the researchers argue that this is because many studies consider "hydrogen applications in silos and, therefore, overlook the synergy of hydrogen assets in improving energy security, resilience against extreme weather events, and system flexibility while decarbonising energy systems."

The authors acknowledge, however, that if the cost of heat pump installations can be reduced by 30%, hydrogen's financial advantage disappears.

Hydrogen has the greatest **storage potential by mass of any fuel** from summer to winter – or even years and decades

Electrolysers producing **green hydrogen provide frequency regulation** benefits to the energy system

Hydrogen in the UK

Since the publication of the UK Hydrogen Strategy in 2021, the development of policy has been close to frenetic. But delivery of actual projects is proving slower.

The latest policy summary, issued in December 2023, lists plans, roadmaps, initiatives and consultations covering the whole hydrogen value chain.[11]

More than a dozen different funding streams provide capital and revenue support for projects ranging from production, storage and transport of hydrogen, and end-uses across industry, the transport sector and grid balancing.

The current UK target is for 10GW of annual hydrogen production by 2030, comprising 4GW of blue (natural gas with carbon capture, or CCS) and 6GW of green (electrolysis powered by renewables).

CCS has had a chequered history in Britain, however, and a recent assessment by the National Audit Office found that the government would “struggle to achieve its 2030 ambitions for carbon capture”.[12]

Since then the Labour government has confirmed previously announced funding for two major blue hydrogen projects: the HyNet Hydrogen Production Plant 1 (HPP1) near Ellesmere Port in Cheshire, with capacity of up to 350MW; and bpH2Teesside with capacity of up to 708MW.[13] It is hoped that production at the two plants will start later this decade.

In December 2023, DESNZ awarded 11 electrolytic hydrogen production projects totalling 125MW, which it said represented “the largest number of commercial scale green hydrogen projects announced at once anywhere in Europe.”

DESNZ hopes that the first of these projects will start operating in 2025 but none has yet achieved financial investment decision (FID). The biggest single obstacle is likely to be securing long term commitments from offtakers. The department also hopes to award 875MW in the next funding round.

Trials of home heating with hydrogen have experienced recent setbacks, following the cancellation of two hydrogen village demonstration projects at Whitby in Ellesmere Port, Cheshire, and in Redcar, Teeside, after local opposition to the plans.

The last remaining demonstrator, at Fife in Scotland, has been delayed by a year amid “supply chain and procurement challenges”.[14]

Lord Callanan, the former Conservative energy minister, said in 2023 that hydrogen “would not play a major role in home heating”.[15] It remains to be seen whether the Labour government will challenge that conclusion.

The last government saw the potential for hydrogen exports and signed two international agreements, with Germany and Belgium.

DESNZ also funds R&D and has been working on standards, regulation, markets and the supply chain.

The UK also hosts three Mission Innovation Hydrogen Valleys (*see Box 3*).

It is not year clear how much existing policy Labour will retain and how much it might change. Labour’s manifesto contained no detail about hydrogen except a commitment to invest £500 million into green hydrogen production.

Despite the enormous potential of its geology, the UK does not yet have any specific policy relating to hydrogen storage in salt caverns. Since that capacity is over 1,000 times greater than Britain could ever need for its own purposes, it would make sense to develop it in collaboration with its European neighbours.

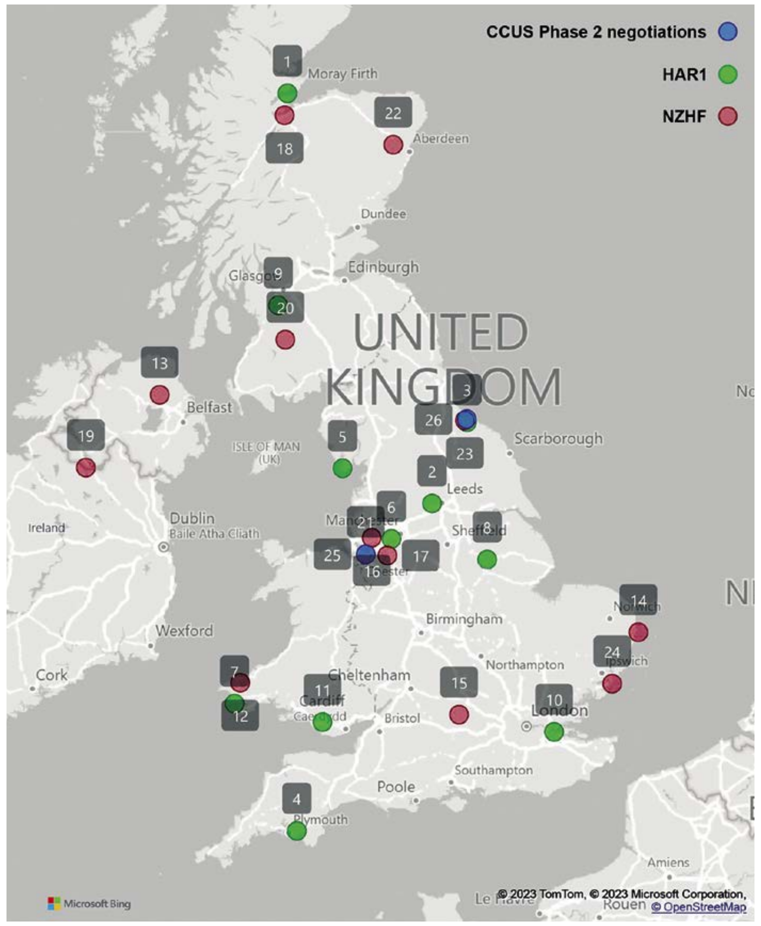
FIGURE 3: HAR1, NZHF & CCUS project updates December 2023

HAR1

1 Cromarty, Scottish Power and Storegga
2 Bradford Hydrogen, Hygen
3 Tees Green, EDF
4 Langage Green Hydrogen, Carlton Power
5 Barrow Green Hydrogen, Carlton Power
6 Trafford Green Hydrogen, Carlton Power
7 West Wales Hydrogen, H2 Energy and Trafigura
8 HyMarnham, JG Pears and GeoPura
9 Whitelee Green Hydrogen, Scottish Power
10 Green Hydrogen 3, HYRO
11 HyBont, Marubeni Europower

NZHF

12 Trecwn Green Energy Hub, Stalkraft
13 Ballymena Hydrogen, Ballymena Hydrogen
14 Conrad Energy Hydrogen Lowestoft, Conrad Energy
15 Didcot Green Hydrogen Electrolyser, RWE
16 Green Hydrogen St Helens, Progressive Energy
17 Green Hydrogen Winnington and Middlewich, Progressive Energy



18 Inverness Green Hydrogen Hub, Getech
19 Mannok Green Hydrogen Valley, Mannok
20 Knockshinnoch Green Hydrogen Hub Project, Renantis
21 Hynet HPP2, Vertex
22 Kintore Hydrogen, Statera
23 H2 NorthEast, Kelias
24 Felixstowe Port Green Hydrogen, Scottish Power

CCUS Phase 2 negotiations

25 Hynet HPP1, Essar Energy Transition Hydrogen
26 bpH2Teesside, bp

Key: HAR = Hydrogen Allocation Round; NZHF = Net Zero Hydrogen Fund.
Source: DESNZ 2023.[16]

Hydrogen: the case for UK-EU collaboration

Hydrogen in the EU

In 2020 the EU launched a wide-ranging strategy to support hydrogen production, demand, infrastructure, markets, R&D and international cooperation.

A year later, the Fit-for-55 package turned the strategy into legislation and set 2030 targets for hydrogen production and its use in industry and transport. Other instruments created regulatory frameworks for hydrogen infrastructure and markets[17] and introduced stringent criteria for renewable hydrogen.[18]

In 2022, after Russia's invasion of Ukraine, the REPowerEU programme sharply reduced EU dependence on Russian oil and gas.

As part of REPowerEU, the Commission approved almost 11 billion euros in state aid to support almost 80 hydrogen infrastructure projects defined as Important Projects of Common European Interest (IPCEI Hy2Use[19] and IPCEI Hy2Tech[20]). But it is reported that payouts under these schemes have been delayed for "two years or more".[21] A further 1.4 billion euros was approved in 2024 to support innovation in hydrogen transport (IPCEI H2Move[22]).

State aid is paid by member states, but the EU also funds hydrogen directly, through several different programmes. The two largest are the Recovery and Resilience Facility and the Innovation Fund, both of which support capital and operating costs.

The Innovation Fund also finances the Hydrogen Bank, which recently started to provide contract-for-difference subsidy for hydrogen production. Horizon Europe, the research and development funding programme, supports the Hydrogen Valleys (*see Box 3*). Total EU hydrogen funding for 2021-2027 is estimated at 18.8 billion euros.[23]

REPowerEU increased the EU's 2030 renewable hydrogen production target to 10 million tonnes and added a new target to import a further 10 million tonnes. Both now look wildly optimistic. There are no targets or subsidies for low-carbon hydrogen.

A report from consultants PwC published in April 2024 concluded that to hit the renewable hydrogen target, the EU would need to build 120GW of electrolysers over the next six years. But although 205GW of projects have been announced, just 3GW had reached FID or started building by the end of 2023.[24]

A report by the European Court of Auditors (ECA) of July 2024 also concluded that "the Commission set unrealistic hydrogen production and import targets – the EU is not on track for achieving them".[25] This report estimates European renewable hydrogen production in 2030 will reach around 2.7 million tonnes including non-EU members.

Amid many other barriers to hydrogen development, the ECA report highlights the stringency of the EU's conditions for renewable hydrogen.

To qualify as renewable hydrogen, an electrolyser must either be connected directly to (say) wind or solar capacity constructed less than three years previously, or, if grid connected, it must secure a power purchase agreement (PPA) that matches the electrolyser's output to the renewable generation hour-by-hour.

These rules are designed to make sure hydrogen production does not lead to higher emissions from fossil generators, but the ECA notes that they also increase costs. Many industrial offtakers would need a continuous supply of hydrogen, meaning the developer would have to build additional storage.

On low-carbon hydrogen, EU has defined it as hydrogen from non-renewable sources that reduces lifecycle CO_2 emissions by 70% but has not yet legislated a methodology for measuring those emissions to determine which projects qualify.

The ECA says the impact of these rules on the cost competitiveness of renewable and low carbon hydrogen "remains to be seen" and notes that the Commission is due to assess this only by mid-2028.

As things stand it seems likely that the EU will fall far short of its 2030 targets. If it wants to hit them, it could consider:

- **Lowering the targets**
- **Slackening the renewable hydrogen criteria**
- **Allowing and supporting low-carbon hydrogen – having legislated a strict assessment methodology**

Alternatively, the EU could consider developing hydrogen production, transport and storage with the UK, its nearest neighbour. EU member states have limited salt geology suitable for hydrogen cavern storage; the UK resource is vast.

Total EU hydrogen funding for 2021-2027 is estimated at
18.8 billion euros

By 2030, renewable hydrogen production is estimated to be
2.7 million tonnes
including non-EU members

Hydrogen: the case for UK-EU collaboration

BOX 3: **Hydrogen Valleys**

Hydrogen Valleys aim to solve the chicken-and-egg problem of how to create a green hydrogen economy – or at least a pilot end-to-end value chain – where none existed before.

They do this by shrinking the problem to a specific region and combining various projects across production, transport and end-use, so that each supports the business case of the others. Supply, demand and infrastructure are created simultaneously.

Hydrogen Valleys are subsidised by the EU as five-year research and innovation projects through the Horizon Europe programme, which has committed a total of 1 billion euros with matched funding from industry.[26] Beyond the EU, they are supported by Mission Innovation, the international innovation organization launched by President Obama at COP21 in 2015.

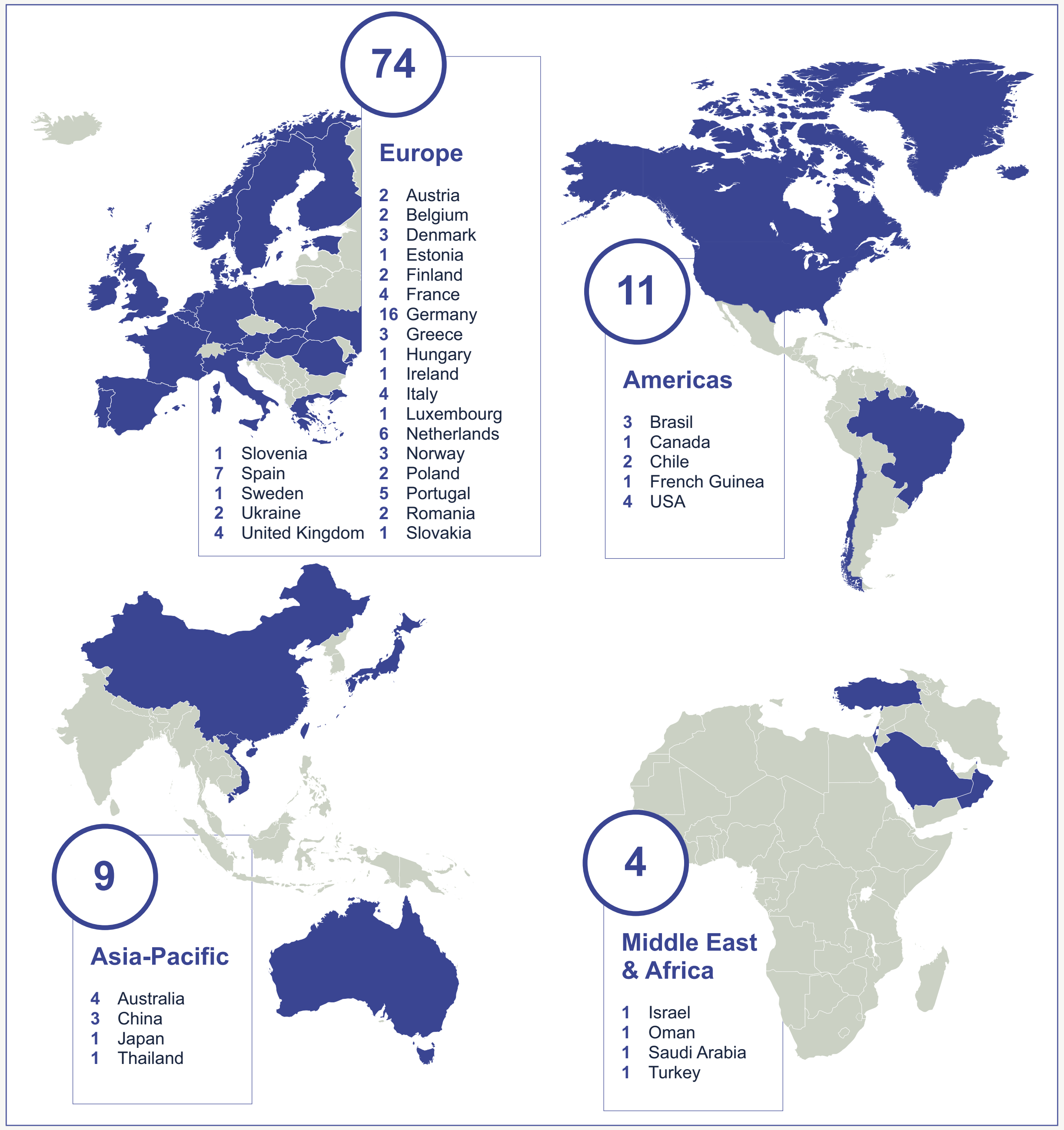
There are now almost 100 Hydrogen Valleys worldwide, up from around 30 in 2021. Three quarters are based in Europe and three in the UK (*see Figure 4*).

Hydrogen Valleys vary in size from smaller projects, which typically produce and consume at least 500 tonnes of hydrogen per year, such as Green Hysland in Mallorca, to larger ones like HEAVENN in the northern Netherlands, which produce and consume more than 4,000 tonnes of hydrogen per year.[27]

Early projects tended to focus on producing and distributing hydrogen as transport fuel, but now the emphasis has shifted more to decarbonising entire industrial areas, and a minority of mega-projects such as NEOM in Saudi Arabia that aim to produce hydrogen for international export.

Hydrogen Valleys have overcome many of the problems of kick-starting the hydrogen supply chain with help of much public funding. But as research and innovation projects they are geographically and time limited. So the looming questions are how to keep them going after current public funding ends, and how to link them together into a wider hydrogen network.

FIGURE 4: Hydrogen Valleys by geography (numbers per country)



Source: Clean Hydrogen Partnership, Mission Innovation[28]

There are now almost

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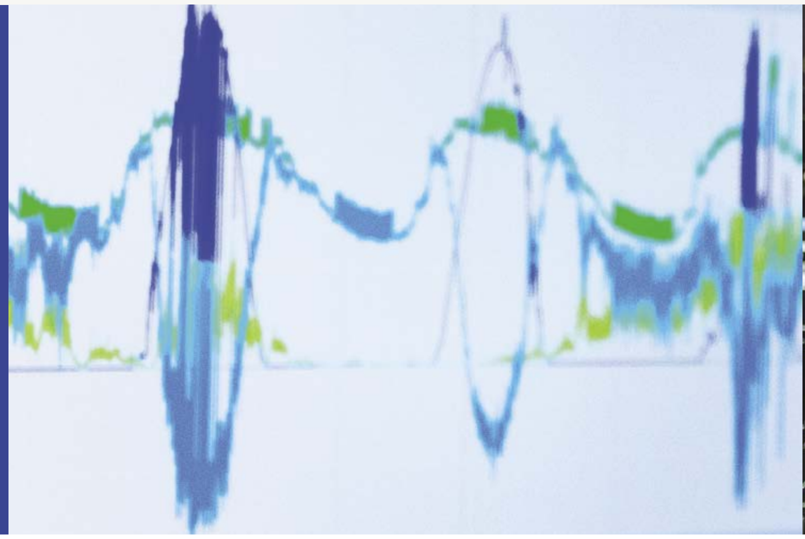
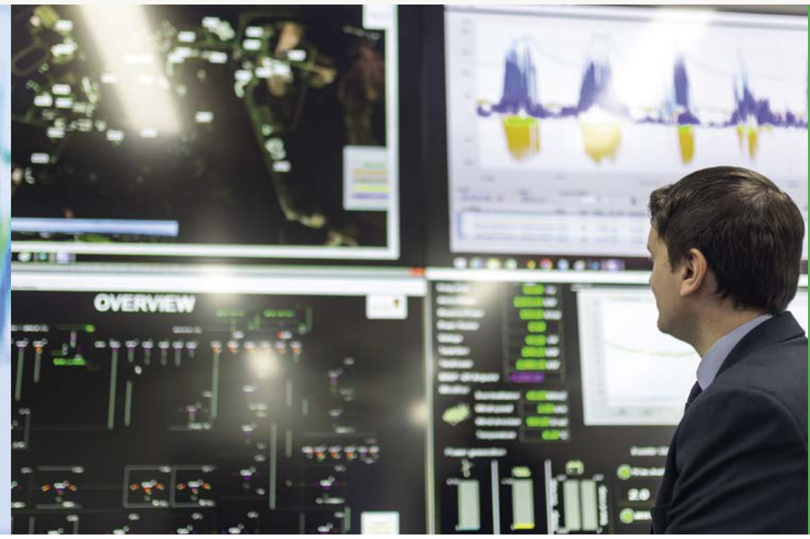




The world's Hydrogen Valleys each produce and consume from

500 tonnes to 4,000+ tonnes

of hydrogen per year

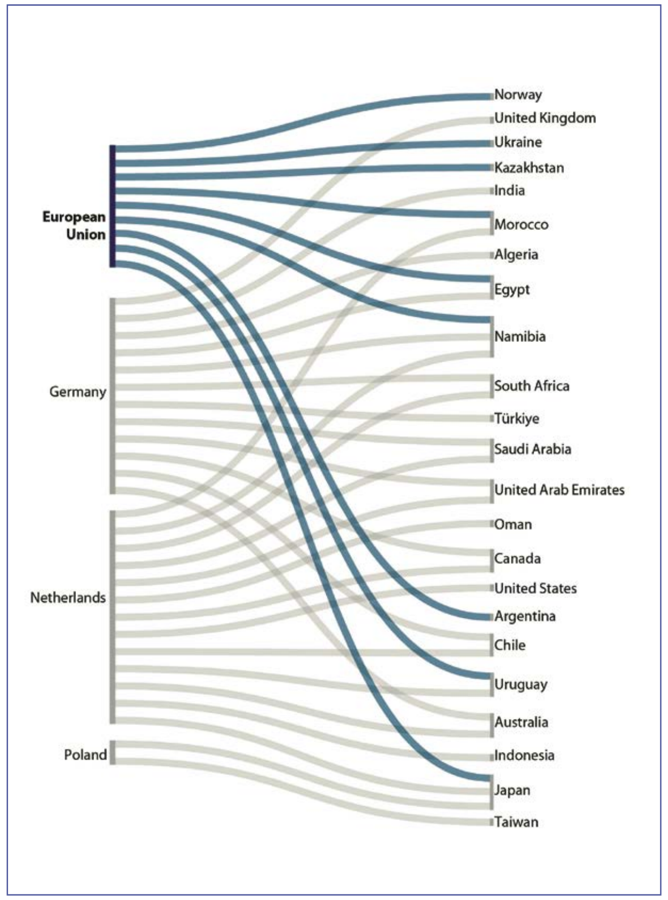
The case for UK-EU collaboration

If the strategic uses of hydrogen could cut system costs at a national level, it seems likely they would do so even more at a regional level because of network effects. We think, therefore, that the UK and EU should collaborate to investigate potential benefits of working together to develop hydrogen infrastructure, markets and policy.

The arguments in favour seem strong:

- **The system-level benefits could be large and reduce costs for everyone.**
- **The North Sea has 250 oil and gas platforms and 45,000km of pipelines that will need to be decommissioned as output declines, but which could be repurposed for hydrogen storage and transport. Centrica plans to switch Rough, its offshore storage facility, from natural gas to hydrogen[29], and other depleted gas fields could be put to the same use.**
- **UK has ideal onshore salt geology in Cheshire, Wessex and East Yorkshire to develop hydrogen storage caverns and could operate as the hydrogen lungs of Europe – to the benefit of both sides.**
- **The new British government is looking for ways to improve relations with the EU short of rejoining and hydrogen could be a relatively contained and mutually beneficial area.**

FIGURE 5: Hydrogen partnerships and memoranda with countries outside of the EU (as of mid-March 2024 for member states and as of end-2023 for the commission

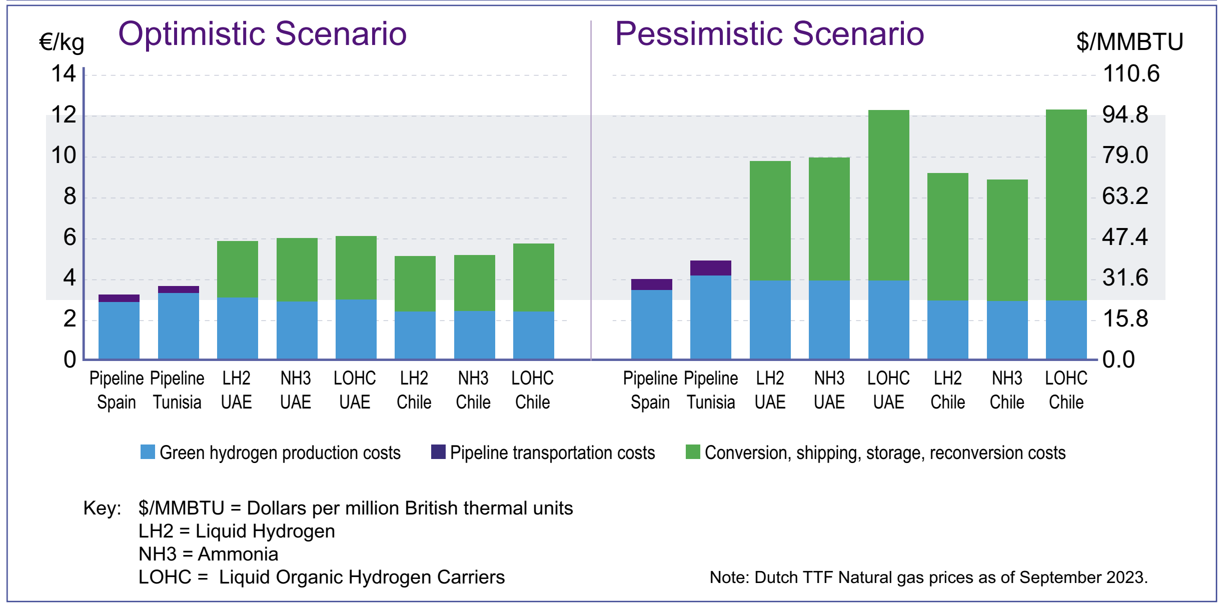


Source: European Court of Auditors[32]

Hydrogen: the case for UK-EU collaboration

- **The EU and some member states have signed hydrogen supply memoranda with countries as far afield as Kazakhstan, Saudi Arabia and Indonesia (see charts), but importing hydrogen derivatives over such distances would be thermodynamically and financially challenging. A recent paper calculated that long-distance hydrogen imports will cost more than $18/kg in 2050 even assuming technological advances.[30] Given the Britain's huge hydrogen production and storage potential, it would be strange if the EU were not to explore similar ideas with its closest neighbour. The European Court of Auditors' main recommendation to the EU is to "make strategic choices without creating new strategic dependencies".[31]**
- **The UK has already signed bilateral agreements with Germany and Belgium but a piecemeal approach risks slowing progress. A UK-EU agreement would be more effective and the Ostend Declaration on cooperation on renewable energy across the North Sea could be a better model.**
- **Both the UK and the EU have extensive hydrogen programmes but rather different approaches, which could benefit from cross-fertilisation.**
- **Now the UK is back in the Horizon programme there is a well-established and well-funded framework for research and technical collaboration.**
- **Agreeing common safety and skills standards would remove important barriers for all, as would aligning carbon trading systems to remove the need for the carbon border adjustment mechanism.**

FIGURE 6: Cost of imported hydrogen Austria/Germany (2040)



Source: Liebreich Associates[33]

UK-EU Hydrogen Taskforce and Agreement

We propose that the UK and EU should set up a Hydrogen Taskforce to investigate the possibilities and to produce a draft Hydrogen Agreement.

The Taskforce would identify areas and cross-border projects where the two sides could pool resources for mutual benefit, plan a joint hydrogen market, analyse how to clear barriers in financing, agree common standards, and devise a platform through which to share best practice. The Agreement would codify the conclusions and provide a framework for putting them into practice.

BOX 4: Flagship UK-EU hydrogen project

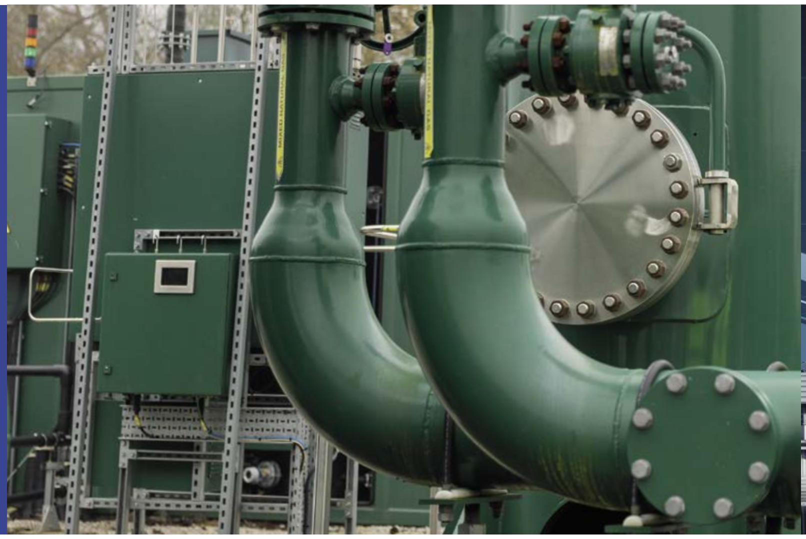
In particular, we think the UK and EU should consider a cross-channel hydrogen pipeline and storage facility linking UK with the planned European hydrogen grid.

Britain has already discussed with Germany the idea of building an export pipeline to supply that country's industry.[34] We fear that bilateral deals risk slowing progress and think an agreement between the UK and the EU would be more effective.

Any agreement should consider two-way transport of hydrogen so that potentially huge UK storage capacity can be integrated with the wider European Hydrogen Backbone.

Any such project would require the UK and EU to develop a joint hydrogen market, and to resolve any issues around hydrogen types, carbon trading schemes and the Carbon Border Adjustment Mechanism.

The UK and EU should consider a cross-channel **hydrogen pipeline** and storage facility



The Taskforce would be led by representatives of the UK government and the European Commission, and include members from industry, grid operators, trade associations, energy traders and universities.

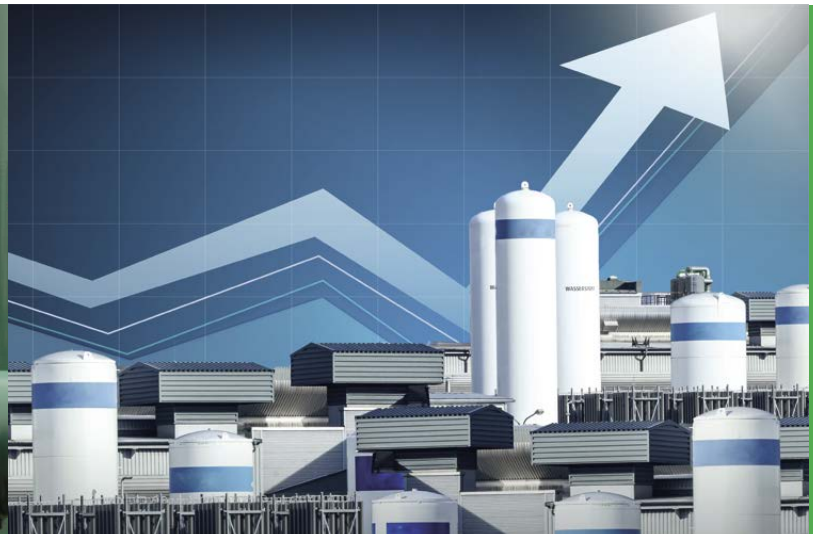
Working groups would include policy, safety, public acceptance, decarbonisation, whole-system modelling, markets and financing.

The precise contents of the Agreement would be for the Taskforce to decide, but we believe they should include:

- **Common safety standards**
- **Joint support for UK-EU cross-border projects including pipelines and storage facilities**
- **A UK-EU hydrogen market**
- **Support for modelling of whole-system benefits**
- **A platform through which to share best practice – perhaps building on the EU's Hydrogen Valley programme**

Together the Taskforce and Agreement could release system, economic and strategic benefits at the regional level; accelerate development in areas where hydrogen has clear advantages; ensure that the development of hydrogen applications and infrastructure genuinely helps reduce CO_2 emissions; set up a joint hydrogen market to discover prices and help bring them down; establish common safety and skills standards; and support a just transition by providing opportunities for former oil and gas workers.

If successful, the Taskforce and Agreement could solve some of the biggest challenges of energy security and cost presented by net zero.



It would require a UK and EU joint **hydrogen market** to function effectively

Hydrogen: the case for UK-EU collaboration

BOX 5: **Ultra-long duration energy storage**

If Britain is to go completely renewable, it will need 100TWh of multi-decadal energy storage, according to a recent study by Professor Sir Chris Llewellyn-Smith of the University of Oxford for the Royal Society. And only hydrogen can do the job, he argues, at least at a price we can remotely afford.

The storage would cost £100 billion to build giving an average electricity price in 2050 of £64/MWh. This wouldn't affect the average electricity price very much because only 15% of our annual consumption needs to be stored.

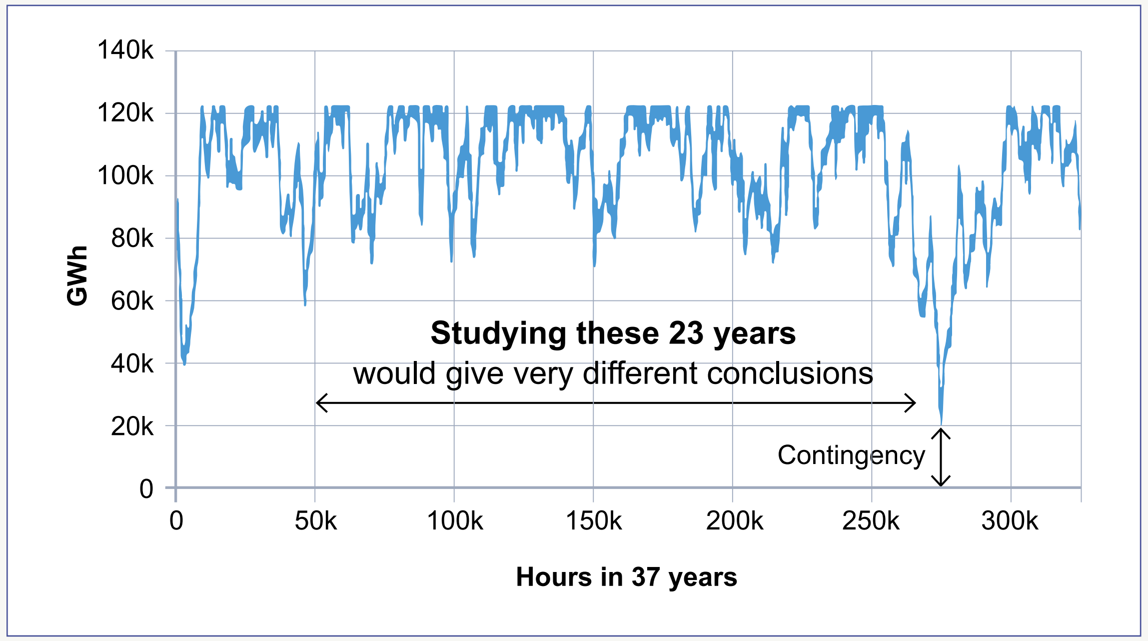
The hydrogen would be stored a mile below ground under huge pressure in salt caverns, for which Britain has enormous geological capacity.

According to the report, in a largely renewable grid, multi-year storage is needed to cope with large decadal variation in wind energy. This is quite separate from the much shorter-term grid storage being used and developed currently, and vital for energy security.

Previous modelling studies based on only a few years' data greatly underestimate the need for storage, whereas the new study is based on 37 years' worth. As the graph shows, you can study wind patterns for 20 years and still miss a major deficit in wind power/renewable output, as occurred in years 29-31 of the modelling (2009-2011).

If we had created the kind of storage needed to deal with that rare shortfall, some of the energy needed would have been stored since 1980.

FIGURE 7: Level of stored hydrogen



Source: Royal Society[35]

Britain has ideal geology for such storage: Cheshire and Wessex each have enough capacity to provide store 100TWh; East Yorkshire has a thousand times more.

In Europe only Germany and Spain have significant geological capacity, so energy storage be an export business for the UK.

According to the study's modelling, building 100TWh of hydrogen capacity would be the cheapest and most effective option.

Among the alternatives, ammonia is made from hydrogen and therefore more expensive. Natural gas with CCS would be far more costly. Compressed air would need 20 times more volume than hydrogen. The need is a thousand times greater than current UK pumped hydro capacity. And this much storage couldn't conceivably be provided by batteries.

Hybrid combinations of hydrogen with smaller contributions from some of these technologies might reduce costs a bit.

A completely renewable energy **Britain will need 100TWh** of multi-decadal energy storage

Hydrogen storage would cost **£100 billion** to build in underground salt caverns

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Hydrogen: the case for UK-EU collaboration

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The ERA HyDEX UK-EU hydrogen collaboration project

Since November 2022, HyDEX and ERA have held a series of summits in Brussels and London to advance the cause of closer cooperation between the UK and EU over the development of hydrogen.

Attendees included policymakers, academics, technology developers and large energy companies. Discussions ranged across policy, barriers, the potential benefits of closer cooperation and what that might look like.

Those meetings generated the thinking represented in this report, but naturally not every attendee will agree with every point included here.

HyDEX is a project which is focused on developing the hydrogen economy in the UK's Midlands region. It is run by the Energy Research Accelerator (ERA), a partnership of the eight Midlands innovation universities, together with the British Geological Survey (BGS).

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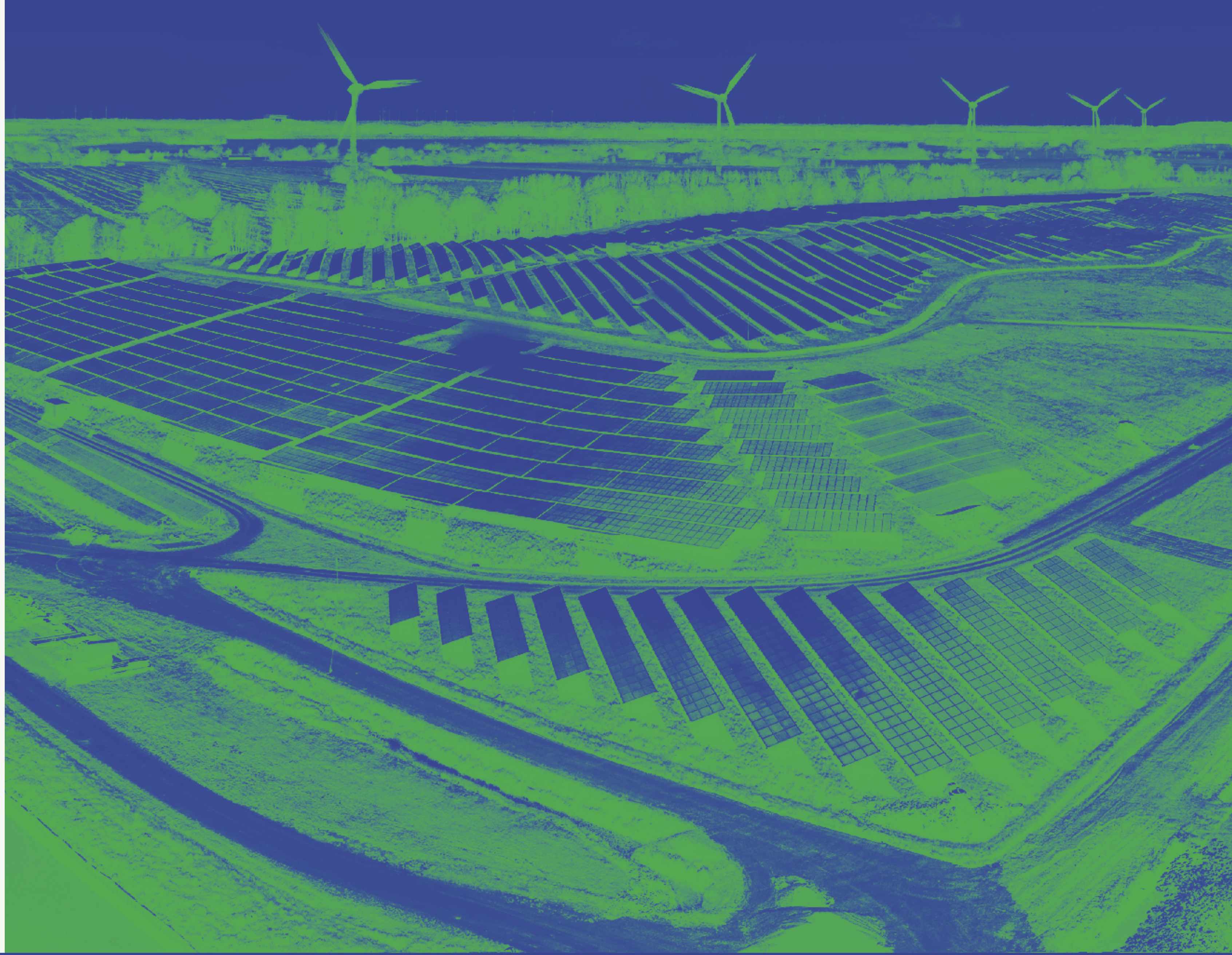

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