Transition Technologies: What's Next for UK Hydrogen Production? (Episode 1)

Oly Moir	Welcome to this Slaughter and May podcast. In this Part 1 of a three-part mini-series, we will be focusing on low carbon hydrogen production in the UK. I'm Oly Moir, a partner in the Energy & Infrastructure team here at Slaughter and May. In this podcast, we will provide a high-level overview of the UK market for low carbon hydrogen production, and for those who enjoy the details, in episode 2 we will take a deeper dive into the UK hydrogen production business model and the UK's Low Carbon Hydrogen Agreement, aka the Hydrogen CFD. Finally, in episode 3, we will be joined by the experts at consultancy, LCP Delta, for their reflections on the economics of hydrogen production projects, particularly in the context of how the business model has been designed. I am joined today by my colleague, Kathryn Emmett, who heads up our Infrastructure, Energy & Natural Resources Knowledge function.
Kathryn Emmett	Hi Oly.
Oly Moir	Hi Kathryn. So, it's been two years since we last discussed the UK law carbon hydrogen market on one of these podcasts. A lot has happened over that time.
Kathryn Emmett	Yep, I think that's an understatement, as since our last podcast we've seen a real uptake in UK hydrogen production project activity.
Oly Moir	That's right. From a Slaughter and May perspective, we've been working on a number of the first green and blue hydrogen projects in the UK, as well as hydrogen projects overseas. We've also been engaging closely with investors, industry bodies and government over the last few years on the development of the business model. A key milestone was the signing of the first low carbon hydrogen agreements by some of the first electrolytic projects in December last year, but I think it's fair to say that progress has been slower than originally signalled and expected. The successful HAR1 projects were announced in December 2023, and whilst three of those have signed, a year after the announcement, the remaining eight projects have not yet signed an LCHA, although it is expected that more will do so in the coming couple of months. The announcement of the short-listed parties for the next allocation round, HAR2, has been delayed, although is expected imminently, and perhaps inevitably will be prior to the podcast being released. And on the blue hydrogen front, neither of two of the first projects, HPP1 and HyNet and BPT Side in the East Coast cluster has signed an LCHA, although is certainly expected to do within the course of this year. There are various reasons for these delays, but one driver is simply that these multi-faceted projects are just really very, very difficult.
Kathryn Emmett	Yes, and whilst there's been a lot of interest in this space from investors, lenders and sponsors, there's also a recognition that this is a new asset class and that can bring challenges, so no project is the same and each one requires careful structuring, taking into account its own specific circumstances. So a single off-taker project with a dedicated pipeline will look very different and has different considerations to a multi off-taker project, delivering, for example, bio-tube

	trailers. But all projects, you need to pull together a coherent package and that comprises credit worthy off-taker or off-takers willing to commit to long-term contracts on investable terms; you need a well-developed policy framework, so including standards and certification – of course in the UK we've got the Low Carbon Hydrogen Standard. You also need robust contracting strategies for construction and operating the project, using technology which is at the required readiness level. You need a solution for storing and transporting hydrogen in a way that meets your obligations to off-takers and meets the requirement of the Low Carbon Hydrogen Standard, and then for electrolytic projects a power-sourcing strategy has to be consistent with the design of the LCHA and there's a lot more to say on that which we'll touch on in a later episode. So, all that long list is quite easy to say but in a nascent market there's a real challenge to bring these elements together. So, there is definitely capital ready to deploy in hydrogen, but the projects need to be investable, bankable and so a coherent and robust contractual framework is crucial, as is of course the support scheme like the Hydrogen Production Business Model.
Oly Moir	Absolutely. As you say, one of the critical pieces underpinning these projects is the off-take strategy. Who will be buying the low carbon hydrogen that's produced and on what terms? From a policy design perspective, we've had a number of discussions around the importance of stimulating off-taker demand. Both the UK and the EU take a carrot and stick approach – the stick being the Emissions Trading schemes in place combined with incoming or newly established sea bands carbon border adjustment mechanisms and by putting a price on emissions and the embedded carbon in imports, these schemes are expected to have a role in driving deeper decarbonisation, particularly in industry and transport, alongside support for production. And the business model, the LCHA, is of course the carrot, so whilst the support is provided to the producer, and we'll explain how in a moment, the support means the producer can market low carbon hydrogen at a price more similar to the counterfactual fuel or indeed, identical to the counterfactual fuel, which in hydrogen's case is often natural gas, but with the added benefit to off-takers that they can avoid the ETS costs they otherwise would have incurred in burning gas. But, even with these interventions, off-takers can find it hard to commit to long-term off-take contracts that new-build projects are looking for simply because in many sectors it's impossible to predict what the business's needs will be in fifteen years-time, and these off-takers are simply not accustomed to committing to their fuel supply for ten or fifteen years, particularly if they are being asked to assume often very significant take or pay liabilities including potentially compensating for the loss of subsidy, if they don't take, which can actually be many multiples of the hydrogen price its contracted to pay. That can be a very significant strategic decision to take, and one which companies and off-takers need to justify to their internal board and investment committees.
Kathryn Emmett	Yes, that's a really good point, and another factor is standards. So, whenever we discuss hydrogen production, we often end up talking about standards, and there are a number of reasons for that. They are important for governments who want to ensure that de-carbonisation goals are met; off-takers as you say need

	to know that their ESG or carbon market obligations are going to be complied with by procuring that hydrogen, and also producers want to meet the standard because they have to do so to be eligible for support. In the longer term, for low carbon hydrogen to become a tradeable commodity, it's going to be important that there is some kind of international recognition of national or regional standards. There are discussions that started at COP28 in December 2023 to try and reach that consensus, but in the meantime projects, particularly those looking at exporting hydrogen internationally, are having to comply with a range of standards, often taking the most restrictive of the two standards if there is a difference between them. So just to illustrate the problem, it really does differ by jurisdiction, so for example, there's this concept of additionality. This is the requirement that a renewable energy generation project for supplying an electrolytic hydrogen production facility, that basically the electricity input is newly commissioned and has taken place solely as a result of the development of the hydrogen production project – that's known as additionality. So, under the UK Low Carbon Hydrogen Standard, additionality is not actually a requirement, but it was a consideration in the allocation process for the first electrolytic allocation round. By contrast, additionality might be required for EU projects that come into operation from 2028, if the emission intensity of the grid electricity is still too high. That said, we heard only a few weeks ago in the clean industrial deal that these rules for renewable fuels of non-biological origin are going to be subject to review so even that question of additionality is being called into question. Another example of this difference in standards is in relation to temporal correlation, so this is this concept of time matching between power generation and hydrogen production. So, the UK Low Carbon Hydrogen Standard requires 30-minute matching of power generation, adjusting for losses and hydrogen production, even for the first projects, although carbon intensity overall is measured on average over a monthly basis, so in that sense you could look at it as monthly matching. In the US though, we've had an announcement just at the beginning of this year, that the rules will be allowing annual matching to 2030, that's quite a big difference.
Oly Moir	Yes, thanks Kathryn. From a developer perspective, changing standards and goal posts is almost as disruptive as setting those too high. Both can add extra cost to a project and it's fair to say we've seen some political turbulence in the UK and overseas although from a UK perspective, as we mentioned earlier, there has been some positive progress on hydrogen in the last twelve months or so with the first green project signing their LCHAs in late 2024. Hydrogen also critically has a role to play in the government's clean power action plan, CP2030, and this envisages hydrogen to power maybe one of the dispatchable power technologies to help balance the electricity system, particularly when the wind's not blowing and the sun isn't shining. A move towards zonal pricing, which certainly appears to be the preferred option at the moment, although let's see where that ends up, would likely be positive for the green hydrogen industry as it will create certain zones, most particularly and obviously in Scotland where the key input costs of projects would be lower than they currently are, albeit the

	impact on the wider power market and the pros and cons of zonal more generally is another question altogether.
Kathryn Emmett	I think we could do another podcast on that!
Oly Moir	Yes, yeah quite! But really the critical issue for the hydrogen industry in the UK now is the government's appetite for paying extremely high subsidies in the context of ever-increasing pressures on the purse strings, not least from increased defence spending but also we know there are pressures on NHS, etc. HAR1 in context is anticipated to cost government more than £2 billion in support over fifteen years for 125 megawatts of projects. Is the government really going to allocate ten gigawatts of capacity before 2030 at strike prices of £9 a kilo. It's unclear how very significant cost decreases will be realised in the short term, although we will touch on that on episode 3 with LCP Delta, but particularly given that developers have no control over the power price. The good news is that if there is continued appetite from the government and particularly the Treasury, we do have a fully finalised business model and regulatory framework for hydrogen production and one where other countries have been pretty envious of it.
Kathryn Emmett	Yes, shall we go into a little bit more detail on the Low Carbon Hydrogen Agreement for those who are a bit new to the topic.
Oly Moir	Absolutely.
Kathryn Emmett	Brilliant. So, the Low Carbon Hydrogen Agreement and the Hydrogen Production Business Model support new build low carbon hydrogen production projects only in the UK. So existing hydrogen production facilities are entitled to a different support scheme if they're retrofitting carbon capture equipment called the "Industrial Carbon Catcher Business Model". So back to the LCHA, that supports a number of different production pathways, so green hydrogen, that's produced using renewable power in the electrolysis of water. What's called "pink hydrogen", so electrolysis but using nuclear derived power, and then also "blue hydrogen", that's hydrogen produced from methane gas in a process called "steam methane reformation" and using then carbon capture and storage to capture the CO_2 and to permanently store them in geological formations. So, these projects are relying on the parallel development and operation of a CO_2 transport and storage network, and we'll come back to that concept and the issue of cross chain risks in another episode. So, the support under the LCHA is provided under a private law contract, with a low-carbon contracts company – that's the same entity that enters into the renewable CfD which has been really successful in deploying that industry. But one of the challenges- I think it's fair to say - that the UK government faced in designing the LCHA was to draft a single instrument which works for all of those production pathways.
Oly Moir	Exactly and while we talk about it as one instrument, one contract, there are effectively provisions within that that are turned on or off depending on the technology type of the projects. So, to briefly explain the structure of the support

	under that 700-page LCHA, it is a contract for difference modelled on the renewable CfD as you said. Under the terms of the contract for a period of fifteen years the producer is entitled to a top up of its revenue from the sale of low carbon hydrogen. For each unit of hydrogen produced and sold, it will be paid the difference between the sales price agreed with its off-takers, which is the proxy for a market reference price, and a fixed strike price negotiated with government reflecting the producer's unit cost of production and an agreed return, and, a key feature is that payment is based on output and volumes sold, so if the production plant is not producing and not selling no support will be provided, subject to volume support which we will touch on in the next episode. So, the hydrogen producer also has to sell the low carbon hydrogen produced under a off-take agreement. So conceptually, the revenues of the production project are the sum of the amounts received under the off-take agreement and these difference payments under the LCHA, and the strike price is currently agreed bi-laterally, i.e. by negotiation with DESNZ. The government are looking to transition to another model, i.e. a kind of auction bidding model as the market matures but we'll be a few years away from that. And we should also say that I said the strike price was fixed, I mean it is, it's a fixed figure but it is then indexed and that indexation differs between technology pathways, so for green projects, or indeed pink projects, the strike price is indexed to CPI – note no power price indexation, which will be a hot topic of conversation as part of episode 3. And for CCS enabled, i.e. blue hydrogen projects, the gas portion of the strike price is indexed to a monthly gas reference price and the rest to CPI, and that gives those projects a natural hedge in relation to their gas input.
Kathryn Emmett	Yes so the challenge is that there isn't currently a hydrogen market price to use as a reference price for the difference calculation you mentioned. So, the reference price for the first LCHA project is based on the producer's actual achieved sales price under it's off-take agreement. However, there is a floor price to ensure that producers can't just agree an artificially low off-take price with their off-takers. This has been confirmed to be the natural gas month ahead price. There is also a small incentive to encourage a hydrogen market price to emerge, so for sales above the floor price of natural gas, called "the price discovery incentive", which allows developers to keep 10% of any amount above the floor price. Overall, the whole design of the LCHA is quite different to what we are seeing in the EU, so for the EU national, kind of within EU, auction under the European Hydrogen Bank the design is structured as a fixed premium, so that subsidy is paid on top of the off-take price regardless of what the off-take price agreed is.
Oly Moir	We should also mention that not all production costs will be supported by and covered within the strike price under the LCHA. These will need to be covered in a separate charge to the off-taker or otherwise born and sucked up by the project. So, for example, taxes and duties, including green levies on electricity that are typically added to grid source electricity, they are not included in the strike price. Similarly, OpEx costs for hydrogen transportation is not included in the strike price either, and that's an important difference to the CfD for

	renewables which doesn't distinguish between the component parts of the strike price.
Kathryn Emmett	Yes, I think, in general, producers need to be very careful to map out these costs and what sits within the strike price and what's outside of it. But in every case, they are going to need to make sure that these are covered and recoverable.
Oly Moir	And we should also say that there are other avenues of support which might incentivise directly or indirectly low carbon hydrogen productions So in the UK, these include the renewable transport fuel obligation and the sustainable aviation fuel mandate, and for the latter, for SAFs, some pathways for which require hydrogen as a feed stock, alongside the mandate government is developing a revenue certainty mechanism, in other words a SAF CfD, but it's fair to say that the primary and most important source of support for low carbon hydrogen projects is the LCHA, and we will be diving into a bit more detail about the LCHA in part 2. So, for now, thank you for listening and for those who are interested in a bit more detail, please listen to episodes 2 and 3 of the podcast series, and of course feel free to reach out by email with any questions or comments.