Transition Technologies - What's Next for UK Hydrogen Production - Episode 3

Oly Moir	Hello and welcome to part 3 of our mini-series on Hydrogen Production. My name is Oly Moir, I'm a partner in our Energy and Infrastructure team here in London. In part 1 we gave a high level overview of the state of the hydrogen production market in the UK. In part 2 we had a bit more of a deep dive into some of the more notable points in the LCHA, the Hydrogen CFD, and that leaves us with part 3 where we are discussing some of the key commercial issues and drivers for hydrogen production projects and therefore I am delighted to be joined by two of our friends from LCP Delta, one of the leading consultancies in the space and indeed the broader energy market, Brendan Murphy, Head of Hydrogen and Matt Deitz, Senior Consultant. Hi guys.
Brendan Murphy	Hi, great to be here.
Matthew Deitz	Hi there, great to meet you all.
Oly Moir	So let's dive right into it and focus on project costs and in particular power costs which represent a significant, perhaps understating it, proportion of the running costs of a green hydrogen production project. We have spoken on the previous podcast in the series about the need to comply with the low carbon hydrogen standards and eligible PPAs. I mean how does the structure of the LCHA and the LCHS requirements impact power procurement for these projects.
Brendan Murphy	So I guess it is well documented that power procurement is a major obstacle for getting a green hydrogen project across the line. It doesn't help that the projects are indexed against CPI and not against electricity, so in that respect blue projects have a distinct advantage although they have their own issues with the business model. We have seen some creative ways to try to overcome those problems with fixed priced fixed volume PPAs but green projects really struggle to compete with kind of the large corporates that are hoovering up a lot of renewable power that is available in the market at the moment. It has resulted in very expensive strike prices, very high strike prices which if you kind of play that further down the track it turns into a very large subsidy envelope that is unsustainable and unaffordable for any government. So we really need to try to tackle some of these quite specific contractual design issues within the business model to bring down the cost of power and not kind of shoot hydrogen in the foot before it has even really started to take its place in the energy transition. I guess for us, you know, we have been at kind of the sharp end of the modelling for clients and trying to get their projects across the line and we have done maybe 3-4 quite detailed pieces of work with the HAR1 projects, some of them are successful, some of them not successful and more recently we have done some quite detailed kind of market design work with government looking at some of the options that you could explore to improve the way that the business model is designed to enable those projects to kind of reduce

	the cost of power or at least to sort of reduce the risk associated with the procurement of power.
Oly Moir	So lets talk about those changes you might make then. So if you were to change the design so it wasn't simply CPI index linked to try and remove some of that power price risk from projects. I mean what are the key options and how would you go about doing that?
Matt Deitz	Yeah so I think just to add to what Brendan was saying there so you spoke about the low carbon hydrogen standard what we really see is sort of there is a risk at the point of bidding in for your hydrogen allocation round. Where there's two key risks that are very difficult to properly understand and be properly insulated from and that is manifesting itself at the moment as a risk premium being added to your strike price. So what you have is, what we frame as decarbonisation pathways risk so that first one is really where the power system in GB does not decarbonise at the rate that you are expecting it to. So i.e.. it really decarbonises slower than what you expect to. That is where the risk really manifests itself. The reason why it manifests itself there for you is because what that will do not only decrease the volume of hydrogen that you can produce which will be less than what you are expecting to in your central case when you are looking to bid into your HAR, but also that will manifest itself as a price increase as well. That being because a more expensive gas power station would be setting the price in the power system more frequently than what you are expecting it to. So what you really need is you need something to insulate yourselves, so to index strike price more accurately than what CPI allows it to, which is the current indexation approach. So you have got different options, one of which could be to index yourself or index your green hydrogen strike price against a forward power price, maybe a month ahead power price or a season ahead power price, but that only really covers the price risk. You would also need some way of covering an element of the volume risk, the volume production of hydrogen risk. So what you could do you could have some sort of like, some sort of hypothetical unit at the point of when you bid into your HAR and then you could compare that on an annual basis or a 5 yearly basis. It makes it more akin sort of like a cap and floor in that you have got interconnectors or will have for LDES (Long Duration Electricity Storage) and then you will have a reconciliation against what you actually produced or what you actually got as a return over that one year period or that five year period but what you actually achieved compared to what the hypothetical unit would have achieved and that can be an increase or a decrease in your strike price, an adjustment almost over that one year or five year reconciliation period.
Oly Moir	And I suppose that latter approach requires an awful lot more surgery to the existing model than the former approach which is simply having a form of indexation for power prices. I wonder… how do you think government will react to potentially ripping up or significantly changing a model that it spent an awful long time fine tuning over the last few years?
Matt Deitz	Yeah absolutely, one thing that I probably should stress is that probably for your early-stage hydrogen projects that get off the ground, probably not the biggest

	issue because most of them will be going for the PPA as Brendan said but what that does particularly for your bigger assets if everything goes through that sort of fixed price, fixed volume PPA that Brendan spoke about just now what that does is that completely insulates the system value that you can achieve from a hydrogen asset responding to low price signals and an over supply of power. On the second part of your question there really I think that probably quite poorly as it is, I think that government has their set policy, they'll want to push forward with it. However it is an issue that comes out in policy making all the time where you do have to iterate and it is an issue that is going to come forward in the future HAR rounds as I said, so really now is a good time as any to reconsider an re-evaluate to make sure that you are really presenting good value for money in the assets that you are supporting.
Oly Moir	Yeah and particularly as capacity allocated and the rounds increases, and we talked in the previous episode about the fact that it cost £2billion for 125 mega watts. We want to do 10 gigawatts by 2030 at least that is the current aspiration and those maths clearly don't work.
Matt Deitz	Also to add to that, Oly, as well, is that I think we all know that within the civil service it's not only a team that is forming these policies, it's also individuals and they have done a fantastic job in how they have formed these hydrogen business models, absolutely no taking away from it, they have got it off the ground you know all the way across its really really good. Those individuals are obviously very proud of the work that they have done, and by no means are we saying these things need to be torn up and start again, it is just in the fullness of time we are starting to identify some issues that are starting to present higher prices or could present higher prices than actually what they may not have to.
Brendan Murphy	I mean just to add to that, in a few short years the grid will be decarbonised, so some of these issues will naturally fall away, and as Matt said a huge amount of effort has gone into designing the business models as they are now, rightly or wrongly, wherever they have landed we have got them so I think it is important to try not to change too much too soon but focus on those really core issues, the small handful of issues we have probably covered today in the short term, just to ensure that those kind of projects that have got away now and the ones that will get away in the next couple of rounds before we get to a clean grid and some of these issues fall away we don't lock ourselves into sort of a very high subsidy territory but not at the risk of consultation after consultation after consultation on lots and lots of changes and risk projects just waiting on FID and not getting those learnings from just doing.
Matt Deitz	When you look into your HAR you will need to take three scenarios into account. Your high scenario i.e.. where the grid decarbonises much quicker than you are expecting it to. A central scenario which is a more realistic expectation of the decarbonisation of the system, and then a low scenario which is where you will assume it decarbonises a lot slower. Now across those three scenarios you will get three different returns. Now whereas most would expect you to take the central scenario that is actually not particularly what debt providers would actually look at.

	They will look at your low scenario so if you are assuming that there is going to be a much slower decarbonisation profile of the GB power system than is realistic then it is just going to put your financing cost and your Capex cost up.
Oly Moir	Yeah, doesn't that pre assume that you haven't got a fixed price 15-year PPA?
Matt Deitz	Yeah that's a good point. I suppose that is on your earlier assets I think as we look forward into the assets I mean the much bigger assets, grid connected assets, these are the ones that will need to be, to provide that whole system benefit will need to be exposed to price signals in the wholesale market so they are the ones that will be exposed to this more than your current ones that will be insulated by PPA.
Oly Moir	Understood, so I think the message there is for certainly HAR2 and probably the next couple of allocation rounds more likely to be tweaks and changes to perhaps the next inflation mechanism and wholesale changes at this point and I think producers will be very happy with that insulating power price risk certainly more than they are currently. Just going back to some of the problems with not having indexation and being forced down this route of a fixed price PPA. One of the issues that we are coming across and our clients coming across is collateral requirements under a long term PPA with fixed price and in context of a project SPV, have you found that your clients are struggling with that, any particularly clever solutions to that?
Matt Deitz	So yes, it is an issue. I think that most of the providers to date have found ways around that and you know you have got some early-stage discussions going on with PPA providers. The problem that these hydrogen producers will have is that they have to compete with these very highly credit rated, more preferable off takers of power - the multinational corporations, you know your Amazons, your Googles etc. In terms of that credit risk though yes like it's the margin requirements can be enormous on these assets and then you also have to get into discussion about what regulation you have to comply with, you know is it a financial contract; if it's a financial contract you have to think about your initial margining and your variation margin, if your captured under that; and then if it is physical you know how else do you collaterise the contract. It does degrade over time, and you know that collateral requirement does come down over time as you get closer to the end of the contract but up front we have heard anecdotal evidence that it is a significant amount to be put forward and lodged up to close to what the capex of your asset can be sometimes, it's enormous.
Brendan Murphy	It's not helped by the fact that it's not exactly a product that the market will require for a very long time. You know, as we move to a point where electrolysers are operating in a merchant way they won't need these products.
Oly Moir	And it's no surprise that a lot of the developers have got electrons within their business and are either directly vertically integrated projects or they are getting electrons on perhaps friendly terms from their group companies, because it is agreed that it is an extremely difficult fact pattern to overcome. And of course you

	may well have secured your 15 year fixed price PPA but turns out that fixed price is not in fact fixed because it is very difficult to negotiate a fixed price with no re-opener for REMA given where we are at the moment, so we can have a whole podcast on this but at a very high level - what do you think the impact of REMA and zonal pricing which looks like where we may be going with it, what do you think that impact will have on the hydrogen production industry?
Matt Deitz	Yeah, no so I think you hit the nail on the head with the PPA thing. So, ultimately we are seeing longer term PPAs becoming more difficult to strike just because of that uncertainty and then there is the conflict between the offtaker and the seller of power, who may or may not want to-enter into a goodwill reopener in the future if zonal were to become a thing. I think when you look at hydrogen, I think when you look at any benefits of zonal for hydrogen which theoretically should exist because you will like to locate that electrolyser close to where the highest amount of wind production will be, which generally will be up in Scotland. But really there is the assumption that zonal won't impact that but actually is it the case that the best place to locate your hydrogen electrolyser is still going to coincide with where the locational signal that zonal will provide - probably not, because there are other things to consider. I mean, a really good example actually is data centres. I saw some analysis a couple of weeks ago where this assumption that data centres are just going to magically go up to Scotland it doesn't really exist. The elasticity of demand in the GB power market is quite low as well or very low. It is just another byline to them, right, the zonal power price. It's an issue of is the land right, is the location right, is the land cost right, is all the other costs and assumptions, you know, even if you got a closed loop electrolyser for example with hydrogen power on the top of it, you're going to locate where a salt cavern is, you're not going to necessarily think you know where is going to be the best zonal price for me. There are so many other factors at play here for hydrogen.
Brendan Murphy	I think simply speaking the assumption is electrolysis moves to Scotland if we get zones because of power prices but that assumes that there is a way to bring the hydrogen back somewhere where it is required, you know and that is a big IF and there is also big questions that are being discussed and explored and analysed. We are working on some of them with Scottish government on new industries in Scotland. So what type of demand for hydrogen will there be over what time horizon? You know we are talking long term here for hydrogen to kind of really fulfil a meaningful role.
Oly Moir	But that sort of brings us relatively neatly on to infrastructure because as you said there is really no point electrolysers all relocating to Scotland if there is no infrastructure to bring it back down to where it is needed. What impact do you think the build out of large scale hydrogen transportation and particularly storage infrastructure, what impact will that have on strike prices and the risk that it mitigates for both offtakers and producers and how does that flow through to IRR required return on capital?
Matt Deitz	So I guess equally important we have covered PPAs and power procurement ,but almost equally important from our experience of modelling projects is the

	availability of storage to a production site and then I guess if you play that out and you expand that out national infrastructure, so connecting this between demand and supply centres. For example, we're just concluding some modelling for hydrogen production and storage, basically a hydrogen ecosystem project in England and the difference between having not just kind of volumetrically speaking enough storage but flexible enough storage for your injection withdrawal is flexible enough to be able to allow you to produce almost, to dispatch your electrolyser in a merchant way fully and access that cheap power. The difference between being able to do that and what the projects in HAR1 have had to do to get off the ground. The sort of delts between that is between something like £75 to £100 per megawatt hour. Depending on how you configure the project. That does also assume that there is more clean power available.
Oly Moir	And it's not just about enabling you to access power when it is cheap and when renewables are plentiful on the system, it is about risk mitigation as well. Both from the suppliers perspective so if you have one of your off takers who has an issue or goes bust giving you that transportation in particular the ready source of ability to get it elsewhere, or just to produce, store and then the offtaker make it up later, from an offtaker perspective knowing there is resilience in the system and then that boils down to a really thorny negotiations around take or pay, supply or pay liabilities which people are under standardly extremely focused on particularly when you have got good point to point supply and whether effectively the whole thing falls down if there is any issue with the producer or even temporarily an issue with the offtaker.
Matt Deitz	Yeah so I think we were speaking about it earlier, Brendan, that the project union to bring or to basically create a transmission network for hydrogen is going to be crucial because at the moment it goes back to counterparty risk again right so if you don't have that network available to you and you literally have one offtaker of hydrogen, that's a single point of failure and to most investors or to most developers I think a single point of failure in any project, any investment is unappealing at best I think is the best way of putting it, particularly when you need to think more about what is the incentive on that single offtaker to always offtake that hydrogen or even prevent insolvency of that single offtaker of hydrogen as well. So yeah I think if you produced a, or if you bought forward a market or bought forward a network that gave you access to potentially hundreds or even thousands of offtakers it obviously mitigates you risk quite significantly. so I think that will be the biggest thing but then you then probably need to create some sort of mature trading market of hydrogen which I think that's decades away at the moment.
Oly Moir	How about as a more immediate mitigant blending into the grid so currently prohibited under the LCHA pending a policy decision one assumes that going forward once a, or if, a positive policy decision is taken and it will be permitted and not immaterial risk mitigant for producers. Again, depending on where you are how much volume you can put into the grid and obviously at what price. You see blending as a pretty big risk mitigant and have a meaningful impact on projects?

Brendan Murphy	So, I don't think blending really moves the needle that much but it probably doesn't do any harm on the sort of short term to help deal with some of the volume issues and the offtake issues but it's not going to make or break the hydrogen environment.
Matt Deitz	Yeah, and I think that, building on what Brendan is saying I think you need all options available to you as a hydrogen producer to try and get your hydrogen out there somewhere to be taken. I think you also need to think about where these hydrogen assets are going to be located though so I do not envy the decision maker in government at the moment. You know there is a lot of infrastructure that relies on the gas network and the gas that's coming through. We even go back a few years ago during the peak of the energy crisis and you know, I have to admit that for my sins probably and you probably won't necessarily be happy about this but I was one of the leading people at government you know negotiating the cold contingency contracts and basically trying to find alternatives to gas or gas from anywhere and that included looking at bringing onshore lower quality gas onto the system to get as much gas here as possible as much of a fuel vector as possible, and one of the issues that really happened is that when you did all the modelling and you considered it, there were areas in the UK that was going to have significant amounts of the lower quality gas which CCGTs, you know were worried about without like good proper due diligence on what that was going to do to their systems and to their turbines and then even you know, what you look at like even smaller scale CHPs - what happens if you suddenly chuck that, chuck hydrogen into the system in a certain area and they get a lot more hydrogen there than they were expecting and then it does damage to their units. It's a very very difficult policy to start proceeding with.
Oly Moir	Ok, understood, so helpful but lots of complex issues and not going to solve things entirely. It sounds like in order to sort out power price indexation, sort out infrastructure and then blending an extra limb.
Matt Deitz	Easy right?
Oly Moir	Yeah, nice and easy. So I wonder if we can move track a little bit and talk about offtaker. Obviously the key source of revenue for a project, I mean notwithstanding a sort of attempt to providing volume support in the LCHA, products are still very much dependant on a robust offtake strategy. Perhaps you can first walk us through what's an offtaker's motivation to use hydrogen?
Brendan Murphy	I mean, I suppose the straight answer is it's cleaner so to avoid the costs of carbon, but the carbon price signal is not doing, again it's not really moving the needle very much, there is a lot of risk still for an offtaker to invest a lot of capital in new equipment. Yes, the subsidy is great so it brings the costs of the clean fuel down but there's all these other risks associated with switching. Another issue that we found quite specifically and modelled, quite specifically in hydrogen's power business model analysis we did for business was the serious concern about fuel availability, and again thinks back to having a network and having infrastructure to move stuff around which obviously is as important to a producer but to an offtaker

	it's also important to know you that you can have, you know that there's enough supply of fuel.
Oly Moir	Yeah, and it's extremely difficult for, you know, an industrial user for example to switch to hydrogen without being able to dual fuel and switch back because you are all of a sudden really increasing fundamentally having very significant risk to the operations of your business that you didn't have previously so certainly most of the offtakers we've seen in industrial space have been, have got the capability to switch back which then does make discussions a bit easier on the liability front. but there are off takers where they can't. For us in shipping or for use in to power hydrogen buses or vehicles and clearly you can't just switch back so it gets into much more difficult discussions.
Matt Deitz	New units, new units, yeah you need, it's a unit they can't switch back easily so you've committed that capital so you need to know that you've got the fuel there.
Oly Moir	And so does that lead us to conclude that the main use case in the next few years until we have that resilience in the system is likely to continue to be affectively those switching for fuel who are using gas and switching to either use a blend of hydrogen and gas or switch entirely to hydro with the ability to switch back to gas?
Matt Deitz	It's funny though right because although that provides you with additional resilience and the ability to ensure you've always got that constant flow of an energy source, it also erases the other issue for a hydrogen producer as well, particularly if you've got only a couple of offtakers and if they can fuel switch to maintain their security of supply and their resilience, you see it in the current market where you get fuel switching particularly in Europe between coal and gas or you see it in, particularly in east Asia one of the most like fuel sensitive or market sensitive regions where the moment the gas price goes up you then switch across to oil for heating, whereas in the UK and with hydrogen does that then raise another issue where it actually gives your offtaker of the option then switch out to from hydrogen to natural gas or another carbon emitting fuel?
Oly Moir	Well I suppose that comes down to two things. One is your take or pay liability and having robust contracts in place and the other is the commercial incentive which is particularly given the way that the LCHA is set up, most contracts are being priced on the basis of gas price. So either directly being sold out at the gas price or a multiple of the gas price or gas price plus, say the VTS costs for example, rather than fixed price and all the fixed prices are so high its going to be way above the gas price unless something really crazy happens on a macroeconomic case. So, there should always be an incentive for someone to use hydrogen on that pricing basis because you avoid the ETS costs.
Matt Deitz	Yes, it's a good point actually and also if anyone here is following the current ETS price as well you say that, Brendan you said how the ETS isn't providing a particularly sharp signal to drive the move to hydrogen. However, you know, we have seen quite a significant uptick in the UK ETS trade price over the past six/seven weeks and that's been driven by Kier Starmer's drive to renew relations

	with Europe and one of the things that came out of that was the likelihood of a UK/EU ETS linkage and with that you are now seeing people trying to, you know, take contracts, trying to buy out contracts and hedge their UK ETS exposure now, before you get that linkage because of the discount that the UK ETS is trading to EU ETS so maybe we will get that sharper signal.
Brendan Murphy	I mean one thing that I personally think, but I'm not close enough to cover the legalities of it but one of the things that I think doesn't help is the explicit denial of being able to sell your hydrogen to an RTI sort of a risk taking intermediary, I think that's a flaw, a big flaw in the contracts, I think, I would have thought you could find a contractual way to protect the government against the risk that they assume if they were to allow that to happen.
Oly Moir	And what risk is that?
Brendan Murphy	Well the risk being that government don't want aggregators or RTIs to play the market and make lots of money on subsidised hydrogen, you know the difference between the price that the producer can sell it to the RTI or is selling it to the RTI and the spread of that and the price of the RTI then sells it at retail for the market.
Oly Moir	Yeah, there is this sort of concern about the Daily Mail headline isn't there about the subsidising effectively energy traders rather than the end users. Although, as you said there must be a better way around that because those market participants play a valuable role in starting, particularly in price discovery which we don't currently have but we need price discovery to actually have a reference price, so one does wonder whether that will be coming out in future rounds.
Brendan Murphy	I agree, I think that those companies, those actors play an important role in creating more transparency in the market allowing different trading strategies, different commercial arrangements to come to the fore…
Oly Moir	And mitigating risks for producers when again….
Brendan Murphy	The most important thing
Oly Moir	They can go off the market and find a replacement
Brendan Murphy	The most important role exactly, is to enable, it's to enable liquidity in the market, it's to enable companies to sell into a wider, hydrogen is not really a commodity market in the way that natural gas is, but to take on some of those features of a commodity market that it currently doesn't have.
Matt Deitz	Yeah Brendan, you actually, you hit the nail on the head there actually. So I think by just preventing risk taker intermediaries from participating in the market it kind of goes against the fundamental principles of the way that you know the energy markets across Europe are created in that you do need those, I mean I'm not going to call them non-fiscal traders but almost like acting in that non-fiscal capacity to

	create that element of liquidity so that you do get a better price discovery across the market, and then those ones essentially acting as storage owners and also buying the price in, you need to find a way of properly mitigating that risk without just bluntly saying you can't participate. You know, we have it, we have those sorts of actors in the gas market as it is today, you know across Europe, you've got the 90% fill target for natural gas storage by, in November and that does largely fall on the owner operator of the gas storage, so you know of the gas storage assets so they are the ones that have to go out and buy the gas in the market to meet their requirements. So, you know it just seems a bit blunt to me to say they just can't participate.
Oly Moir	I think we're all agreed on that one. Just while we're talking about price discovery and perhaps our final point today, what about the price discovery incentive mechanism? So for those listening who may not be familiar with that, because of the way in which the reference price under the hydrogen CFD is set, there is an incentive issue in that if you are always topped up to your fixed strike price above the price at which you are selling or above the floor price why would you ever go and try and sell your hydrogen above the floor price and the way that DESNZ has sort to deal with that is to include a price discovery incentive mechanism, whereby for every penny over and above the floor price that you sell hydrogen at you get to keep 10% of it as an additional revenue stream to incentivise you to go out and beat the floor price. Is that a meaningful consideration for projects when they are going and negotiating their offtake contracts do you think, do you thank a 10% uplift means any meaningful difference, is it creating price discovery in the market?
Brendan Murphy	So, from our experience of modelling this it doesn't do anything. It's well intentioned I think it's a good thing to do but its not a strong enough signal to really move anything at all just from the sort of the modelling and work we've done with commercial clients trying to reach a strike price, trying to sort of understand what the revenues are for the project. At the moment that 10% doesn't do very much at all.
Oly Moir	I'm not surprised to hear you say that and also if you think about it, if you are only going to get 10 pence in the pound for any increase, why not use that low price to offset contractual terms and say look I'm giving you very cheap hydrogen here and therefore lets have a sort of asymmetric liability regime and I want some pretty friendly terms because I'm providing you very cheap subsidised hydrogen and certainly in our experience, you have those discussions and it does seem that that is a trade off that is going in, in one direction but were the 10% to be higher maybe it would slightly different consideration.
Brendan Murphy	Yes, interesting point.
Oly Moir	So, Matt and Brendan we talked about a number of potential issues, challenges and improvements that could be made to the model, although taking a step back I think we would all agree that DESNZ has done a good job in developing the regime to date. If you look around Europe and other parts of the world they look quite

	enviously at the development of the hydrogen CFD, and indeed the level of strike prices and therefore support that's being provided by the government. So I guess ending on a positive note, what do you think the picture looks like for the rest of the year, what are you looking forward to in the hydrogen sector over the course of 2025?
Brendan Murphy	So the way I always think about this, I think its quite similar to the world we were in years ago with offshore wind and the prices that developers were asking for then, and you know the noise was around why are we paying this much money for an intermittent source of power, we should just build more gas. I think hydrogen's really suffered the last few years in that respect. It's a different solution, it's a different energy vector, you know when you're starting out or when somebody comes up with a kind of a new solution typically you sort of say can do everything and hydrogen suffered from that a lot as well and I think we're getting to the point now where the rubbish applications are ones that are not useful have fallen away. I'm personally looking forward to seeing these contracts being signed and revenue flowing and EPC contracts as being active and contracted to build stuff. I think we are going to see a lot of change over the next few years from a kind of contractual point of view, policy point of view, but I think it's still going to be pretty tough for hydrogen simply because of the costs so we really need to focus on that, it's really boring and dry to say that but it's true, and I think, I mean Matt might see this slightly differently to me but I think energy seen through a more kind of energy resilience prism now after the Russia/Ukraine conflict, I don't think hydrogen's going to solve that, but I think it gives it another reason to be considered really a very important part of cleaning up the economy and cleaning up the power system.
Matt Deitz	Yeah, I'm probably going to go a little bit more macro which is probably bit unsurprising for the person who leads up the economics team at LCP Delta but I'm going to say this year has to be the year of like proper change and things really starting to come forward to meet, not only Clean Power 2030, but properly decarbonise the power system in GB. So I'm, when you look at it you've got interest rates although still resistant to this downward movement, they are starting to fall and starting to gradually come down a bit but then actually you've got, well then you've got your gas price, your energy prices starting to come down over the past few weeks in response to, you know the likelihood of like calming tensions in Russia/Ukraine, although I'm not going to touch on the actual deal about that and the politics behind that, but then with this new Trump administration in the US, whereas we saw capital flows going into the US for you know, clean power, clean energy projects, I think we are going to start to see those investors that don't really have a home start to come to Europe and I think the UK has a real opportunity to capture those investors and bring them into the hydrogen sector in the UK. So yes, I'm very positive about that, if it's not going to happen in the next few years it's going to happen in the 2030's so we've really got a chance this year to turn that dial.

Oly Moir	Great and for what it's worth I am really looking forward to seeing spades in the ground this year on the first hydrogen projects which will happen. So, plenty to look forward to in 2025. Matt, Brendan thank you very much a very interesting conversation covering a lot of ground and it has been a pleasure and thank you everyone for listening. If you have any questions, please do not hesitate to reach out to myself, Matt or Brendan. Thanks all.