HOUSE OF COMMONS

Environmental Audit Committee

Oral evidence: Technological Innovations and Climate Change: Tidal Power, HC 982

Wednesday 27 January 2021

Ordered by the House of Commons to be published on 27 January 2021.

Watch the meeting

Members present: Philip Dunne (Chair); Duncan Baker; Barry Gardiner; Mr Robert Goodwill; Jerome Mayhew; John McNally; Dr Matthew Offord; Alex Sobel; Nadia Whittome.

Questions 1 - 48

Witnesses

I: Sue Barr, Chair, UK Marine Energy Council; Simon Hamlyn, Chief Executive Officer, British Hydropower Association; Henry Dixon, Chairman, Tidal Range Alliance, British Hydropower Association; Neil Kermode, Managing Director, European Marine Energy Centre; and Andrew Scott, Chief Executive Officer, Orbital Marine Power.

II: Rt Hon Charles Hendry CBE, Chair, Independent Review of Tidal Lagoons.

Written evidence from witnesses:

- UK Marine Energy Council
- European Marine Energy Centre
- Orbital Marine Power

Examination of Witnesses

Witnesses: Sue Barr, Simon Hamlyn, Henry Dixon, Neil Kermode and Andrew Scott.

Q1 **Chair:** Welcome to the Environmental Audit Committee session this afternoon, where we are looking at our framework of inquiries into technological innovation and climate change. Today we have two panels talking to us about tidal energy, the first panel with sector experts in both tidal range and tidal stream, including technology developers. Then we will hear later this afternoon in our second panel from the former Energy Minister, Charles Hendry, who undertook a review into tidal lagoons.

I would like to start by introducing our first panellists. Perhaps you could tell us what your role is and who you are representing.

Sue Barr: Many thanks, Chair, and thanks to the members for the opportunity to speak. My name is Sue Barr. I am chair of the UK Marine Energy Council, and I represent the wave and tidal stream sector.

Simon Hamlyn: My name is Simon Hamlyn. I am the chief executive of the British Hydropower Association. I am also representing the Tidal Range Alliance, which sits under the BHA.

Henry Dixon: Henry Dixon, chairman of the Tidal Range Alliance, speaking for the tidal range industry in the UK.

Chair: Neil Kermode, you are the managing director of the European Marine Energy Centre.

Neil Kermode: Yes, I am, based in Orkney. That is correct.

Andrew Scott: Good afternoon, everyone. I am Andrew Scott. I am the chief executive officer of a tidal stream technology development company called Orbital Marine Power. We are headquartered in Orkney and have an office in Edinburgh.

Q2 **Chair:** Thank you very much indeed. I am going to kick off by asking a general scene-setting question to all of you. The UK should be very well placed to develop energy by the fact that we are surrounded by seas with one of highest tidal ranges in the world, but hitherto there has been a number of fledging—perhaps that is slightly rude—or relatively small-scale attempts to capture energy for use onshore from these schemes, but nothing really commercially viable. Could you give us a sense, please, of what you see as the potential for tidal stream and tidal range in meeting UK renewable energy needs?

Sue Barr: You have highlighted the opportunity very clearly. We are an island nation surrounded by fabulous indigenous resource that relates to our tidal range capacity—and I will leave that to Henry and Simon to discuss—and also tidal stream and wave power, the three being very different forms of kinetic energy that we are hoping to extract and change into electrons to help support UK energy systems.

We have a huge opportunity here in the UK. We have the majority of the European resource based around our coastline. What does that mean in potential for our electricity system? We have over 40 developers based here in the UK, both project and technology developers, so we have already secured the lead globally in terms of developing technologies for wave and tidal stream. In terms of the resource we have, we know there is over 1 gigawatt of leased tidal stream sites in the UK, with 10 megawatts of tidal stream capacity already in operation. That is over 40 gigawatt hours on to the grid from tidal turbines that are deployed in high-flow environments.

If we reach commercialisation, the UK tidal stream and wave potential is between 30 and 50 gigawatts. That is 20% of the UK's electricity, so there is a real opportunity to be gained here in terms of developing the sector, both from our indigenous resources, the waves and tides we have around our coastline, but also our industry. We need support to see the technologies brought through in the project development. My response to the Committee is that this is not simply a question of capacity in terms of electrons and our ability to produce terawatt hours, but it is also about building a sector, maintaining our global lead and securing those GVA economic benefits here in the UK.

Notably, we have 30 key tidal sites around the UK alone. These are very good high-value tidal stream sites, so that is where you get flows of water that are fast, with high levels of kinetic energy, where we can deploy tidal stream turbines. Those 30 sites alone have 6 gigawatt potential. That is 11% of the 2019 capacity that we had here in the UK. We have a huge potential for generating clean and predictable resources from our UK coastlines.

The wave potential is much higher. We have a practical resource of 23 gigawatts. The majority of this potential resource—the indigenous resource we see in the UK—is based around our UK economy, around the coastlines of the UK and the western seaboard. We see a high degree of tidal and wave capacity on the other side of our island to where we are seeing large-scale offshore wind being developed, so some very interesting questions about the locational benefits and also the capacity that we can derive from this sector.

Q3 **Chair:** Thank you. I am going to ask Simon to characterise, if he would, the distinction between tidal stream, tidal range and wave technology, and also turbines on the ocean floor or on the river bed. I imagine that is tidal stream. I have been an MP for nearly 16 years. I remember at one of my first party conferences going to a demonstration of a bendy, snake-like object made of metal, which was being promoted as the answer to future renewable technologies. I notice Barry Gardiner nodding, so they must have also visited the Labour conference when it was a Labour Government, which is not surprising. I have not seen it in use, but maybe it is. Could you give us a quick tour d'horizon of the alternative technologies that are being trialled?

Simon Hamlyn: You will have to excuse me, but I have just had a rather major piece of dental work done and I am still recovering from the effects of the drilling.

The question you asked was the difference between the two. Tidal range is the way by which we harness the tides through a seawall in which there are turbines that can generate power on the incoming and outgoing tides, whereas tidal stream benefits from turbines being lowered into water and benefiting from the currents around the coast. The two are different in that sense.

The Tidal Range Alliance was formed to provide a platform for suppliers and developers to promote tidal range and all the benefits it accrues. I think it would be a good idea if I asked Henry to set out a little more of the detail, please.

Henry Dixon: Do you want me to continue, or shall I talk generally about range and its potential?

Q4 **Chair:** If there is something that Simon did not cover in terms of the alternative types of range and stream systems, but in particular I would be interested in which of the tidal range—which I think is the area for which you are particularly responsible—is closest to commerciality.

Henry Dixon: The total capacity around the UK has been variously estimated as up to 45 gigawatts or beyond. In real terms, there are currently nine projects around the west coast of the UK and, realistically, we could have 10 gigawatts of installed capacity generating 20 terawatt hours by the early 2030s. The projects range from the relatively small, as in Mostyn or Wyre, to the large, as in north Wales or Somerset or Liverpool, Mersey. We would position tidal range as being an important part of the future mix, particularly when we are looking at net zero and climate change, as Sue has already said, and as part of levelling up. As I say, we are talking west Somerset, north Wales, Merseyside and Cumbria, places where jobs, employment and economic regeneration are important.

We are talking also about grid security. Again, in common with tidal stream, we do not have to rely on imports of gas and we do not have to rely on interconnectors, whether there are political issues or whether there is a weather system that is over France and Holland as well, so the wind energy they have is not available. We do not have to rely on supplies of uranium, so in a post-Brexit world we are totally relying on our own feet.

Also grid stability. Tidal range has the potential, as an industrial-scale energy producer, to provide near baseload, which again will be very useful to the grid. I am in Shropshire at the moment and it is pretty cold, there is no wind and there is not a lot of sun, frankly, so there are going to be times when it is useful to have a consistent and predictable power supply.

Q5 **Chair:** What you are saying is that the tidal stream and range technologies do not depend on the rise and flow of the tide in the same way as a lagoon scheme might. This is constant, and it will vary with the strength of tide and the flow based on location, but otherwise it has the potential to generate electricity 24/7. Is that right?

Henry Dixon: No, sorry, that is my mistake. A tidal lagoon requires the tide to come in, to capture the tide, to wait for the tide to go out the other side of the wall and then to release a significant amount of water through the turbine. We are basically using potential energy, whereas tidal stream has kinetic energy because it is in the currents that are flowing consistently. There are other significant differences in terms of future potential for industry. Tidal stream has real possibilities of creating an industry to sell thousands of turbines. Where our industry is different is we have real possibilities of generating jobs in location, but the volume of material is going to be very different.

Q6 **Chair:** Sorry, I am a bit confused. Tidal range is different from tidal stream. Is tidal range used to describe lagoons?

Henry Dixon: Yes, lagoons and barrages.

Q7 **Chair:** Thank you. You were touching on the opportunity for the UK to exploit a market lead in the same way as we are seeking to do with offshore wind. Perhaps I should ask Neil whether he is well placed to describe in global terms where the UK sits at the moment. What is the export potential if we were to capture a lead in this technology for both stream on the one hand and lagoon or range on the other?

Neil Kermode: The UK is in a very interesting position in that it has certainly been the world leader. We have had more devices deployed in UK waters than pretty much anywhere else. A lot of them have been deployed at the site I run up in Orkney, but I have to say that we are also seeing our lead being eroded by countries that are making stronger efforts than we are making at present. We have already seen some developers leave the UK and go elsewhere because there are support mechanisms. The point is that we are extremely fragile at the moment because it is a small industry and we have yet to generate the substantive nature that will mean an industry is properly anchored, so it is mobile at the moment.

However, there are tidal streams all around the world. Other countries such as China, but also Canada, France and Chile—a number of different countries—have strong tidal resources. The opportunity for the UK is several-fold. First, if we have a strong home market, we become the people who can go and do this elsewhere. We can export our skills in the same way that people from Aberdeen are very good at drilling holes in difficult bits of the earth's crust to go and get oil out. That is based on a strong home market. If we have a strong home market, we will be able to go and export this technology.

The point that was also made is that the UK is in a very unusual geographical position, in that it has a huge amount of tidal and wave resource here already. It is a bit like the industrial revolution, in that we found we had coal, iron ore and limestone all in the same place. We pulled it all together and built industries that were then profitable for generations to come. We feel we are on the cusp of that and there are opportunities.

In terms of the nature of the sites, they tend to be quite different. Where there are very strong tidal flows roaring past an area, that is where you can use tidal stream. Where there are very high amplitudes of tide—high rise and fall of tide—that is where lagoons and barrage-type processes work best. It is highly geographically specific, but these are not unknown places. They are well known. They are on Admiralty charts around the world, so we can find them. We know where they are and we are working with a number of them already.

Q8 **Chair:** Neil, am I right in saying that your organisation is the only accredited body to accredit such systems in the UK? Is that the case also around the world? Do you have visibility of what is happening internationally in this space?

Neil Kermode: Yes. We are an accredited testing laboratory. We are created by UKAS, the United Kingdom Accreditation Society, which is effectively the governing body of laboratories in the UK. It is part of an international scheme, but we are the world's only site that is doing this for both wave and tidal and certainly at grid connection.

We do have visibility. We also have a lot of the supply chain elements that are here in the UK, such as the consultancies and various organisations who are experienced in helping get permits and assaying these sites. The UK has not just the hard tides and all the rest of it; it has some of the manufacturing capability that it has deployed so far. It also has a lot of the soft skills that are eminently exportable. We have the lead at our feet, it is just whether we choose to kick the ball properly.

Q9 **Chair:** I am going to bring in Andrew, who is an operator and has been for some years. Andrew, you are operating the system in Orkney. Could you give us a bit of colour about the potential for this market to develop both in the UK and internationally, from your perspective?

Andrew Scott: Yes, certainly. Both Neil and Sue have done a good job hopefully in contextualising it. Ultimately, from a tidal stream perspective, estimates are maybe in the region of 6 gigawatts of contribution to the UK electricity demand. Neil said it is a global resource, and it is. The estimate, to contextualise what the market could be both in the UK and globally, is that it could be up to 100 gigawatts.

Turning that into a financial market, we estimate, could result in a global market worth somewhere in the region of £20 billion to £25 billion a year, which is on a par, if not maybe slightly larger, than the offshore wind

industry as it sits at the moment. That may be the prize we are shooting for here.

In terms of where we are, from a technology development perspective, we are obviously tidal stream. The solutions are more analogous to wind turbines in lots of different ways, where we install them at sites, like Neil's site. That is where we have been operating our technology.

It should be understood that developing technology in this space, both marine and for large-scale generation, is not a quick journey. Our company has been developing this technology for over 15 years and that is due in part because of the challenges that come from the environment and the challenges associated with engineering, of growing. We start small scale and we incrementally build that up and build our confidence.

In 2016 we launched the world's most powerful tidal stream turbine, which was built at Harland & Wolff. It was a 2 megawatt unit and it was successfully installed at Neil's site up in Orkney. Over a 12-month period we consistently fed predictable power into the Orkney grid. At times we were reaching 25% of the whole of Orkney's demand and we generated over 3.25 gigawatts of electricity.

From our perspective, there is always a journey, a cycle associated with product development and bringing it to market, but we firmly believe the technologies that have principally been developed and pioneered here in the UK, for the good reasons that we have all discussed—this is in our industrial DNA, doing offshore engineering—is now positioning us well to capitalise on what should be a very significant global market.

Q10 **Chair:** I am going to round out my questions by coming back to Sue. We have heard about the scale and the potential opportunity. Some of this normally requires Government support, and the energy White Paper just published had barely a glancing reference to tidal power. The national infrastructure strategy, which the Treasury published back in November, had no mention at all of tidal power. What have you been doing to try to get this on the Government's agenda? The Government appear to be uninterested. Why do the Government appear to be uninterested if the potential is as has been described?

Sue Barr: I want to reverse back to some of the comments made previously. You talk about what we need and why we are not there yet. I have been involved in the marine energy sector, both from a Government position and from a technology development position, and now subsequently as chair of the UK Marine Energy Council, in a position where I am lobbying Government for support.

The narrative around our technologies is this: if Government want this to happen, they need to commit to a route to market. In doing so, that is bringing technology through from early R&D stages through what we call the valley of death, which is effectively when you are trying to commercialise your technology. You are undertaking the key challenges

that both Neil and Andrew are very close to in terms of commercialising the technology, and that means making more of them, putting more in the water, learning by doing, driving those learning rates and driving down the cost of energy.

The UK Marine Energy Council has been working very closely with the UK Government—predominantly BEIS and Kwasi Kwarteng in particular—to look at what we require, so the actual mechanisms that would bring forward the tidal stream sector and, following through from that, the wave sector. We have heard a lot of very strong narratives for why this sector is important to the UK, but how do we deliver it?

I want to touch very briefly on Denmark. Denmark is a very small country that developed wind technology and exported it globally between 1980 and 2000, so we are talking a 40-year heritage of being able to develop this technology, and this refers back to that long route through to get kinetic energy into electrons from very difficult receiving environments. It now has a global export potential with 29,000 jobs from the offshore wind industry and £10.64 billion in revenue. The reason that is in place, the reason it has been so successful, is because it put in place a revenue system in the early 1980s that supported this type of development, getting projects to scale.

What have we been doing with the UK Government? We have been presenting where the costs are being driven down, so we have looked at and worked across the industry in a collaborative way because, as you may understand, there are multiple different technologies. I think we need to be very clear on that: at the moment there are different technologies for tidal stream and wave power.

We have been arguing that, in order to deliver those benefits, to deliver the export potential and also the peripheral economy and GVA benefits here in the UK, we need a route to market. We need a revenue mechanism that supports, with the right measures and appropriate checks and measures in place, the technology from early R&D, where we see capital investment through UKRI and other capital mechanisms, through to commerciality.

At present, the contracts for difference system, which has proven how it can drive down costs in large-scale offshore wind development, does not work for the wave and tidal sector. The costs of the sector are still too high. That is not to say that the metric we are at at the moment, the cost price, cannot be driven down very quickly.

Through the work that we have done with the Offshore Renewable Energy Catapult and across the sector, we have empirical data that is showing a clear trajectory of levelised cost of energy that brings us down and under £100 per megawatt hour by 90 megawatts of installation. We are seeing very good driving down on the costs, with 1 gigawatt of installation, and you come down below £100 per megawatt hour.

We know and believe that we can do it faster than offshore wind did. The reason for that is we have a very, very sophisticated supply chain and we already have the knowledge capacity. As Andrew alluded to, our heritage is in maritime economies. We know how to build ships. We know how to build offshore oil and gas installations. We know how to engineer out the costs, so the sophistication in our supply chain is already there. We believe we can deliver a sector that will be cost competitive with other forms of renewables, including offshore wind, by the early 2030s.

What do we need now? We need a route through to that. We have asked the Government for two things, and the first is a revision to the contracts for difference. This is important because we have over 100 megawatts of projects waiting to get access to revenue. These are projects that have their offshore consents, that are being developed out and are at an advanced stage of project development. The opportunity is absolutely ripe, it is on the table and there.

If we can find a way through the contracts for difference to allow those projects to come forward—and these are the leading projects, the leading technologies, of which Andrew's is one, and there are others that will supply into these projects—we will see very strong institutional financial support. The projects become bankable and you start seeing multiple projects going in the water and multiple technologies. At the front end, a change to the CfD to allow for tidal stream development to come forward is very important.

Chair: I am going to break in there because we are going to come on to many of these things in some of the subsequent questions, but that is a good tour d'horizon.

Sue Barr: No problem.

Q11 **Duncan Baker:** Neil Kermode, we have heard there is a huge opportunity for the UK and it is about building a sector. I am from the east, so wind is particularly big in my neck of the woods, not so much this technology. First of all, what are the main areas for tidal stream technology and where is the industry currently focused? It strikes me that the Chair was probably right when he diplomatically put what has been going on. I don't think it is as prevalent as some renewable technologies are, so where is the industry focused and what is the potential for other sites to be developed? In effect, where is the sky's limit?

Neil Kermode: I can put your mind at rest to start with, as unfortunately not much of it is over on the east coast. Principally it is in the north in Pentland Firth, which is between Orkney and Caithness. When you come anti-clockwise, you see it between Northern Ireland and Scotland and in areas of north Anglesey and Pembrokeshire, and then you come around to the south coast, principally Portland Bill and the Isle of Wight. Areas where there are strong tides that go around corners or get through necks, those are the main areas.

One of opportunities that exists is that those are highly localised and they are often in areas that are quite challenged financially for other reasons. Therefore, in terms of the levelling-up agenda, these are generally in areas that, by definition, are not the south-east, so they work to that agenda particularly. They are also areas that often have quite a strong maritime heritage, so there are already facilities that exist for scale.

The point is that most of these machines are at a scale that is small ship sized, they are not oil rig sized. The kit can be handled quite often in these comparatively small ports, and it does not require massive infrastructure to do it. It is both an opportunity to use the resources that are there in terms of the tides, but also the practical resources in terms of harbours and infrastructure. They are well-known sites and they are pretty much in an arc that goes anti-clockwise from about us to about the Isle of Wight.

Q12 **Duncan Baker:** I am going to come to Sue Barr, who has her hand up, but, from what Neil describes, the deployment seems reasonably straightforward. What is the potential to have these further sites developed? Would additional development add to the maximum 6 gigawatts that the industry is predicting?

Sue Barr: Thank you, and apologies for taking from Neil. We know the supply chain that supports this industry is based across the UK, so it is very diverse, from the east coast to the west coast into the north coast of Scotland, on to the isles of Orkney and down into the south and the Isle of Wight and the maritime skills that are there.

In terms of what we call the development phases of these sites, the advanced stages of development are the projects around the Pentland Firth and Orkney. MeyGen is one of the key projects there, PTEC on the Isle of Wight is another, and Morlais in north Anglesey. We are looking at the Isle of Wight, at Anglesey in terms of the near term for Morlais, and then at the north coast of Scotland. What we are seeing is that those projects are developing quickly. We are driving forward the expertise and the knowledge in terms of not only how to build technology, but how to develop projects.

Q13 **Duncan Baker:** Henry Dixon, are you in agreement with Sue Barr that, if we had the right funding—I guess that is one of the first things to consider—it will be those tidal range projects that are closest to delivery, the Isle of Wight, Anglesey and the north coast of Scotland?

Henry Dixon: The locations are a bit different. Wind, SMR, carbon capture and, indeed, our friends in tidal stream have all received Government funding, either European or UK funding. To my knowledge, tidal range has never received £1 or €1 of funding, so everything to date has been done through private investment. That is why having no policy in Westminster that supports marine energy, either range or stream, makes it very difficult to go to investors saying, "Look, this is a serious opportunity for both types of energy."

Tidal range locations are still on the west coast, because that is where the tidal height is the best, so we are talking Somerset, Bristol Channel, south Wales, north Wales, Mersey and Cumbria. Interestingly enough, there is a lagoon proposed for Hull. That brings me into a whole other area, which is that tidal lagoons are not just a question of energy. The seawall certainly in north Wales is all about coastal protection. We all know the challenges we have; we know what the latest temperature predictions are. The flooding in north Wales—as I know to my personal cost—is increasing in frequency and severity.

One of the issues we have with BEIS is that it will only look at tidal range as an energy-led solution. It needs to take into account two factors. One is the co-benefits. We all offer employment in good places, but what we offer is huge benefits of stability and security to the grid, but also in north Wales—and I happen to know north Wales best—we protect the main line to Ireland and the main road to Ireland, both of which were built half a mile from the sea. They are now 10 metres, for anybody who knows that road at all, and £3 billion-worth of assets. It is at the moment very much focused on the west side. There may be opportunities for similar things on the east side but for different reasons. Like Sue, the supply chain potentially spreads right across the country, particularly into the steel world.

Q14 **Duncan Baker:** That is very interesting. I will come on to some of the benefits in a moment, but I will bring in Andrew Scott. Watching the development of wind down the east coast of the country over the last decade, it has been quite a seismic change from a reasonable standing start. I take the point that there has been very little investment in the marine energy market, whereas it is completely different for wind.

What are the challenges involved in getting tidally generated energy into the grid when—coming back to wind—there was always this concern, of course, that the wind only blows at certain times of the year and therefore you will have a lumpy flow of energy coming into the grid? How will you meet the strong periods of demand for electricity, and will our infrastructure allow efficient distribution of energy created across the grid?

Andrew Scott: You have rolled a lot of questions together. What I would say is we are on a mission to get to net zero as a country. That will probably pose an unequivocal challenge from a technical perspective, not least the grid, especially as we move to reliance on intermittent renewables. We are seeing the effects of that already. In the wind market, we are seeing day-ahead market trading going sub-zero and so forth. That is impacting across CfDs. Part of the argument here is: what is the right portfolio of low-carbon solutions that helps level out the whole effect?

Because of the points that we have raised, tidal is linked not to the wind and not to the sun, but to the very predictable, consistent movement of the moon and the earth around the sun. We have a different

characteristic associated with our power output. That will help to offset some of the dynamics that are created by other new emerging sectors. It lends itself very well from a compatibility perspective to energy storage, whether or not that is battery, and because of its dependability it also lends itself to areas like hydrogen or ammonia production.

In a way, we have to transcend where we are now and we have to understand that where we need to get to for net-zero output is a very different system of power generation and power usage. We firmly believe that tidal and tidal stream has a role to play in that journey and that solution.

Q15 **Duncan Baker:** Simon Hamlyn, can I ask your opinion on that? Are we going to suffer in being able to get tidally generated energy into the grid?

Simon Hamlyn: Going back to the original point that Sue was responding to about Government involvement, the BHA has been involved in tidal range for a long time but we have never had a great deal of traction with Government, either in Westminster, Scotland or Wales. Part of the challenge of addressing the point you have raised is getting Government to have a policy that supports both tidal range and tidal stream.

We have engaged with several Government Ministers. Up until recently it was Mr Kwarteng, who then got promoted so we did not have that opportunity. Some kind of policy position that supports tidal range and tidal stream would help enormously in encouraging the Government to recognise that tidal stream and tidal range are a crucial part of the UK's energy mix. Indeed, tidal range is a significant aspect of grid stability because we know the tide is going to come in and out every day unless there is some terrible disaster.

Andrew Scott: From a locational thing, the thing to understand is that you do not have to rewire the UK's electricity or energy system for tidal. We have to do it anyway to accommodate wind and everything.

Henry Dixon: In terms of location, if we look at the West Somerset Lagoon, which is near enough but not too close to Hinkley, there are power transmission systems in place. If you look at north Wales, again a power system is in place for Wylfa, which at the moment looks as if it is not going forward, but a lot of work has been thought about and done. If you look at Mersey, which is very interesting, they are looking at smart grids, they are looking at regional grid integration and smart storage.

Again, picking up on what Andrew said, the very predictability of tidal ties in well with storage techniques. Whether you are using a battery, hydrogen or pumped hydro, there is a real opportunity there. That again allows tidal range and tidal stream the opportunity to provide continuous power to the grid when it is needed. In a lagoon we can bring forward or set back our operation by half an hour, which again may be very useful in

terms of voltage and frequency control, because we have huge turbines with inertia, and that inertia is extremely useful to the grid.

Q16 **Duncan Baker:** I hear loud and clear that one of the biggest challenges that you all feel we face is Government policy. Therefore, the main thrust of being able to get this energy production under way is probably a change to policy. One of the ways of being able to demonstrate why it is so necessary is the benefits it would bring. I noticed when we first started talking that there were quite significant challenges in many of the communities where these projects are potentially to be located.

One of the benefits is that we can certainly say there will be employment and investment. I have heard the comments about stability to the grid. Put some meat on the bones. What are the real benefits that this development of tidal technologies will have for those regions where potential project clusters may develop?

Henry Dixon: An economic impact assessment done by Glyndŵr University on the north Wales tidal lagoon showed that there would be 26,000 jobs created. Those jobs are during the research, development and the EIA HRA phase up to consent and licence, and then a significant number of jobs, about 12,000 jobs, during the construction phase. What is critical is that there will be jobs thereafter in terms of operations and maintenance, but also spin-off jobs. If we have a source of renewable low-cost energy on our doorstep, we can create data centres. The north Wales tourism brand has changed enormously in the last 10 years with the mountains. We could do the same for the beaches.

Again, if we required it, along with Somerset and Mersey. If there was a turbine development and assembly centre in Deeside, for example, to supply each of those, that would create a lot of opportunity for jobs, employment and transformation not just in north Wales but in south Wales, Somerset, Merseyside and up in Cumbria.

Sue Barr: What is interesting is that there are different types of projects, tidal range and tidal stream, but similar benefits. We know that we are seeing 50% to 60% of the GVA, the socioeconomic benefits, land in the local communities. We know that, to steal one of Neil Kermode's very famous phrases, "Innovation breeds innovation." We see spin-off activities around not just energy production, but around economic benefits, capacity building and infrastructure.

We talked about the grid, jobs and GVA benefits landing in those local communities. Orkney is a very good example. A number of years ago, the European Marine Energy Centre set up over £300 million-worth of GVA into the economy in the UK and the majority—almost half—of the full-time equivalent jobs landed in Orkney, a peripheral economy. If we are looking to level up and drive the industrial strategy, marine energy in all its forms can help meet those needs. We know the benefits land locally, and they are significant.

Q17 **Alex Sobel:** My questions follow on directly from the Chair's questions. The last thing you were saying, Sue, was about bringing projects to market and the barriers. We have had successive attempts at bringing tidal stream technology to market. Obviously we have the big Scottish project, but other projects are not coming through. Your point about contracts for difference was that they need to be changed. It would be interesting to hear what those changes need to be and, if we got those changes, how quickly the market would develop. Is the sector ready for delivery if those changes come through? Can it deliver low-cost power to the UK in the short term?

Sue Barr: Very interestingly, you touched on the point of timing. Are we ready, and can we deliver in the short term? The prospect that tidal stream and wave is bringing is that we need to develop the technology during 2030. We have projects that are ready to go. I have talked about those: the 124 megawatts that we anticipate could bid into auction round 4, so the next auction round within the CfD.

We know that the route to market is a barrier to putting multiple devices in the water. Why don't we have projects with multiple devices in the water? We do. We have some of the world's first arrays in Shetland and in MeyGen—the big Scottish project—where we see multiple devices in the water. How can we build those projects? You need to have a route to market. That route to market should be within the CfD system.

What we are asking the Government for is effectively to have a pot within a pot, so, rather than compete with other forms of technology that have had 40 years to drive out their costs, allow us to come in at a higher price of 100 megawatts in this first AR4 and add a higher strike price. What does that mean? We know they are ready to go; they are absolutely ready to go. We stress tested this across the sector and we have that volume of technology ready to go in the water through the AR4 process.

Therefore, it is a ring fence or a provision within the CfD to allow tidal stream and other forms of new and emerging technologies to come forward at a higher strike price, an administrative strike price we advised through the BEIS marine evidence committee and through their call for evidence that that should be in excess of £200 per megawatt hour. We are talking about £250 per megawatt hour to bring this technology forward.

In terms of how you get to those projects, they are the leading technologies. If you want to bring additional technologies forward, what we are asking for is an innovation power purchase agreement. This allows smaller sub-5 megawatt projects to come forward, a tax rebatable system, so the power off-taker is given a tax rebate on the difference between the market price for electricity and the increased metric or value above that within which marine energy comes forward. In doing that, we can deliver significant gigawatts on to the grid in the 2040s.

I know Andrew is waiting to come in on that but, in short, that is what we are looking for. We have technology ready to go and we need a route or a pathway through to commercialisation to secure all of those benefits.

Q18 **Alex Sobel:** Andrew, as a developer, how quickly can you get going for us?

Andrew Scott: Just a little bit of context here. It should not be lost that there has been a huge amount of private sector investment in technology development in this industry, probably over £0.5 billion that principally came through from 2000 to 2014. Most of that came from outside the UK and was invested in UK projects and companies. That was in an endeavour to get products to the commercial start line. You could argue that projects like MeyGen were exactly those starting shoots of a commercial sector. MeyGen was deployed in 2016, and it was in 2016 that the Government removed a market mechanism support for tidal stream energy.

There needs to be an appreciation that when companies are pre-revenue, when you are in R&D stage, you are massively reliant on equity investment. If your investors, your shareholders, cannot see a route to making money, it sends you into a hiatus. I don't think we should avoid that it is part of the context that we sit in here: for the last five or six years it has been almost impossible for us to raise equity investment to continue the technology development and demonstration process because we simply have not been able to demonstrate or point to a method by which investors will warrant a return. That is an important part of why we have been in something of a doldrums or a flat spot for the last four or four years.

In terms of why we are ready—I touched on it before—it is that the technology programmes that we have seen, certainly in the tidal stream space, have commonly converged on similar technical solutions of how to generate the power. Almost without exception they have generated reasonable amounts of power. That started early doors with Bristol-based Marine Current Turbines, which generated 9 gigawatt hours with an early prototype system into the grid in Northern Ireland from Strangford Lough.

We saw multiple gigawatt hour style technologies being demonstrated at the EMEC site up in Orkney, including our own, which generated over 3 gigawatt hours after 2016. I think MeyGen is now up at 28 gigawatt hours. As a technology developer, I would say we are now demonstrating the empirical evidence base of performance that can start into that commercial journey, but that commercial journey can only be taken if we have the right support mechanisms.

It should not be lost that, when onshore wind first appeared in the UK under NFFO contracts, in today's money it was around about £175 a megawatt hour. That was after Denmark and Germany had principally done the heavy lifting in the early stage of product development and

market support through the 1980s. As Sue said, what did they get from that? Tens if not hundreds of thousands of long-term supply jobs.

Offshore wind is a more recent demonstrator. It was only five or six years ago in today's money that the CfD strike prices were about £180 a megawatt hour. Both those sectors, offshore and onshore, have reduced their costs by approximately 75%. These are things where we have demonstrated evidence cases that we can do this, but we can only do it if we are provided the opportunity under a commercial mechanism.

Q19 **Alex Sobel:** Thanks, Andrew. I am going to move on, because we do not have a lot of time. I will try to bring Henry in on a future question. When I first became a climate activist, alongside wind, which is a successful renewable technology, and solar, which again is a successful and mature technology, we talked a lot about wave power, utilising the wind power on surface waves, but that has never come to market. There are no large-scale projects and it has mainly been left behind now in terms of the industry base. Are there any lessons to learn, turning to tidal, from what happened to wave energy and wave energy projects?

Neil Kermode: The point is that they are different industries. They are driven by different things and they encounter different challenges. EMEC was first set up to bring on wave energy, because wave was further ahead, and then we were going to do tidal afterwards. As it is, tide has taken steps faster than wave. As Andrew said, to a large extent that is entirely down to the route to market. How much do you want this? What are the signals like? How much effort is it worth putting into this? Investors have a choice as to where they put their money. If they see they can make a better return somewhere else or if they are not quite sure about something, they will go and do the other thing. We never really saw the "throttles wide open" support that we really needed to get some of these technologies away.

Tide is a slightly easier one for the market to understand because, as Andrew said, it is a bit like underwater wind. You have a rotary kit and people can get their head around it quite quickly. We know that there is the opportunity for wave energy. I certainly know the waves are here because I get them on a regular basis. The challenge is that we need these long-term signals. If we keep turning the signals on and off, people do not know where the hell they are.

We have to have a long-term concerted drive with unremitting determination to make sure these technologies come on because, working in a heavily weather-driven environment, it is easy to be thwarted for a few weeks or a few months while you wait for the weather to change. We cannot afford delays, so clear signals, solidly set and determinedly supported are very important. That will then reduce the cost of capital, and it therefore makes the schemes more investable.

Andrew Scott: I spent 12 years of my life in wave energy with those big, long sea snakes, and I emphasise what Neil is highlighting. Other

than the working environment of seawater, everything else is different generally. The benefit of tidal is that the resource is familiar, it is moving fluid, so in a way it is condensed like a form of wind resource, although obviously it is due to something else. What I am trying to say is that we already have the fundamental components, systems and engineering that understands how to turn that into electricity. That is why so many tidal turbines have worked very successfully because they are based on technologies that we already know.

The even better thing is that there are big supply chains ready to invest in this space, because they understand it. Wave energy is voodoo. It is not like anything else the world sees from an energy resource perspective, so they have the double challenge of trying to work out what the right power take-off system is and then to get it to the right cost, whereas tidal has always understood what the right power take-off system is. It has just been a challenge of getting it to the right cost and getting the right performance evidence.

Q20 **Alex Sobel:** I talk a lot to wind farm developers, and they talk a lot about the supply chain—particularly steel in my region of Yorkshire, places like Forgemasters and William Cook. What are the opportunities for that manufacturing supply chain, and what is the export potential for that supply chain, if tidal technology matures?

Henry Dixon: Andrew is right about the challenge of going to equity investors when there is no clear policy. One really needs policy. The cost of entry into tidal stream is probably 100 to 1,000 times less than the cost of entry into tidal range. What we need is the policy, but we also need to clear up some of the misinformation that is still held in some of the older parts of Government. Charles Hendry is talking later, so he can talk much better to his report, but what we need is to clear the air.

In the last five years there have been huge advances in construction technology. There have been advances in turbines, in terms of both their performance and their fish-friendliness and things like that. What we need at this stage is some support to do that, open and transparent, so everybody can look at it and say, "Does tidal range work or not for the next five or 10 years?" If it works and if there is the right support mechanism, the smaller lagoons—whether they are in the Wyre or in Mostyn—can be done in three to five years, with the bigger ones following five years after that.

On the support mechanism, one thing I have not mentioned is the sheer life of a tidal range scheme. It operates for over 120 years, so during that time a wind farm will have been taken down and rebuilt four times. One of the interesting things about where we are now in 2021 is that in 25 to 30 years' time we will be hitting 2050, when capacity will have had to double for the amount of energy needed and double again because of the capacity. All those wind farms are going to have to be taken down and put back up again because they are coming to the end of their life, whereas tidal—whether it is range or stream—will still be working away.

The CfD mechanism at the moment does not work for tidal range because we are looking at something that works for 100 years and our cost of entry is so high. If we had the data I have talked about and if we could get the funding package to do the necessary environmental, financial and technical research work, we would know and we would be able to discuss with the Government whether we should go to a regulated asset base or a modified CfD over a longer period or whatever it is.

Coming back to your question, supply chain, yes, absolutely. I have to say there has been some excellent work done looking at the steel required from Sheffield; the construction steel for the lagoons themselves. In modern technology there is a real need for caissons, so there will be a use for ports and casting yards in four or five locations along the west coast to bring in caissons, because that is the new way of building these large walls. That again will bring employment to fringe areas on the west coast and, indeed, over in Ireland. The consultants we use on the environment, birds and fish are not just local, they are regional, so there is a real chance to spread those jobs around. For export potential for tidal range, it is going to be a skills resource. We will learn how to do this.

The consultants, of which there are excellent ones in the UK, will be able to go out and sell that knowledge base. At the end of the day, a lagoon is a locally built dam—a great big one, but a dam—with turbines. It is not as if we are going to be the same as tidal stream, where I really support them selling thousands of turbines from British manufacturers. Ours will be a skills sale, but if we manage to build west Somerset, north Wales and Mersey lagoons, we would need 360 25-metre turbines. That will certainly keep Sheffield Forgemasters busy for a year or three, I can promise you.

Alex Sobel: Great, that is very good news.

Sue Barr: We know that the skills and expertise base in the UK is geographically diverse. We know that it is across the whole of the UK. We are already doing offshore wind, the vessels, the harbours, the ports. We are now looking at large-scale development of floating offshore wind. This fits very well with our maritime history and our ability to deliver wave and tidal technologies. We have a diverse supply chain that is ready and poised to move. It is geographically diverse and we know that we are going to drive very high levels of UK content into that supply chain.

Alex Sobel: Andrew, do you want to come in on this? You are obviously in the supply chain at the moment.

Andrew Scott: Absolutely, yes. That is what I was going to say. As we speak right now, we are just nearing the end of the build of what will be the world's most powerful tidal turbine. That is an activity that we are centring in Dundee up here in Scotland.

Just to give you a flavour, we have steel sheet that has come from Motherwell here in Scotland. We have hydraulics from Yorkshire. In fact, I think William Cook may have supplied the sails for SR2000. We have anchors that are coming from north Wales and we have some of the largest composite blades ever put on a tidal turbine coming from Southampton, from Gosport.

At this stage we estimate that, from a build perspective, it is just over 80% UK content. To put that into context, I think in 2015 the average CAPEX UK content for offshore wind was about 18%, so we are talking about being able to achieve the inverse. We do not think that is a concession. We are broadly unanimously working with very skilled, capable and able suppliers here. The only sad thing is that, when we are exiting a lot of these workshops, there is not a lot coming behind them.

In terms of what that means, at the moment we are estimating that somewhere in the region of 80 full-time equivalent jobs have been created directly and indirectly associated with our O2 turbine build within the UK economy. We would probably need that to come down as we come down from a cost trajectory perspective. Again, putting that into context, that is an order of magnitude different from what is being generated from offshore wind. One way to think about this is delivering 100 megawatts of tidal stream into the UK economy, from a CAPEX construction perspective, will have a similar effect as building 1 to 2 gigawatts of offshore wind. I would argue that is a massively disproportionate return, in terms of what we are being asked on a commercial mechanism support.

In terms of long term, the global market is much bigger than what we have here in the UK. One of the nice things with tidal stream is that, because it is a condensed form of energy, everything is a little bit smaller. The notion of being able to manufacture and assemble blades, the sails and ship them around to a world market is absolutely 100% within the gift to be taken here.

Alex Sobel: It is good to know there is probably an economic multiplier effect, which will help the supply chain and other communities outside where the energy is being generated.

Chair: I am afraid, colleagues, we have to speed up now. If you could just address questions to one member of the panel rather than everyone, we should be able to get through it.

Q21 **Mr Robert Goodwill:** Sue Barr, I hesitate to pour cold water on what are very optimistic and positive witnesses, but it does seem—particularly from what Henry Dixon just said—that we have become used to the fact that nuclear and some offshore wind technologies are very capital intensive with lower running costs. It is almost that we have created a whole new category, which has such a high upfront cost, even more than nuclear, that we have to create new ways of subsidising it.

Looking at what Kwasi Kwarteng said in a Westminster Hall debate, the

Government seem to be very sceptical that we can bring down those costs to make tidal range projects competitive. Sue, you talked about finding a way through and finding bankable projects, but do you not concede that some of these technologies will be very difficult to deliver, even at the levels of subsidy that we are looking at or with cross-fertilisation between different types of generator that we have at the moment?

Sue Barr: I will speak specifically for wave and tidal stream. Then, if you do not mind, I might revert to Henry in terms of tidal range because I think we need to decouple the two. They are very different projects in terms of the capital intensity needed at the front end. What we are saying at the moment is that we still need high levels of revenue support. Those are not high in terms of what we are going to provide, so the added benefits that we are going to bring. They are not high in terms of the stage of technology development. If we get a strong signal, we know we can bring those costs down for tidal stream on a trajectory that is faster than offshore wind.

Arguably, the Government have presented the UK offshore wind market as being highly successful through the CfD mechanism. What we are saying for tidal stream is we can do that again. We can do it quicker and we can build more capacity here in the UK. As Andrew alluded to, there are high levels of local content, so the value for money is much higher for tidal stream.

In terms of technology development, wave is some stages behind but we believe that, by putting in the revenue and support mechanisms for that technology, we can drive similar levels of UK content and technology development here in the UK. Therefore, a different ask to tidal range, which—as Henry has alluded to—is very capital intensive at the front end. What we are saying is we have a technology. We can build it, we can learn and we can drive down those learning rates much quicker than offshore wind.

We know how to do it. Give us the support now and we will get those costs to be cost competitive with other forms of renewable energy very quickly. I think it is a positive message and certainly, in personal conversations and in the work we are doing with Government, we know how to demonstrate those empirical values and how we are going to get the costs down.

Q22 **Mr Robert Goodwill:** Very briefly, Henry, I have heard what the Chair said. They are not even opening up allocation round 4 of contracts for difference to tidal range projects, so they are obviously very sceptical about standing up these projects financially.

Henry Dixon: I refute completely your claim that tidal range is more expensive than nuclear. Hinkley is currently at £28 billion. To build an equivalent sized tidal lagoon is £7 billion. Hinkley does not provide electricity any cheaper. In fact, our potential cost at the moment is £90 a

megawatt hour, which is cheaper than Hinkley. Our lagoon will last twice as long, so we have no decommissioning costs, which are not built into any of those. We protect the coastline, which is worth £3 billion, so I am afraid the numbers that have come out of some Government sources are distinctly odd.

That is the reason why we are not in CfD, but I would say that we are caught in a paradox. BEIS will say to us, "Give us a fully designed scheme with all the numbers and the financial model, the environmental model and everything else and we will then consider it." We say, "Give us a policy so we can support it to do that," and they say, "We are not going to do that." I would refute your numbers completely. I think we are an equivalent, if not better, source of baseload than nuclear.

Q23 **Mr Robert Goodwill:** Maybe the Chinese are listening to this conversation and will be knocking on your door in the morning, as they are always keen to find good investments.

Turning back to Sue, obviously we are looking at innovative ways of funding this new type of technology. The innovation power purchase agreements, which seem to be a way of using the tax that the supplier would pay as a way of subsidising the generation, is that something you see could work in practice?

Sue Barr: As I described earlier, we are looking at a route through from early-stage technology through to that ability to compete commercially within CfD rounds. The industry, the wave and tidal sector, as a collaborative effort were asked by Government to come up with something that kept costs off consumer bills. We worked over the past two years to look at that. I want to make it very clear to this Committee that cost is not the only metric. What we pay for our electricity is not the metric by which we should measure the success of these technologies. I will just put that on the table.

The innovation power purchase agreement is a concept that allows technology developers to bring their technology into the water, sub-5 megawatt projects. Then the buyer would reclaim any difference between the higher strike price and the market price as a tax rebate. In the short term, we are talking about 120 megawatts. This would allow small arrays to utilise that extensive resource we have around the UK coastline and it would bring down the cost. It is also very important to note that the private capital takes all the risk there, so what we are saying is that any rebate is only available on your performance. It removes risk. It takes it off consumer bills.

What that mechanism should look like is something that we want to work with Government on. We say a tax rebate system. We have given provision and we have done a lot of work on this as a sector, but we would like to work with the Government to find out what that mechanism should be from early stage, through R&D and capital investment in research and development through to commercialisation. By providing

that route through, we believe we can deliver all these technologies and the associated benefits that we have alluded to.

Q24 **Nadia Whittome:** Henry Dixon, it is evident that tidal range projects are long lasting in nature. How should revenue support mechanisms be structured for those longer-lasting projects? More broadly, how should financial support be structured to assist technological and project development in this area?

Henry Dixon: You are right about long lasting. It is worth pointing out that the La Rance barrage in Brittany was built in 1966 and, once it had paid off its capital 26 years later, has been generating the cheapest electricity in Europe.

In terms of a support mechanism, to be honest, I don't know and that is why I would like to get some work done on the financials of the whole system of a tidal range lagoon. We have the challenge that you cannot start generating electricity until the whole lagoon is built and the last turbine is dropped in. For a small lagoon it will take five years and for a large lagoon 10 years, because you have five years of environmental studies to get things right and then five years to build it. That is why it is so capital upfront.

If you think that they have 110 years of operation, the first 20 or 30 will pay back the capital and then you have 70 years when the O&M costs are minimal, frankly. Your fuel is free. Our hydro turbines are not a new technology. It is well known.

There needs to be a mechanism—and Charles Hendry may be able to comment on this, because he knows these things better than I—but we have talked with the Government briefly about a regulated asset base. I know there have been suggestions that there should be support upfront and then a repayment system after the 30 years, so once the capital has been paid off the repayments go into the Treasury from then on. Those mechanisms need to be looked at.

As Sue said, it is not just about price; it is also about the form of the electricity. The reality is that in north Wales we are looking at a 2.1 metre sea level rise. Surely, if the lagoon is being built and can help with that, some of that value should be taken into account by the people who pull these things together. I cannot give you a precise answer, but I would love to have the chance to work with Government to do the necessary work in order to have that discussion.

Q25 **Nadia Whittome:** What lessons have been learned from the failure of the Swansea Bay tidal lagoon to receive Government backing? How do you think tidal schemes can reduce costs to make them more commercially competitive? Why do you think that, despite so many relatively large marine resources, there are so few developments in that area?

Henry Dixon: If we are going to talk about the Swansea Bay tidal lagoon, I would prefer to let Charles talk about that later. I would just like to say two things. One is that the rules of the game changed halfway through. Swansea Bay was designed as a pathfinder. That was the idea. It was never meant to be a standalone business making significant money or whatever else. The rules changed, and then it had to stand on its own feet. There are other places in the UK where the coastline is much better, the technology that can be employed is much better and the larger lagoons are more efficient. Since then, construction techniques have come along, turbine techniques have improved and we are looking probably at a 30% cut in the construction costs and a 20% improvement in the operational efficiency.

As I say, the legacy of Swansea is a challenge for any developer in this space. Why haven't we seen many of them? Partly because of that, partly because again it is easy to get people excited about tidal range. You would be amazed. You go into a pub—which we can't do anymore, sadly—or if you go anywhere on Zoom and talk to people about it, they get it. I have been trying to do this for six years now.

If you have to rely on private investors—and there has not been, as I said before, a penny of Government money either from the UK or Europe—it is very difficult to do the necessary work to provide the convincing science to support it. That is why we are where we are. It would be such a shame to let such an extraordinary resource go to waste.

Nadia Whittome: Thank you, Henry. That is very helpful.

Chair: Thank you very much, Nadia.

Nadia Whittome: Did Sue want to answer that? That question was for Sue as well.

Chair: I am afraid I am going to move us on. We have only quarter of an hour left and two more questions to come, but thank you, Nadia. Sue may be able to address that if she answers another question.

Q26 **Jerome Mayhew:** Mr Dixon, the key challenge that we seem to be coming up against again and again this afternoon is the challenge of demonstrating from principle to commercial large-scale competitiveness. It is fair to say that the UK Government have expressed considerable concern over the ability of the sector and tidal range technologies to achieve the cost reductions necessary to make it commercially viable. As a starter, is it possible to do a cost-benefit analysis for tidal range compared with other renewable energies?

Henry Dixon: It is worth saying right off that we will never compete with offshore wind. The current projections are around £90 a megawatt hour, and I do not see that we will ever get down to the £40s of offshore wind or less than that. That is because we are still being forced to model it on a 35-year basis. If we were able to look at the fact that our lagoon lasts for four times as long as a wind farm, it would be feasible. If we were able to bring in co-benefits, the coastal protection, the transport links and

everything else, again that would make it affordable. There would have to be a bit of joined-up thinking in Government to look at the various strands to make it feasible.

Charles Hendry came up with some ideas as to how that might go forward. There has been talk about a first of a kind. I do not like the word "pathfinder" because it puts too much emphasis on that, but on a first-of-a-kind lagoon—which Swansea might have been; it is not, but there are still people interested in Swansea—there are small lagoons, as I say, in Wyre and Mostyn. The bigger lagoons are more efficient per megawatt hour, per gigawatt hour. It is a real challenge, and I would argue with some of the basic numbers, but people need to take onboard the value, the inertia, the stability and the security. On cost alone it honestly cannot be justified, but if you look at coastal protection and everything else it can.

Q27 **Jerome Mayhew:** I know you do not want me to focus just on cost but it is important, none the less. You have contracts for difference for offshore wind based on a 15-year payback. I believe for nuclear energy it is 35 years, from memory. Yet we have heard today that your infrastructure would last perhaps up to 100 years. If you took that into account and had a much longer payback period to consider, do you start to get down to comparable cash figures?

Henry Dixon: I would like to send you some information after this, but the answer is basically yes. If you are an accountant and you discount cash flow and you put in a discount rate, frankly, any costs or, more importantly, revenue after 35 years disappears. The fact that you are generating, at current rates, £400 million-worth of electricity a year for 70 years is completely irrelevant. We believe in community ownership, so we already have the support and partnership of the local councils, and their share would make a huge difference to the whole region. That is a whole area where—again, Charles may be able to comment on this—I think we can get it down over 100 years to where it is certainly affordable and competitive.

Q28 **Jerome Mayhew:** Dealing with the anticipated development of technology and the prognosis for further cost reductions, are you in some sense stymied by having a relatively small number of projects that you can foresee over the coming years? Therefore, the projects are unlikely to develop scale efficiencies or technology efficiencies. Do you see very significant reductions in the cost of production in the way that we have seen in offshore wind, for example?

Henry Dixon: I can see some cost reduction in the civils, which is one third of the costs, but not a lot. This is a known technology. We are making dams and hydro-schemes. I can see some cost reductions in turbines because more people will come in as the market develops. We already have interested players in Norway, America, and Holland who approached us with a very fish-friendly turbine and very efficient turbines.

The only area where costs might come down is in the financing. If we could get the financing at Government rates rather than commercial rates, that would make a huge difference. Certainly, the Welsh Government expressed an interest recently. I would like to support my tidal stream friends, who have a real cost-reduction curve that they can show you. We are not in the same ballpark, but I would still say we should be part of the energy mix.

Q29 **Jerome Mayhew:** Before I move on to tidal stream, I would like to test one other issue with you. It seems to me, given the conversations that you have had with the Government, that the sector is now more focused on commercial development rather than development with direct Government support. Is that the case? If so, is there anything the Government can do to help with that private development process?

Henry Dixon: There are two things. One is to have tidal taken seriously as part of policy. It is reprehensible that the industry should be asked to answer a call for evidence on marine energy and then, two months later, there are 19 words in the energy strategy that say, "We might look at tidal and marine energy later." The industry put in an enormous amount of work.

I am asking for a £20 million fund to establish exactly where we are in terms of construction, turbines, environment and financial modelling, so that we can clear the air, get the facts and start talking about long-term use, or not, of tidal range. If we do the £20 million work and it does not work, I can go back to farming. It would be really useful to look at that, and it would be positive for everybody.

Q30 **Jerome Mayhew:** Thank you very much for those answers. I am going to move now to Andrew Scott so we can explore tidal stream installations. The story seems to be more optimistic here in terms of cost reductions. I am going to start with a similar question: is it possible to give a cost-benefit analysis of tidal stream compared with other renewable energy sources in their development phase and then compared with where they are now?

Andrew Scott: Yes. I indicated from a cost perspective that wind, both onshore and offshore, has reduced costs in the order of 75% or more since it has been used in the UK generation mix. That has principally come from two functions. This comes from a scaling effect. It went from a few handfuls of megawatts to now tens of gigawatts of capacity on the wires here. Volume economies of scale have a big impact. If you have a cookie cutter, the more you use it the more your costs come down.

Innovation plays an important role. We think it is around a 50:50 split where the cost reductions come from, both from innovation and scaling. Innovation can be a scaling in itself: the size of the turbine, getting them bigger, making things simpler and easier to manufacture, and making them more efficient or generating more power.

The asking price we are starting from is broadly analogous or similar to where wind was back in the early days. Those are the types of metrics that we point to that give us evidence, or comfort and confidence, that we can deliver a similar type of effect. The part of the conversation that we have also had here is: do we want the upside from the socioeconomic and jobs perspective? If we do, it is imperative that those spoils go to the early market. Once they are embedded, they are very, very difficult to remove. That has been demonstrated where we had a technical lead in wind and it went to Denmark and Germany. Despite having the world's largest offshore wind market, we have not been able to dislodge the supply chain from those places. If we want those long-term, sustainable supply chain opportunities, we have to be prepared to invest in the early stage.

Q31 **Jerome Mayhew:** The relevant strike prices that have been mentioned during our conversations are £180 for offshore wind and £175 for onshore, yet Sue Barr suggested a strike price of £250 for your technology. It is significantly higher than like-for-like prices for the other technologies. The other number that has been bandied around is a 75% reduction in costs. Do you see that as achievable for your sector, or could it be more?

Andrew Scott: Absolutely. The explanation is the same for those two points; we are before the start of these graphs. In the 1990s the onshore wind sector had already delivered hundreds of megawatts in America, Denmark and Germany. They had already come down those cost curves. We are at a handful of megawatts at the moment. We are before a lot of these curves have even started, hence why our costs are that little bit higher.

Certainly, by the time of getting a gigawatt—as Sue said, that is the target, a gigawatt by 2030—we can bring the price down. Maybe it will not be as low as offshore wind is right now, but it would reflect something that is more like a 60% to 70% cost reduction on those early starting prices. There is an explanation as to why we are a little bit higher than those places were, because we are a little bit earlier from an industrial perspective. If you want those long-term industrial benefits, that is the part of the equation that you need to be able to solve.

Chair: We spent most of this session talking about the energy aspects but, as we are the Environmental Audit Committee, we must talk about the environmental implications of some of these schemes. To do that I will ask Barry Gardiner to finish the panel.

Q32 **Barry Gardiner:** Henry Dixon, the evidence of altering hydrodynamic patterns affecting water quality came through in the environmental impact assessment from the Swansea Bay tidal lagoon. There was evidence of build-up of contaminants in the water due to the reduced flushing rates. That naturally has an effect on habitats, reduced water speed, resulting in reduced suspended sediment, which affects the seagrass meadows and the reef habitats. Can you tell us what lessons

you have learned from that study and what steps you believe it is possible to take to minimise those impacts?

Henry Dixon: The first thing to say is that each tidal range project is bespoke. Whether it is a barrage or a lagoon, or whatever, you have very different environmental challenges. Interestingly enough, Simon and I were talking to the Environment Agency yesterday, and one of the things that is needed is an understanding of what the baseline is and what is happening in hydrodynamics. Again, in north Wales we have just discovered over the last nine months—ourselves, with Reynolds International, Bangor University and SEACAMS—that the Constable sandbank, which is offshore and was thought to be a tidal deposition, turns out to be the remains of a hill that had sheep on it 140 years ago and is being eroded.

The understanding of where sediment is going and where it is coming from needs to be in place, so part of the spend that I am asking for, the £20 million, is to select a couple of leading sites and to start getting the environmental data in place to understand what the hydrodynamics is, what the geoscience is in terms of your foundations, and what birds, fish, mammals, invertebrates and humans exist there. There is a wide strip around the coast that very little is known about.

The big lesson from this is, rather than designing something and then going to the NRW or EA and saying, "Here it is. What do you think?" is to work with them very early. I know a couple of the developers have put forward a preliminary environment and scoping document to the regulator, saying, "Here is the big picture. Let's between us agree where the red flags are and where the difficult bits are." Then you need to embed from an early start in the design any mitigation or, indeed, any positives. You get that in early.

One of the great challenges for all of us in tidal range is going to be separating the impact of climate change from the impact of the project, because there are areas, frankly, where the intertidal habitat is going to disappear because of sea level rise. We need to understand what is there and what we can do about it. In north Wales we will be protecting Talacre Point. We will be deposing sand on it. We are protecting the tern sites. There are all sorts of positives. Let's have a look at the negatives and the positives.

The main lesson is where we are on the baseline and making sure that any environmental work for whatever species is done at an early stage, so we make sure that the flushing mechanisms are in place so it is not damaged. Can we actually help? If there is a river going to that lagoon, can we help with its flushing? That will then help fish lay eggs, and all that sort of thing. Get in there early and understand what we are doing.

Q33 **Barry Gardiner:** You mentioned the Welsh scenario, and the Welsh Government's assessment of wildlife impact said that there could be 70 or more sites that would be adversely affected, particularly looking at

birds and intertidal flats. I am a supporter. I do not want you to go back to farming. I want you to be able to push ahead with this and succeed. I think it is important that you do that up-front environmental study, and perhaps also, if you could expand on how you see the importance of setting out the environmental impacts of tidal range with other renewable technologies. It is always difficult to compare it against a baseline of nothing, but if we are going to get our power from elsewhere then we have to compare it with the environmental impacts of that elsewhere. Therefore, I think it might be important for you to look at that and to put that upfront as well.

Henry Dixon: That is very valuable advice, and I think you are absolutely right. We could compare with another source of baseline, whether it is nuclear, wind or solar. I accept the point, and it is a good suggestion. Thank you.

Q34 **Barry Gardiner:** Neil, you and I are a lot older since we last met in Orkney, but based on your experience of demonstrating tidal stream technologies, can you tell us what you have learned about the technology and its impacts on wildlife? In particular, if you look at the way in which tidal energy diminishes our natural carbon sinks, including saltmarsh and seagrass, I think they have the potential to absorb up to 40,000 tonnes of carbon a year around our coasts. Are you aware of any studies or research that the Committee should note that shows the impact of tidal stream on those carbon sinks, and, again, how can we overcome those factors?

Neil Kermode: Yes, it was a while ago since you were up. Nice to see you again. I think with tidal stream the conditions are already quite aggressive. In other words, the streams themselves are going through channels and, by definition, they have pretty much stripped out a lot of the sediment. They are often bare rock.

The lesson we have learned so far is that what we have been doing has had practically no effect on the environment. The major impact we are likely to have will be on some of the mobile species, maybe fish. The studies we have done so far have shown that there are some effects that happen when you are out working on the machines, and when you leave the wildlife comes back.

Andrew has some good film of birds nesting on top of his turbine in the middle of the site. They become fishing platforms for birds. The impacts are not always negative. There can be impacts because you are taking energy from the system and you are changing it fractionally, but not always for the worst. We should not always assume that an impact is negative. I do not think we have seen any particular impacts.

In terms of the seagrass, that is not something that is near the sorts of sites that have very strong tidal flows. It tends to be in estuaries, and we are out off the headland.

One of the points that comes out of this is that trying to do some of this research is quite a burden for the early-stage developers. We are often faced with questions posed by the regulator—and I used to work at the Environment Agency—and we have to answer those questions. The first one into the water has to answer all these difficult questions.

The point I would make is that at the moment we are trying to get the UK's R&D spend up from a miserable 1.7% of GDP to 2.4%. It seems that there are a lot of research aspects that could be addressed in this arena if we actively realise that this is an industry that we wish to have happen, and we therefore mobilise our research activity to support it. I would strongly suggest that there is an opportunity here to answer those questions.

We have looked hard, but we have not found anything yet. What we need to do is keep looking—

Q35 **Barry Gardiner:** There was a 2019 study that found there was a reduction in listening space, thereby preventing communication and foraging, for example, in harbour seals. That listening space was reduced by over 80% when you got closer to the tidal turbines. There are impacts here. They need to be documented, and then the environmental impact that they will have needs to be factored into what we are doing. I am hugely supportive of getting this from experimental right through to commercial development. It is absolutely vital that we have clear sight of the real impact that we are going to have on the environment as a result of these technologies.

Neil Kermode: I completely agree, because we need to deserve to be in the water. We do not have a right to be in the water. We need to prove that what we are going to do is appropriate.

What we have seen is that the machines are pretty benign, and often the worries that are expressed are quite humancentric. In other words, we worry about this, but I do not know how a whale thinks and, unfortunately, you cannot interview them so you have to put one near a turbine to find out. The practical application of technology is critically important with appropriate study around it: deploy, monitor, adapt is absolutely critical because you cannot theorise all this.

We see there is a bigger R&D opportunity for this, which itself generates revenue into the economy. The work done by BEIS last year showed that increasing R&D increases GDP. We think there is a win-win here.

Chair: That is a very convenient moment to bring this to an end. Thank you, Barry, and I would like to thank our first panellists, Sue Barr, Simon Hamlyn—I do hope your tooth is better—Henry Dixon, Neil Kermode and Andrew Scott, for joining us today. Thank you very much.

Witness: Charles Hendry.

Q36 **Chair:** We are now going to move straight into our second panel, which is a panel of one, with the right hon. Charles Hendry CBE. Very good to welcome you back to Parliament, Charles. You undertook a review at the request of the then Secretary of State. I think you were commissioned back in 2016 and reported almost exactly four years ago on the prospects for tidal lagoons. It was not related to a specific lagoon but you were looking at the principle. Could you start by explaining to us the remit you were given and your initial impressions of what the prospects were for tidal lagoons around the UK?

Charles Hendry: It is a privilege and a pleasure to be welcomed back into Parliament again. Thank you for that. It is fascinating to hear the conversations that you have had so far, and I agree with an enormous amount of what your previous witnesses said.

The remit was essentially in two parts. First, is it a feasible technology to develop tidal lagoons? Secondly, if it is feasible, should we be doing it and how is it best going to be financed? The first part was an existentialist element, and the second part was more focused on how we would go about doing it.

The principal conclusions were that we have an enormous resource, as we heard—the second largest resource in the world—and that the cost reductions are most affected by scale. The greater the scale of the project, the lower the cost is going to be. We need to look at this in totality, rather than simply as a power-generation facility.

Q37 **Chair:** You were undertaking your review at around the time that the Swansea Bay project was being promoted. Did you form any specific views about the prospects for Swansea Bay and what it could contribute to UK energy production?

Charles Hendry: We looked at that specifically with regard to whether it should be first of a kind, a pathfinder technology, and we concluded that it should be. To go straight to the largest type of lagoon, which would be perhaps £5 billion to build, we took a view that that would be unfinanceable. People were interested in the technology but, if it had not been built at a small scale, you would not be able to bring in the large element of funding for that and, therefore, we saw that it was one with a significant advantage.

In addition, it was not going to have some of the environmental consequences that tidal lagoons higher up the Bristol Channel could have. It was a project where you could learn some of the issues. It would be an important part of the process of understanding the overall contribution that lagoons could make, but it would minimise the downside.

Q38 **Chair:** You looked at the environmental consequences of the lagoon specifically, did you?

Charles Hendry: Not specifically. That was outside the terms of the remit. Evidence was submitted to us by local fishermen and the bird sanctuaries, and issues like that. It was not part of the remit to reach conclusions, because there would be a separate environmental consenting process.

Q39 **Chair:** Did you look at any lagoons operating in other countries? We have heard about the lagoon in France, which has been operating for decades.

Charles Hendry: The one in La Rance is a barrage more than a lagoon. It crosses a river, where a lagoon would be different. It joins the land together; it forms its own hub and the water comes in and out of that area. No lagoon has been built at scale anywhere in the world. This was an area where we believed the UK could be a leader, just as it has been in offshore wind.

Q40 **Chair:** Could you summarise your conclusions for us as to whether, on balance, you thought this would have more benefit to the UK than disadvantage?

Charles Hendry: My view was that this was almost a no-brainer. We have this extraordinary resource, and work will be going on for decades ahead to see how you can harness the tides. People have talked for hundreds and thousands of years about how we could take advantage of that, how we can create a UK industry that could capitalise on it.

It seems to me that we have led the world in offshore wind. What are the next technologies where the UK can do that and get a lot of jobs on the back of it? Next generation nuclear, carbon capture and storage, and tidal is part of that. The number of options for us are quite limited.

Q41 **Chair:** You brought to this review your experience as an Energy Minister at the beginning of the coalition period in office. Did you have the opportunity when you presented your review to your successors in the Department to understand their rationale for rejecting the review? We will come on to some of the financial consequences, but were you given any opportunity to make your case to the Department?

Charles Hendry: I had a meeting with Greg Clark, as the Secretary of State. He subsequently called me on the morning of his statement to say he would be making a statement, but he could not give me the details of it because of the potential financial issues—perhaps thinking I would go off and buy or sell shares accordingly in the next hour and a half—which I thought was slightly peculiar. He said he would call me later to discuss it. That was two and a half years ago, and I am still waiting for the call.

Q42 **Chair:** You have never had a proper debrief on what the Department thought about your views, other than what you read in the statement?

Charles Hendry: I have spoken to some of the civil servants subsequently, but not to the Secretary of State.

Q43 **Dr Matthew Offord:** It is good to see you, Charles, after several years. I

was quite a supporter of the Swansea Bay scheme, and I was disappointed when the Government decided they would not go ahead with it. One of the reasons they cited was that they felt it offered poor value for money—not only for the taxpayer but also for the electricity consumer—when they compared it with other forms of renewable technology, particularly thinking about onshore and most latterly offshore wind. What is your feeling about the Government's value for money approach, and do you think it was justified?

Charles Hendry: The Government made an error in that regard. The problem was discussed extensively by your previous witnesses, which is that there is an issue about ultralong-life projects. When you have a project that is going to last for 25 or 40 years, you can come up with a funding mechanism quite easily through the contracts for difference, which enable you to give a guarantee for the income they will receive for a significant part of their lifetime.

It is much more difficult for a project that will last for 120 or 150 years, where it will perhaps need turbines to be changed after 40 or 50 years but will not need much more massive construction work beyond that. We need a formula—that the CfDs do not adequately do—which enables us to deliver ultralong-life projects. What this will do is, when the cost is paid back, it gives us almost free electricity for decades to come.

When we look at the amount we have essentially borrowed from our grandchildren to pay for things that we want now, I thought this was a good way of giving something back very substantially in terms of green and affordable power for generations to come. They missed out on that opportunity.

Q44 **Dr Matthew Offord:** Can I just pin it down? On the characteristics of tidal range technologies, particularly the longer life span, are you saying that that was not taken into account by the Government in their model for deciding value for money?

Charles Hendry: No, because as soon as you do take it into account it changes the economics. I took a view that it is very difficult to have a CfD for 125 years. That does not become financeable and, therefore, you have to do it over a shorter period of time. If you were doing it, say, over 30 years, you are doing it for a quarter or a fifth of the life of the project. That makes it a much more expensive process.

I also said that the value for money comes when you move from a relatively small lagoon, like Swansea, to a larger lagoon. Henry talked about that in north Wales, and there are other projects elsewhere in the country. Then the costs come down dramatically. I showed how, once you start looking at the larger scale ones, the cost does indeed come down below that of nuclear, for example.

Dr Matthew Offord: That is very helpful, thank you very much.

Q45 **John McNally:** Thank you, Charles, for your honesty and

straightforwardness in answering the questions. When I read through your report, I thought it must have felt like a punch in the stomach from a heavyweight boxer for the UK Government to have responded to you in that way. There was a huge disparity in the cost to the taxpayer from your conclusions to the UK Secretary of State, Greg Clark, at that time. The difference was quite incredible. You were talking about 30p per household per year for 30 years, and the UK Government came out with £15,000 for every household in Wales over 20 years. They are not even close together.

What is very apparent—everybody agrees—is that this is a new technology and needs to be driven forward. It seems to me once again that, for certainty of policy, all Governments, the UK Parliament and the devolved Parliaments need to be brought together. We have heard, over the last few weeks in particular, that all parties' manifestos should be driving towards renewable technology and I am baffled why this should be withdrawn. What capacity do you think there is in the Government to foster new entrant technologies to the renewable generation sector?

Charles Hendry: There is an appetite for that, and the energy White Paper shows there is an appetite. At the moment, that does not include tidal as much as it needs to. The tidal lagoons, bizarrely, pretty well stop at the border. The Solway Firth is the last place you can put them, because after that the Scottish waters get too deep too quickly. Obviously, for the tidal stream technologies, some of the Scottish waters are the best in the world. One needs to separate out the two types of tidal technology in terms of where they can deliver the most and deliver the greatest benefit.

We are seeing almost every week new ideas coming forward for how we can help to meet the net zero challenge. That makes this an incredibly exciting time of innovation, and I absolutely believe that the UK Government and the Scottish Government completely get that and want to see it happen.

It does bring some additional challenges. At the moment, there is 6 gigawatts of interconnectivity between Scotland and England. Just with the known offshore wind developments, which are happening, that needs to grow to 15 to 20 gigawatts in the next decade, and to at least 25 gigawatts by 2035. There is nothing like enough work and money being allocated to ensure that, where some of these resources are at their greatest, they can bring the power to where it is going to be needed. That requires Governments to work together and to develop a common approach to how they can deliver the best outcome.

Q46 **John McNally:** We heard earlier that the route to market, basically the contracts for difference, is causing problems and that needs to change. How would you bring that contracts for difference scheme to offer a better revenue support mechanism for emerging tidal technologies, and what changes would you like to see to make it possible for everybody to enter into contracts for difference on an even keel?

Charles Hendry: It has to reflect the cost of emerging technologies better. You cannot expect an emerging technology to compete alongside a relatively mature technology. We have heard from others in this session how the cost of offshore wind has come down by three quarters from £175 per megawatt hour. We have seen how the costs of other technologies have come down dramatically as well. What we need is a mechanism that will enable us to give greater support in the early years because we recognise that there is a bigger prize at the end of the process.

That applies not just in terms of affordable electricity but in terms of the other benefits—which Henry Dixon was talking about—of coastal defences. In Swansea it was going to be the complete revitalisation of their tourist industry, which is going to be a significant driver of jobs and new opportunities.

Also, it is the creation of a global industry. I want the UK to be a global leader in this regard. If you want to be a global leader in an energy technology, you have to be an early adopter. That is what has happened in offshore wind. We got in earlier. We were willing to pay a higher price and, as the price has come down, the UK is seen as the indisputable global leader in offshore wind. That is why companies are setting up their factories in the UK because they see this as the country to do it. If you wait until others have done the work and brought down all the costs, the consequence is that you can buy it more cheaply but you give the jobs to somebody else.

There are very few jobs in the UK in manufacturing the parts for onshore wind because we ceded that opportunity to others. What I do not want to see in tidal is for us, with the second-best tidal resource in the world, to be buying in the technology from somebody else and those jobs to be set up somewhere else. We have the opportunity to do this.

The other aspect is that, if you want to bring down the cost of construction, we should be looking at a more modular approach, called caissons, where you essentially build in a dry dock. They are part of the Clyde Hunterston, which would be absolutely fantastic for this, where you build them there, you can reduce the cost of construction and then you float them to where they are going to be required.

We can, again, create a significant number of jobs for this. Greg Clark said I talked about 28 jobs. That was simply the running jobs. He did not talk about what I talked about, the thousands of jobs in construction and development. This is an area where more work needs to be done because there is a big prize to be had.

Q47 **John McNally:** What you are saying here is that, as well as the certainty of policy—the long-term policy that you are speaking about—certainty of investment would follow. I wish we had the policies to meet the certainty of the tide. Everyone would probably follow on and say, "This is the right way to go, it would be absolutely right." This technology is going

elsewhere. People will follow investment where there is a certainty of policy, and you are absolutely right to point out that we could lose that investment. As I said in an earlier Environmental Audit Committee meeting, you now have these huge pension funds with lots of money to invest. They are moving away from fossil fuel technology and, if this is prohibiting them from investing, we are making a really bad mistake. Would you agree with that?

Charles Hendry: We are seeing them investing very heavily, and one of the very encouraging aspects of offshore wind is how the pension funds and the international sovereign wealth funds have been willing to invest at a much earlier stage in the process than people thought originally would be likely. It was assumed that they would not take construction risk and they would only invest in built assets when they were operational, but what is happening in offshore wind is they are saying, "We understand that technology now. We understand the construction risk. We know that the rate of return is not spectacular but it is predictable for many years to come." That is exactly the model.

There is no shortage of money to invest in renewable energy. The world is awash with people who are looking to invest in the low-carbon sector. It is finding the right projects. I applaud an enormous amount of the Government's energy policy—Kwasi Kwarteng absolutely gets many of these issues—and I support much of the Scottish Government's separate energy policy as well, but I would like to see both Governments seizing the opportunity here and driving it forward.

Q48 **Chair:** Picking up that last comment, your review obviously focused on tidal range and lagoons, do you have a view on the relative speed of adoption and the cost-benefit analysis of stream versus lagoon?

Charles Hendry: In terms of how quickly we would see the benefits or the costs coming down?

Chair: Yes, and take up. There have been attempts to get lagoons built that have floundered, whereas the stream technology appears to be getting adopted, albeit in small scale at the moment. Is it right that the emphasis should be more on stream than lagoon, in terms of Government support?

Charles Hendry: Lagoons are inevitably a much bigger construction project, because you have to build the wall that will contain the turbines. That is a much more substantial project. Realistically, there are only a relatively small number of sites around the UK that would be suitable for lagoons.

There are many locations that could be suitable for tidal flow in the UK, in the Channel Islands and elsewhere. I went on one occasion to Alderney to see what they were looking to do there, and the French were there from the port of Cherbourg. I said, "I had not realised that you were looking to invest in this technology." He said, "No, we are not. We are going to wait for the British Government to invest in it, and we are going

to manufacture everything for you." They could see the commercial opportunity and that we did not have a sufficiently joined-up energy and industrial policy to bring the two together. That is what is important when there is a prize here to be secured. That applies both to lagoons and to tidal flow.

Chair: That is very interesting. Thank you very much for joining us again today, Charles. It is good to see you back in Parliament, albeit virtually and not in one of our Committee Rooms. Thank you for your time. I am pleased that at least some of us in Parliament have had an opportunity to talk to you and question you about your review, which obviously you put a lot of work and effort into all those years ago, so not wasted.

Charles Hendry: Thank you so much.

Chair: Thank you very much.