OFFICIAL REPORT
AITHISG OIFIGEIL

Net Zero, Energy and Transport Committee

Tuesday 14 December 2021

Session 6

The Scottish Parliament
Pàrlamaid na h-Alba

Tuesday 14 December 2021

CONTENTS

NET ZERO, ENERGY AND TRANSPORT COMMITTEE
14th Meeting 2021, Session 6

CONVENER

*Dean Lockhart (Mid Scotland and Fife) (Con)

DEPUTY CONVENER

*Fiona Hyslop (Linlithgow) (SNP)

COMMITTEE MEMBERS

Natalie Don (Renfrewshire North and West) (SNP)
*Jackie Dunbar (Aberdeen Donside) (SNP)
*Liam Kerr (North East Scotland) (Con)
*Monica Lennon (Central Scotland) (Lab)
*Mark Ruskell (Mid Scotland and Fife) (Green)

*attended

THE FOLLOWING ALSO PARTICIPATED:

Erik Dalhuijsen (OceanValley Ltd)
Professor Stuart Haszeldine (University of Edinburgh)
Alan James (Storegga Geotechnologies)
Colin Pritchard (Ineos)
Collette Stevenson (East Kilbride) (SNP) (Committee Substitute)
Mike Tholen (Oil & Gas UK)

CLERK TO THE COMMITTEE

Peter McGrath

LOCATION

Committee Room 2

Scottish Parliament

Net Zero, Energy and Transport Committee

Tuesday 14 December 2021

[The Convener opened the meeting at 10:15]

Decision on Taking Business in Private

The Convener (Dean Lockhart): Good morning. I welcome everyone to the 14th meeting of the Net Zero, Energy and Transport Committee, which we are conducting remotely this week. We have received apologies from Natalie Don. Collette Stevenson is once again attending the committee as a substitute.

Agenda item 1 is consideration of whether to take agenda items 4 and 5 in private. Item 4 is consideration of the evidence that we will hear on carbon capture, utilisation and storage, and item 5 is consideration of the committee's work programme.

As no members object, we agree to take items 4 and 5 in private.

Subordinate Legislation

Environmental Protection (Single-use Plastic Products) (Scotland) Regulations 2021 (SSI 2021/410)

Scottish Road Works Commissioner (Imposition of Penalties) Amendment Regulations 2021 (SSI 2021/431)

10:15

The Convener: Agenda item 2 is consideration of two negative instruments. The instruments are laid under the negative procedure, which means that their provisions will come into force unless the Parliament agrees a motion to annul them. No motions to annul have been lodged.

The first instrument that we are considering is the Environmental Protection (Single-use Plastic Products) (Scotland) Regulations 2021. The committee heard evidence on the regulations from the Minister for Green Skills, Circular Economy and Biodiversity on 30 November and from stakeholders on 7 December.

Do members have any comments on the instrument? As there are no comments from members, I invite the committee to agree that it does not wish to make any further recommendations in relation to the instrument. As I do not see any further comments, we are agreed.

The second instrument under consideration is the Scottish Road Works Commissioner (Imposition of Penalties) Amendment Regulations 2021. Do members have any comments on the instrument? As there are no comments from members, I invite the committee to agree that it does not wish to make any further recommendations in relation to the instrument. As I do not see any further comments, we are agreed.

Carbon Capture, Utilisation and Storage

10:17

The Convener: The next item on the agenda is an evidence session on carbon capture, utilisation and storage—or CCUS, for short. We will hear from two panels of experts this morning. The purpose of this evidence session is to hear expert views on the extent to which CCUS has a role in achieving Scotland's net zero targets.

I welcome our first panel. Erik Dalhuijsen is director of OceanValley Ltd, and Professor Stuart Haszeldine is professor of carbon capture and storage at the school of geosciences at the University of Edinburgh. Thank you for accepting our invitation; it is very kind of you to join us today.

I understand that you both want to make a short opening statement. Perhaps we can start with yours, Mr Dalhuijsen. You probably need to wait for a second to allow broadcasting to turn on your microphone.

Erik Dalhuijsen (OceanValley Ltd): Thank you. I think that my microphone is working now.

I am honoured to be joining the meeting. I am a physicist and a petroleum engineer, and I first worked on carbon capture and storage during the £1 billion United Kingdom Government CCS competition in 2012. In fact, it was CCS that triggered my interest in climate change.

For me, this is about CCS, hydrogen and net zero. The overall aim is rapid decarbonisation and then full decarbonisation. The top priorities are phasing out fossil fuels and maximising renewables growth. After those, the priorities are reducing energy use and wastage, adding storage, electrifying, driving modal shifts, and finding a solution for the unavoidables. For unavoidable emissions, such as those from cement manufacture, CCS technology would be useful. Anywhere else, alternatives would seem to be better.

Many numbers will come up in the conversation but, without context, numbers mean nothing. For example, fossil-fuel-based hydrogen is currently cheaper than green hydrogen. The economics of blue hydrogen are based on that. However, it is generally accepted that, by 2030, green hydrogen will be cheaper, so investments that run beyond the current decade will be stranded.

The cost of CCS in the Sleipner project is presumed to be £43 per tonne, which is about half of current estimates. However, $43 per tonne is the price point at which, globally, 50 per cent of all emissions can be removed economically, according to recent work by Goldman Sachs.

I have another example for context. It is easy to get the impression that CCS is widely proven, but my own professional position is that it is not. That is based on essential differences between the long-term storage of CO_2 and its use for enhanced oil recovery. The context is essential.

Professor Haszeldine's helpful submission on the cluster indicates a context in which CO_2 availability seems to be the weak link for CCS support at the moment. The strange solution to that is the production of extra emissions through new fossil and hydrogen installations. The aim was to reduce emissions, was it not?

The transition is urgent, and it is best driven by the new energies, not the old ones. Coal companies did not supply jobs when they needed to close; that was not their business. Moving away from fossil fuels is not within the expertise or in the interest of oil and gas companies.

CCS jobs are not green jobs, but CCS can deliver some oil jobs. A just transition requires jobs that are outside the oil industry and outside CCS and blue hydrogen. That is not the terrain of the oil industry.

I realise that the problems can be complex but, in my view, the path is clear.

The Convener: Thank you very much, Mr Dalhuijsen. I bring in Professor Haszeldine to give his opening statement.

Professor Stuart Haszeldine (University of Edinburgh): Thank you very much, convener.

I think that there is common ground between me and Erik Dalhuijsen. I think that we agree that Scotland is on a journey towards halting and decreasing its greenhouse gas emissions, which change the climate, and that Scotland has the ability to build and operate carbon capture and storage as well as to use natural means of mitigating and storing carbon dioxide, which is the primary greenhouse gas. I think that we also agree that that means becoming more energy efficient; switching from high-carbon to lower-carbon fuels and to near-zero wind, wave, tide and solar energy; and capturing the emissions from all the other things that humans do that emit greenhouse gases, whether they are from agriculture, forestry or industrial activities such as plastics, petrochemical, cement and glass-making activities—all those primary industries. Capturing and storing all those different emissions involves building carbon capture and storage.

The attributes of carbon capture and storage that currently commend it to that mission are that it can decrease emissions extremely rapidly, by many millions of tonnes per year rather than our

waiting for natural processes, which are much slower; it can store the carbon back underground, where it came from, very securely, for timescales—they are very important—of tens of thousands of years, not just 10 years; it can recapture carbon that has already been emitted from biomass, such as trees or crop waste, and from fermentation processes, such as brewing and whisky making; and it can reduce the emissions of all those contaminants of the atmosphere and obtain much cleaner air.

There have been attempts to develop carbon capture and storage in Scotland since 2005. That was when the first project became public. I think that we are now on our fourth attempt. Each time, a large-scale industrial project has been proposed and costed, but has failed to be funded by the Westminster Treasury.

That is where we are. The issue is to examine why that impasse has occurred and whether there are any ways around it. I will be pleased to try to help with that this morning.

The Convener: Thank you very much, Professor Haszeldine.

Those opening remarks are enormously helpful. We have heard quite different outlooks when it comes to the future role of CCUS specifically and negative emissions technologies more widely.

I will start with Professor Haszeldine and bring in Mr Dalhuijsen separately. Will you elaborate on your opening remarks and explain how significant CCUS could be in achieving Scotland's transition to net zero? What policy measures do the UK Government and the Scottish Government need to implement in order to make it a central part of the journey to net zero?

Professor Haszeldine: I draw the committee's attention to predictions that were made by the Climate Change Committee, which is a UK committee with a sub-group that reports specifically on Scotland. That committee's role is to understand carbon dioxide emissions now and to predict pathways that might result in net zero emissions by 2050.

The net zero change, which came about in 2019, has revolutionised and accelerated the interest in and the strength of developments to try to reduce and recapture carbon emissions, as I said in my initial statement. It is clear that emissions of carbon dioxide and greenhouse gases can be reduced to perhaps 80 per cent of their present values. That can be done by switching fuels and becoming more efficient, which can be commercially profitable and sensible economic measures, too.

We also need to do other things, such as recapturing carbon as well as capturing it. That balances the residual emissions from using fossil fuel fertilisers in agriculture or from industrial activities. Those residual emissions are really expensive or really difficult—or both—to recapture. That is why some negative emissions are needed. The Climate Change Committee projects that significant carbon capture and negative emissions need to be under way by 2030 if we are to be on a pathway to meet the Scottish target of net zero by 2045.

That is why the years that we are in now are particularly important. If we are to meet our ambitions by 2045, we must start now, because the projects are large-scale industrial ones.

The Scottish Government has control over surface planning, but it has very little control over the large-scale finances that are needed. Therefore, it falls to the UK Government to introduce policies such as putting a price on carbon through the purchase of emissions certificates. That policy is now in place in the UK, and it means that the price of emitting carbon dioxide becomes more expensive and carbon capture and storage eventually becomes cheaper than emitting. It creates an economic imperative.

The UK Government also makes subsidies and financial support available for the first projects. We see that in activities to decarbonise clusters of industrial activity around the UK. Five or six clusters are planning to decarbonise. At the moment, only two of those—on the east coast, in Teesside and Humberside, and in north-west England and Merseyside—have access to carbon capture and storage. That ties in with the debate around the Acorn project and CCS in Scotland.

An alternative way of decarbonising would be a Government simply mandating that carbon dioxide should be recaptured and stored by oil and gas companies. That is not policy at the moment, but we have to find a way of transitioning nationally from the initial subsidy-driven projects to commercially driven, business-as-usual projects. That issue is maybe something to discuss later. At the moment, we are discussing the first steps for the first projects because Acorn failed to gain access to the initial subsidies.

The Convener: Thanks very much, Professor Haszeldine. That is a very helpful overview of a number of relevant issues.

I will bring in Mr Dalhuijsen. I think that it is fair to say that you do not see CCUS as having such a central role in the transition to net zero. Could it still have a role in the more carbon-intense sectors as a means of helping them to minimise their emissions?

10:30

Erik Dalhuijsen: Absolutely. I come at CCS with a slightly different approach. I started working on CCS in 2012, and in that work and the later projects that I worked on, as well as the conversations that I had with Acorn about four years ago, I was really keen to see CCS operate. That is because you cannot learn how it works until you have it functioning. It would be helpful to have CCS working.

I do not think that it is by accident that CCS projects have started and stopped and started and stopped again. I do not know the precise reason for that, but it is extremely frustrating from a technical perspective, because you stop at the point where you would have begun to learn. From my understanding of CCS, there is a lot to learn, especially on the storage side. Please let CCS projects start as soon as possible, because there is a long timeline for a CCS project before you can use it for scaling up, before you understand the risks and the issues, and before you even know which aspects of the storage spaces are high or low risk for long-term storage.

As I tried to clarify in my written submission, the total run time is a long time. That is not a geological way of looking at it. When you look at things from a geological perspective, you see that you have already had the stabilisation period in the past. You look at the past million years and see that it is all quite stable. With CCS, we are looking from an engineering perspective at where the changes and upsets will happen in the first 10, 20, 50, 100 or 1,000 years that will have an impact on the remaining residence time.

My feeling is that CCS needs to start as soon as possible, but we need to understand that it will not be functional and scalable for quite some time. However, that does not mean that we have to start with one location. It is perfectly valid to start with multiple locations, because there are enough differences in intentions. I have tried to describe the huge difference between the approach in the Netherlands of using old gas fields and the approach in the UK, which seems to focus on saline aquifers and involves a totally different principle for storage.

As Professor Haszeldine suggests, reducing emissions by 80 per cent is the easy change. CCS should not come at the risk of pushing back progress that is made elsewhere. The big risk with CCS is that it is being tied to hydrogen. That is visible in the two clusters that have been approved and in the Aberdeen cluster. Hydrogen is tied in, and that involves the intentional creation of emissions for another purpose. The risk is that, once you start assuming that CCS will work and will be scalable and you therefore tie in something else that increases emissions, which you hope will be rescued by CCS, you are playing a really dangerous game. That is where I come from on the issue.

The Convener: You have both touched on the risks associated with CCUS. Will you briefly touch on the key technical, environmental and financial risks that are involved in the technology? I know that that could be a lengthy answer, but I ask you to be focused in your response.

Erik Dalhuijsen: A lot of the carbon capture processes are relatively well understood, and the financial risks have to do with supply and the amount of time that you can keep your process functioning. The technical and environmental risks are closely related. They have to do with whether the CO_2 stays where you put it. Of course, I am simplifying a little, because it will not stay where you put it, as the intention is that it distributes itself. If you put it into gas fields, the CO_2 will typically go towards the top of the gas field where the gas was, but it will also dissolve in the aquifer if there is one. As it dissolves in the aquifer, there will be displacement, because water with dissolved CO_2 in it is heavier than the water in the aquifer, and it will start very slowly to mix with the aquifer.

In some of the fields that I have looked at, the aquifers flow, and that is partly because of oil and gas production elsewhere. I do not know whether there are other reasons, but the flow from historical production will continue, which means that where the CO_2 sits in the fields will keep changing. There is a technical risk in that respect. You could monitor remotely to some extent through seismic oil-field technology, but it is not cheap and it would have to be done over a period of years. The point is that, after you store the CO_2, you still need to spend money on monitoring, and whether you need to do so for 10, 20, 30, 50 or 100 years is anyone's guess.

Moreover, if, in the course of monitoring, you see something unexpected, will you be able to remedy that? Can you change things afterwards? Those are quite complex issues, and I am aware of them from the nuclear industry, where they still have not been resolved. That industry looks at these things on a timescale of an order of magnitude greater than this, but the principles are the same. You are looking at the really long term.

The technical risk, therefore, is whether the CO_2 will stay down there. The timescale is so long in engineering terms, but the data that we have on the response is all very short term.

The Convener: Thank you very much. I would welcome Professor Haszeldine's thoughts on this issue, too.

Professor Haszeldine: I will answer your question about technical, financial and

environmental risks in a slightly different way. The main technological issue is what is usually described as the difficulty and the costs of capturing CO_2, which is the separation of pure CO_2 from flue gas or whatever other source. That comprises about 80 per cent of the coal cost of carbon capture and storage, and the focus of many activities is to reduce that cost.

As Mr Dalhuijsen has said, carbon capture is well established as a process or, indeed, as many different processes. In fact, there are maybe six to 10 different processes, which have different purposes, and the mission is to make all of that activity reliable and cheaper and to decrease any emissions to zero during commercial processing.

In any project, that sort of thing needs to operate reliably when the CO_2 is handed over to the business that runs the transport and storage through the pipeline. At that point, there is a handover risk, which is a business risk. Indeed, the competitions that the UK Government runs always focus on such handover points, because they are commercially difficult for companies to handle. It can be addressed by its being contracted out and effectively underwritten by the UK Government, and the benefit of these early projects is that they discover how to handle the risks and make these things work.

The risks with the equipment in the capture setting can be handled through knowledge and extension of chemical and refinery industry processes. These are all engineering processes that are built and operated on the surface in an industrial setting, and people should know how to do that.

As for transport and storage risks, pipelines are usually considered for transporting purposes. There are many pipelines running carbon dioxide under the sea in Norway and across land in the United States, Canada and some parts of Turkey, Hungary and the European Union. The risks are therefore understood, given the 30 or 40-year track record of doing that kind of thing. Indeed, the safety record of carbon dioxide pipelines is usually better than that for oil and gas pipelines. In other words, the risk is low.

Many people focus on the issue of storage. I should say that my background is in geology—it is, if you like, my specialist topic—and I think that there is a very low risk in this respect. However, there is a lack of understanding and appreciation of the issue in the general population, so I will briefly describe what happens, to help with things.

We are talking about injecting carbon dioxide as a pressurised liquid—carbon dioxide gas becomes a liquid under pressure just as the CO_2 in a fire extinguisher is a liquid. The liquid CO_2 is injected down a borehole into the tiny microscopic pore space underground in the sandstones. That is very similar to where oil and gas came from and it can either be in a gas field or in a sandstone filled with salty water—the so-called salt-water aquifers, which have no environmental use as anything else for humans at the moment. The carbon dioxide spreads out and displaces and fills up the pore space.

We have undertaken a lot of research on natural occurrences of that, because CO_2 is quite a common fluid, globally. We have looked at natural CO_2 occurrences in the North Sea, where it has been resident for many tens of millions of years without leakage; we have looked at CO_2 leaking out actively along faults in Italy, where volcanic CO_2 is documented as having been leaking since pre-Roman times; and we have looked at natural storage and leakage of CO_2 in the Colorado Plateau states of the United States.

We understand the geological processes that contain carbon dioxide and those that enable it to leak, and we can quantify those processes and look for places underground where we find analogies to those natural places. Our quantification means that we can come up with a statement that at least 98 per cent of the CO_2 will remain securely stored for 10,000 years if we have chosen the correct geological site. That is a site with no obvious leakage routes through faults or boreholes. If there are boreholes, those can be cemented before CO_2 is injected.

We can also track carbon dioxide underground. To give the committee an idea of the size and scale, we inject CO_2 into a sandstone and that spreads out to roughly the area of Edinburgh. If you looked at it on a map, that is the size of the storage site that you would be dealing with. Some of the storage sites offshore are areas the size of Glasgow, for example. The sites come in different size scales and the spacing between the sites offshore is at that sort of distance of tens of kilometres.

Therefore, each site is different. They have individual geological characteristics. We can examine sites in the North Sea and the Irish Sea—the central North Sea and the southern North Sea—which have all retained carbon dioxide safely and securely, as I said, for many millions of years. As Mr Dalhuijsen suggested, we can survey that. Seismic reflection oil and gas technology can be converted in order to image, understand and locate the CO_2 and effectively give many decades of warning if any misbehaviour of the CO_2 that has been injected underground is occurring.

I have described the option of injecting CO_2 for safe and secure storage for tens of thousands of years. The two alternatives are behaving as we are at the moment, emitting all the CO_2 into the

atmosphere, which is the worst possible case—100 per cent leakage—and the radical alternative of stopping producing oil and gas and fossil carbon overnight, or as soon as possible, which is very difficult to do in our industrial society. We are progressing towards finding different sources of clean energy. Stopping overnight is technically possible but very socially disruptive.

The Convener: I thank both of you for those fascinating insights and for sharing your thoughts with the committee on the risks and the wider perspective on CCUS. I will bring in other members with questions.

Fiona Hyslop (Linlithgow) (SNP): Good morning, and thank you for sending very useful papers to the committee. It is clear that we have a climate emergency and we need to drive to net zero. I understand that the biggest potential environmental risk of carbon capture and storage is that it interferes with or delays green developments such as green hydrogen or other forms of green renewables. Looking across the UK, what type of carbon capture and storage or utilisation projects would be the best option if we have to do it quickly? I ask Erik Dalhuijsen to answer. I will ask Professor Haszeldine a separate question later.

10:45

Erik Dalhuijsen: If I have translated it correctly, the question is which type of CCS application would be most relevant. CCS is focused on unavoidable emissions. There is clarity about what are really unavoidable emissions, what may be unavoidable emissions and what are avoidable emissions. That would not necessarily take away the current storage sites, but it would remove hydrogen from the equation, because that type of fossil fuel hydrogen does not support decarbonisation. It relies on CCS and additional volumes of CCS storage space enabling us to store stuff that we could acquire in a different way. That is a critical part of the issue.

The alternative is not to either keep on emitting or stop overnight; the alternative is to transition, but we wasted 30 years before we started transitioning. That was the time in which we could have done it at a lovely, slow and considered pace, but we now need to do it more dramatically. Focusing on unavoidable, or currently practically unavoidable, emissions is a valuable place to start, but letting it drag in anything else that stimulates emissions is not a good idea.

Fiona Hyslop: I come to Professor Haszeldine. In your submission, you were direct about the disadvantages to the Acorn project of the Department for Business, Energy and Industrial Strategy criteria. If we have to move ahead as quickly as possible on carbon capture and storage projects, how will those criteria advantage some sites but disadvantage the Acorn site? Is the issue the focus on the volume of CO_2, or is it that the combination of different sites adds to the volume? The point about connection to emitters is at the crux of why it did not go ahead in phase 1, but what is needed to make sure that it definitely goes ahead in phase 2?

Professor Haszeldine: I tried to explain in my submission that, in running what is in effect a competition across the UK, BEIS created a set of criteria to try to make it fair for all bidders. The criteria were published in a BEIS briefing paper and are weighted with different percentages. In effect, they are five exam questions. Around 35 per cent of the weighting is for the tonnage and a further 25 per cent is for the cost per tonne. If your project claims a large tonnage of CO_2 to be disposed of before 2030, you win out on that tonnage metric.

As I mentioned, around six industrial areas in the UK moved over the past couple of years towards making bids, which were submitted during 2021. One of those is Teesside, which is a large industrial area, and another is Humberside. During the bidding process, those two projects each claimed that they could produce and store about 10 million tonnes a year of carbon dioxide. That fitted well with the criteria. However, there was an interesting step that I do not have an answer for. When the expressions of interest went in to the UK Westminster Government, those two were separate projects. By the time the awards came out, they were a joint project.

I can understand that 10 plus 10 is 20; obviously, the size is bigger, and that is how people win. However, the physical layout of the projects involves capturing some carbon dioxide at Teesside and some at Humberside—the two are not geographically the same—and then building two different and separate pipelines from Teesside and Humberside to the different parts of the same offshore geological storage site. In effect, as I said in my analogy, when it comes to the size and the scale, one of those might be going to west Glasgow and the other to east Glasgow. I am intrigued that that became viewed as one common project. I do not know how that was arrived at but, obviously, it gained a lot of marks.

I move to the second part of the scoring—the other 25 per cent. That is the cost per tonne of the CO_2 that is shipped, or moved—I will be careful with my language—by building pipelines.

It is well established that, if a pipeline has a large diameter and a lot of carbon dioxide running through it, the cost per tonne of moving that carbon dioxide is less than for a small pipeline with

less CO_2 moving through it. That large tonnage becomes an advantage for such a project.

The Acorn project does not produce as much carbon dioxide as quickly, because its philosophy is rather different, in starting with existing carbon dioxide rather than building new sources, as Mr Dalhuijsen has correctly stated; in using and converting an existing pipeline, which involves less cost; and in going into an existing storage site, which has been well evaluated since about 2007, when it was in the first carbon capture competition. We have a lot of background for that in Scotland.

There are several independent analyses of the costs of doing that. Again, I do not know what costs the bidders have put into BEIS; that information is commercially confidential. However, I draw the committee's attention to a recent report by Element Energy for Scottish Enterprise, which was published a couple of weeks ago and which produces costs for the different storage sites around the UK. According to that, the costs for Acorn might be £10 or £15 a tonne, whereas those for the Merseyside HyNet project might be £37 a tonne and those for the Teesside East Coast Cluster project might be £15 a tonne. It is therefore a bit strange to understand how the Acorn project came bottom in all the evaluations, given those costings.

There is something else that I want to mention. We talked about the different geologies around the UK. What the UK Government has chosen at the moment, with the East Coast Cluster project, which goes into the Endurance storage structure, and the Merseyside HyNet project, which goes into a Hamilton depleted oilfield, are two geologically very similar—almost identical—sandstones. As a country, therefore, we are failing to test out the variability, the security and the performance of different types of geological storage. Acorn offers first access into a huge diversity of geological storage, offshore, in what is known as the central North Sea, north-east of Aberdeen. The UK Government may have chosen on cost, but it has introduced a systemic risk. That is not a sensible thing to do.

Does that answer enough of your question, deputy convener?

Fiona Hyslop: Thanks—that is extremely helpful. I am sure that colleagues might want to follow up some of those points, but I am conscious of the time, convener. It is clear from what we have heard that the BEIS criteria are highly questionable, both financially and environmentally. I will pass back to the convener now, as other members have lots of questions.

Jackie Dunbar (Aberdeen Donside) (SNP): I thank the gentlemen for coming to the committee. The decision to put the Scottish Cluster on the reserve list has already been touched on, but what will the impact of that decision be on our emissions reduction targets?

Professor Haszeldine: My perception of that is that the non-availability of a carbon capture and storage takeaway route is fundamentally detrimental and serious for Scotland, because it prevents Scotland's enacting CO_2 capture and storage and negative emissions technologies—the emissions recapture and storage that I talked about briefly earlier. Those both need to be in operation by 2030. There is a five-year lead time for building such a project, so deciding now how we are going to handle that is fundamental to Scotland being able to meet or failing to meet its 2045 net zero target. That is why that is a serious business in terms of industrial and environmental planning and infrastructure provision for the future.

Mr Dalhuijsen has also spoken about testing different types of geological storage and different types of operation, and I think that that is a material consideration. That is why we need to understand how to move Acorn forward. At the moment, as far as I can understand from the BEIS publications—the official BEIS documents—and also from conversation with people who are intimately involved with the project, there is no advantage in being involved as a reserve bidder. It means that you have to go to a lot of meetings, but there is very little chance of one of the other bidders being declared void. In effect, you are being asked to run on the spot with very little or no funding, and focusing on that prevents you from generating other opportunities in the meantime.

That places a company such as Ineos, which the committee will take evidence from later, in a difficult position. It has to decide whether it is going to direct its CO_2 down towards Teesside, which would be relatively expensive, because there is no easy route from Grangemouth to Teesside or whether to wait and hang on and hope for the best, which would be that, at track 2—a subsequent wave of projects—the Acorn project will win out. Of course, we do not know the rules for a track 2 project, so we have no way of telling whether Acorn's rebidding would win out. I am sure that there will be at least two more bidders for carbon capture and storage projects from England in the track 2 set of projects. Therefore, depending on the criteria, we are just gambling again.

Jackie Dunbar: Mr Dalhuijsen, what do you think the impact will be?

Erik Dalhuijsen: I will keep it short, because I am not as familiar with the political specifics as Professor Haszeldine. I assume that the effect on carbon storage of any project that starts or continues now will not be felt at any relevant scale for perhaps another 10 or 15 years. Therefore, I

imagine that the impact is not going to be tremendous, but I assume that there will be an impact because, even during the learning process, you can still store some CO_2. Having said that, I do not think that it is a sustainable way of hitting the net zero targets. Does that help?

Jackie Dunbar: Thank you. Professor Haszeldine, what can St Fergus and the Scottish Cluster do to evolve and adapt in the short to medium term to ensure on-going investment and to secure jobs?

11:00

Professor Haszeldine: There are several things that the Scottish Cluster can try to influence. First, we need to understand what the rules for track 2 competitions might be. In particular, we need to understand whether transporting CO_2 by shipping will be allowed; it was specifically excluded in the track 1 projects. The Peterhead deepwater port is well set up for importing carbon dioxide, shipping it in what are, in effect, small tankers from the coastal locations of the UK, whether that is London and south-east of England, Southampton or south Wales. That could be a profitable business that helps those other parts of the UK to decarbonise by transporting their CO_2 to a geological storage site beneath Scottish waters.

Secondly, the UK needs to try to keep the carbon price high so that the UK has a carbon emissions trading scheme, rather like the existing European trading scheme, under which big industrial emitters need to purchase permission to emit a tonne of CO_2. With the move to net zero, that price has moved up from £20 a tonne to about £70 or £80 a tonne in the past year. That is important, because the price of emitting starts to come very close to the price of carbon capture, transport and storage. Storing is obviously much better than emitting, environmentally, and with that approach the financial difficulty starts to go away. It is in the UK's gift to try to keep that carbon price high. That will encourage decarbonisation of industries all around the UK, so it would be a sensible backdrop to do that.

The other type of feature that the Acorn project could consider is not bidding for financial support from the UK but running Acorn as a market-driven model to create a business in CO_2 storage. We know that, around the North Sea and the Baltic, the Norwegian project on CCS acquires carbon dioxide commercially from other emitters in different countries, takes it to Norway and stores it for a fee. That highly priced CO_2 takeaway and disposal service was oversubscribed by a factor of about 10, so it is clear that there is a huge unmet market for taking away, transporting and disposing of carbon dioxide.

Acorn could choose to bid in to that market, which it could do commercially, but that would need to be underwritten by a commercial licence from the UK BEIS department, which takes overall responsibility for monitoring, regulating and eventually taking ownership of that carbon dioxide. That is the same for all the other projects—the projects that are slated to go ahead. We are saying that Acorn could try to go ahead as a commercial operation, with that economic underwriting permission from BEIS. It would need only a small subsidy for capital expenditure—the cost to build the equipment—and it would not need the huge running costs of operating expenditure, which the other projects aim to take from the UK taxpayers.

Does that help?

Jackie Dunbar: Yes, thank you. It was very helpful.

Liam Kerr (North East Scotland) (Con): I have a very brief question arising from the remarks that we have just heard. Professor Haszeldine, can you confirm that the selection criteria were all known about and set out very clearly in advance, that all the interested parties for the programmes pitched against those criteria and that the scores were allocated against those criteria? I just want to be clear on that.

Professor Haszeldine: That basic factual statement is correct: the criteria are published in advance, as are the different subsections, which is this why the Teeside project and the Humberside project could calculate that creating a form of merger would give them an advantage against those criteria. As with any criteria, there is a huge amount of expert judgment involved in how they are applied. Anyone who has ever bid for a commercial project can understand that the criteria are sometimes written down but a little difficult to understand. There is a lot of latitude in the interpretation and credibility factors that BEIS and its advisers put on those different criteria. There is perhaps something to unearth about how different actors perceive those criteria.

Liam Kerr: I am very grateful for that answer. I have no further questions at this stage, convener.

Mark Ruskell (Mid Scotland and Fife) (Green): I want to ask a critical question about how we deploy CCS in a way that does not build in dependency on fossil fuels. We have heard comments from Erik Dalhuijsen about fossil hydrogen production and, related to that, there might be on-going dependence on natural gas if we are to use it for domestic heating. Where do we draw the line and refocus on the hard-to-abate sectors—for example, cement—without playing into enhanced oil recovery or fossil hydrogen

production, within the economics of CCS? I put that to Professor Haszeldine.

Professor Haszeldine: First, I want to disentangle the matter of enhanced oil recovery by saying that the various processes of carbon capture and separating CO_2 from other gases are well established. The use of that same carbon dioxide for enhanced oil recovery is a business and market decision. In the United States, companies can sell that carbon dioxide for enhanced oil recovery and the company doing the oil recovery will buy it. Therefore, the company will get a better price for selling CO_2 than it would for storing it. It is a separate commercial decision.

In the UK, we are trying to put a high carbon price in the background, as I described earlier, so that the price of emitting becomes more expensive than the price of storing. That would create a market in storage that would enforce, enhance and encourage storage and would not encourage enhanced oil recovery. We need to be cautious about coupling those things together, because they are fundamentally different.

How do we ensure that we do not just carry on producing fossil fuels? I will be slightly contentious and say that some fossil fuel use and production will continue because it is phenomenally useful as very high density and portable energy storage. For example, for an aeroplane, whether we like it or not, transporting fuel energy as kerosene is much easier than transporting it as hydrogen or batteries. We know that we can make electric planes and hydrogen planes, but they do not go as far normal planes because they cannot carry enough energy. We need to offset that. That can be done by capturing CO_2 from biomass from fermentation processes. There are 3.5 million tonnes a year of bio CO_2 that we in Scotland are just venting but should be trying to capture at relatively low cost in order to put it back underground as a negative emission.

Of course, we can also drive up the price of using fossil fuel and decrease the price of providing renewable energies. At the moment, the abundance of renewable electricity is good enough to supply most of our basic average electricity needs throughout the year. However, in winter we sometimes use six times as much heat as electricity. If we add in heat, meeting that demand change and having the extra energy for the winter would mean that we would have to multiply our renewable electricity by a factor of three or four, as well as storing energy.

That is a long way off. When I say “a long way”, I mean 20, 30 or 40 years. We are busy and engaged in building windmills around Scotland for 10GW more electricity, but that is still well short of what we need in order to supply our energy needs in the winter. That is why I think that use of gas, or gas that is converted to hydrogen, will have a longer future than many environmental activists would prefer. That is why I think that CCS has a role as a rapid large-scale way of reducing emissions. Eventually, we will have to price out, or regulate out, use of fossil fuels progressively, as the alternative methods of mitigation are brought in.

Mark Ruskell: I will ask specifically about blue hydrogen, because it seems that the Acorn project is economically dependent on its production. If we are putting 20 per cent of blue hydrogen into the gas grid, we might get a carbon saving on that, although the figures for blue hydrogen production are questionable. What about the 80 per cent? What about the natural gas that we will continue to be dependent on to run the particular type of national grid that is required for heating? Does that not build in dependence on unabated natural gas?

Professor Haszeldine: We are dependent on natural gas right now for practically all of our heating in our homes and in our industries, and we are, of course, still dependent on natural gas for a very large part of our electricity production. Although we in Scotland can calculate that, on average, 100 per cent of our electricity is from wind power, that is not the case for the rest of the UK, so we are dependent on methane.

A shift to hydrogen is a way of asking whether we decarbonise methane gas at the point of use—in your house or my house, or in industry such as at the Ineos Grangemouth complex—or where it arrives at source, upstream. That is what the process of making hydrogen at the Acorn project, at St Fergus, would involve, using not a steam methane reformer but an autothermal methane reformer. That uses a different chemical process that keeps the CO_2 inside the process. It is a more efficient and effective process that can, according to the developers, capture 99 per cent of the carbon dioxide that is produced.

We need to get into some detailed specifics on that blue hydrogen route, because that route in the UK will be bringing CO_2 onshore from pipelines from the Scottish or Norwegian parts of the North Sea, where there is minimal leakage of methane from production and pipelines, and there is very little embedded energy involved in moving the methane. If we can convert that methane very effectively into hydrogen at the point of entry and send the CO_2 offshore, that will be a very neat industrial way of minimising emissions.

It is anticipated that there will be 2 per cent, then 20 per cent, eventually moving up towards 100 per cent hydrogen in the gas system. Of course, that will mean processing more and more methane to make more and more hydrogen. Until or unless we can match that chemical energy of methane or hydrogen with renewable electricity production,

that is our option. We could not go straight to electrifying everything right now even if we wanted to, because we do not have the required amount of electricity for the winter months.

Does that help at all?

Mark Ruskell: It helps a little bit.

Professor Haszeldine: Ask me another, then.

Mark Ruskell: That answer perhaps addresses the question about the 80 per cent of natural gas that will still need to be used within the gas grid for blending.

I invite Mr Dalhuijsen to comment, to give another perspective on things.

Erik Dalhuijsen: I have a very different view on the matter. Yes—Scottish heating costs in winter are quite large compared with the electricity supply. There are things called heat pumps, with which the committee will be familiar. They multiply the heating efficiency of electricity by a factor of between three and five, depending on how it is done. It takes only a very small amount to stay closer to a multiplier of five, using geothermal energy or other solutions to get to that point.

11:15

I will not step into an explicit discussion of how quickly we can build renewables, because that is not the issue. The change to hydrogen in itself carries an efficiency penalty, just as carbon capture and storage does. There is an additional 20 per cent to 25 per cent cost in energy to inject the gas underground, in comparison with the amount that is produced. We have to take the whole picture into account. It is too easy to say, "Oh well, we'll never do that in time, so let's do something else."

With regard to the suggestion that we replace 20 per cent of the gas system with hydrogen, that would have very little impact. Recent studies that have been widely commented on illustrate the amount of upstream emissions from natural gas. The upstream emissions—they include methane as well as CO_2—cannot be controlled to the extent that they would disappear. Robert Howarth from Cornell University and Mark Jacobson from Stanford University have done some work using real-life data from areas that are impacting on the global averages, where a large percentage of methane is lost in the production of natural gas.

Although Professor Haszeldine suggests that we can do it better, and we do not spill as much gas during our production process, the UK is a net natural gas importer. It is easy to say that we will use our relatively clean gas—it is not clean, but relatively clean—and turn it into hydrogen, but that means that we will need to import more natural gas from elsewhere, where the leakage rate, and therefore the methane spillage, is higher.

For comparison, the Howarth and Jacobson paper "How green is blue hydrogen?" came to the conclusion that CSS, because of the additional energy requirements if natural gas is used, is actually less efficient than burning natural gas, rather than converting it into hydrogen. There is a loss of energy balance, and there is a lot of context to consider. It is difficult to say, "This is the answer."

I am confident that renewables can be built in time, as are—as far as I am aware—the CCC, the International Energy Agency and various other groups. If that can be done, and given that we need hydrogen to make life easier for certain areas, green hydrogen is a far better way—a zero-emissions way—to bring the level down. Given that green hydrogen is, for both the CCC and the IEA, the long-term target anyway—all models assume that green hydrogen will be needed to rule out use of grey or blue hydrogen—and that Scotland has one of the two highest-potential green hydrogen initiatives, I see no reason not to go there straight away. Scotland can take the interim step of increasing natural gas production and the emissions that go with it, and increasing further embedding of the oil industry in the energy system—it has, over the past 30 years, been incredibly difficult to get rid of it from the system—but the risk in taking that path is extremely high, from many perspectives.

Mark Ruskell: I have another follow-up question. The Government's "Update to the Climate Change Plan 2018-2032: Securing a Green Recovery on a Path to Net Zero" discusses the deployment of CCS technology in respect of energy from waste incineration plants. There are numerous such plants in Scotland. Can you comment on the economics of retrofitting existing plants, and on whether CCS could be deployed effectively at that scale for future energy production from waste incineration plants?

I will go back to Professor Haszeldine on that question.

Professor Haszeldine: That is a good question. A lot of the waste that we are combusting in energy from waste is bio waste—organic waste. If the CO_2 from that is captured, that could form another route to negative emissions. We could capture CO_2 from the atmosphere with normal biological organic processes if we burn that waste and put the CO_2 underground.

It is a huge disappointment, and a huge systematic planning error that the UK has failed to take advantage of energy from waste plants, either in supplying heat for district heating or trying to capture the carbon dioxide from those plants.

If those plants are running at 20MW or 40MW, which some of them are, it should be commercially feasible to capture the carbon dioxide by using existing known carbon capture technology. However, because planning by local authorities has often located plants in the far-flung regions of their areas, it will be difficult to move the carbon dioxide away to a storage location. That would need a little more work. It would be a case of trucking CO_2 to a railhead and railway wagons or to a pipeline terminal where it can be put into the main artery of CO_2 disposal—from Grangemouth to St Fergus. I would be very keen to see those waste plants included in our environmental low-carbon ambition.

Erik Dalhuijsen referred to the paper by Jacobson and Howarth. That article is notorious in the academic community because it deliberately makes very pessimistic assumptions about leakage of methane from pipeline systems. That is somewhat justified in relation to the United States, but here in Europe, and particularly in the UK and Norway, we have much better measurements and can be far more sure that we are not leaking anything like those quantities of methane. The development of blue hydrogen therefore causes much lower emissions than the paper says it would.

The elephant in the room is that the UK will be importing more and more methane from liquefied natural gas shipping. The compression and cooling of that gas has huge embedded emissions. We want to get out of that bind as far as possible. As was briefly mentioned, one way out of that is to make our housing and buildings much more efficient in their insulation and energy use. That is how we will escape.

Mark Ruskell: Time is moving on. Mr Dalhuijsen, do you want to answer any of those points or speak about waste incinerators?

Erik Dalhuijsen: In principle, I agree with Professor Haszeldine about waste incineration. The risk is that waste incineration is also where single-use plastics end up. Most of the carbon in single-use plastics is hydrocarbon sourced.

The way I see it, moving waste incineration to CCS will probably be a tool for plastic manufacturers to say that single-use plastic is not a problem as long as we throw it away afterwards, because its carbon will all end up being stored. That would continue the cycle of fossil fuels to CCS. So, while waste incineration per se is a relevant option, we must take care that it does not get used as a tool for single-use plastics in the way that CCS is used as a tool for hydrogen. That has become a growth area for fossil fuel companies.

The related emissions depend very much on the capture process. The capture processes that I am familiar with are capture and transport and injection processes. Those processes need quite pure CO_2. That means that all the additional emissions, which include nitrogen oxides and toxins of all sorts, keep going into the atmosphere. The health impacts of extracting only the CO_2, rather than removing all the emissions, will remain the same. Those health benefits will, in effect, disappear.

Thirdly, on the assumptions in the Jacobson and Howarth paper being pessimistic because they are based on the situation in the USA, I think that that is a fair point. However, we are talking about actual measurements, and the authors have made it very clear what would happen if the parameters were to be changed. I have to say that I have a lot more confidence in a paper that is based on actual measurements than I have in the Committee for Climate Change's response, which takes as fact vendor promises about the efficiency of CO_2 extraction. That is where the 99 per cent figure for large-scale efficiency of extracting CO_2 from flue gas comes from. That might be achieved at some point, but it is very rare for any industrial-scale activity to achieve efficiency on that scale.

Mark Ruskell: Thank you. Back to you, convener.

The Convener: I call Monica Lennon, to be followed by Collette Stevenson. As we are now very tight for time, I must ask members for very focused questions. Moreover, I fully appreciate that this is a very technical and fascinating area, but if the panel's answers can be a bit briefer, I will be able to bring all members in.

Monica Lennon (Central Scotland) (Lab): Good morning. Some of the biggest supporters of carbon capture, utilisation and storage also support developing new oilfields such as Cambo and maximising the economic recovery of oil and gas. How do you respond to people's concerns that reliance on the fossil fuel industry for carbon management will delay the just transition away from those fuels?

Professor Haszeldine: Again, that is a fair question. If we are to engage in carbon capture and storage, the fact is that, like it or not, the oil industry has the skills and technology to understand where carbon dioxide is and put it underground. As a result, some derivative of the oil and gas industry is likely to be involved in such activity. The next panel includes Alan James, who came out of that industry but is very engaged with trying to dispose of carbon dioxide, and he is a good example of how people can use their existing skills for a different purpose.

We have to be very careful about whether CCS can be used to justify new oilfields. Cambo is a good example of what is going on at the moment. The question is: if we reject such projects—as Shell has done by deciding to pull out of Cambo—does that set the North Sea on an irrevocable and inevitable decline? That could be one way of doing that, and it all depends on politics and on what politicians decide. If the oil and gas industry in the North Sea declines rapidly—by which I mean in five to 10 years—it is not clear whether people who have jobs there at the moment will have renewable jobs waiting for them through the just transition. We have to measure the pace of decline in the North Sea and mix that with the rate of increase in renewables, which could, of course, be accelerated.

There is an alternative. As the granter of licences, the Oil and Gas Authority sets an environmental test for any new development. It is not at all clear what that test is, but it could—and should—be about ensuring that no carbon is emitted from the net overall hydrocarbon that is produced. In other words, with a Cambo-type development, a developer would be bound, mandated and forced to store the equivalent amount of carbon dioxide to ensure that there were no net emissions. That would be the true environmental test: you can continue to extract oil as long as you make sure that there are no additional emissions. Again, it is up to Parliament and politicians to regulate for, and impose a legal mandate on, that.

Erik Dalhuijsen: There is a huge risk in all this, and it is no coincidence that the two things are tied together. With regard to the purpose of CCS, I note that the oil industry refused to self-fund the study in question, even though it knew what was coming. Every time something was stopped because Government funding ended, the industry did not continue with it, other than to lobby for it.

I am convinced that the CCS push is driven by natural gas growth. That is supported by the fact that the large oil companies, which include Equinor, Shell and BP, all have a gas growth strategy for which there is no energy-balance reason. The only reason is that, if you push blue hydrogen, you can sell more gas. If you push CCS and power it with natural gas, you can produce more gas. If you power CCS with renewables, you take away from the renewables budget, which is necessary to remove fossil fuels.

11:30

There is a huge risk. I mentioned that in relation to single-use plastics and hydrogen. CCS must be removed from the oil industry. The CCS knowledge is not specific to any oil company. There needs to be a clear separation between them. Maximising economic recovery of oil and gas—MER—and the support for Cambo have no consideration for the climate crisis or, for that matter, the just transition. The just transition is another aspect that has been hijacked by the same drivers as those of CCS. CCS jobs are called green jobs, but they are not; they are oil industry transition or decline jobs. None of that is green.

The risk is huge.

Monica Lennon: My final question is for Professor Haszeldine. If carbon capture, utilisation and storage does not go ahead in Scotland at the scale that we have discussed, what will it mean for Scotland's journey to net zero, jobs in Scotland and our obligations and response to the climate emergency?

Professor Haszeldine: The simple understanding is that, with no CCS, the pathway that the Climate Change Committee has projected for Scotland could not be achieved, because we could not reduce our emissions by capture of CO_2 and neither could we undertake negative emissions to capture CO_2 from the air, biomass, plants or fermentation and put it underground. The 2045 net zero ambition would disappear.

On jobs, it is calculated that CCS projects in Scotland would add something like 2 or 3 per cent of gross domestic product. That would be of huge value across Scotland, but the direct jobs would be on Scotland's eastern seaboard. It has been calculated that 10,000, 20,000 or 25,000 jobs would be directly related to CCS. A huge supply chain could be involved in CCS projects in Scotland and the rest of the UK.

Therefore, the situation has a serious consequence. There might be a way through it, but when I talked with the Climate Change Committee about the matter last week, we could not think of a way out of it at the moment. We might need to take much more assertive action on making housing more energy efficient, decreasing energy use and making energy use more efficient, but that entails much bigger social change and social acceptance. It has taken between 30 and 50 years so far. We know exactly what to do to make houses much more energy efficient, but we have failed to land that positively with many of the public. How to do that in the timescale that we have remains an unanswered question.

I hope that that helps.

Monica Lennon: Thank you. That is a helpful answer.

We are running out of time, so I ask Erik Dalhuijsen to respond briefly to the question that I asked Stuart Haszeldine and to the points that he made.

Erik Dalhuijsen: There are many routes for Scotland to achieve net zero. What you get out of a route is decided by its parameters. If CCS and hydrogen are included, you build the route around them, but there are other ways of building a route to net zero in Scotland without CCS.

For as long as I have been alive, every organisation has taken jobs out of context. Allocating jobs to something such as CCS and saying that they add to gross domestic product is a bit of an irrelevant approach, because any alternatives to CCS will also carry jobs. It has been illustrated that, if that alternative relates to renewables and renewable technology in any other way—for example, the use of green hydrogen—it will create more jobs than the technologies that we are talking about. Therefore, it should not be a consideration at all; those numbers are replaceable.

The Convener: I will bring in Collette Stevenson. I remind everyone that we are extremely tight for time.

Collette Stevenson (East Kilbride) (SNP): Good morning. It has been very interesting to hear from the witnesses. I would like Stuart Haszeldine to clarify an earlier point about the methodology that was used for the criteria. Were things such as storage capacity and the ability to take emissions included in the criteria when the methodology was carried out?

Professor Haszeldine: As far as I am aware, the methodology was not specific on the total tonnage of available storage. Applicants had to be able to provide storage only for the amount of CO_2 in their project. There is no strategic insight in the criteria, if that is what you are asking. For example, the Northern Endurance Partnership structure from the East Coast Cluster project might be able to take 400 million tonnes of CO_2, but if the project requires to use only 100 or 200 million tonnes of CO_2 storage, that is all that applicants need to be certain of. That is my short answer.

Collette Stevenson: I come to my main point, which relates more to finance and investment. In your opening statement, you mentioned the role of the Treasury and of BEIS. Will you flesh out that role? What role do you envisage the Treasury having when it comes to the Acorn project for carbon capture's reserved status?

Professor Haszeldine: [*Inaudible*.]—by the underpinning money from an allowance that it has projected, so there is that famous £1 billion of capital allowance. However, the money comes in multiple types. Everybody focuses on the £1 billion of capital funding to build a couple of CCS projects, but the real big money—possibly three times that amount—is the running costs of the CCS projects on the east and west coasts. The Treasury calculates all that as the total cost of the projects.

BEIS—the department for energy—submitted three projects to the Treasury, but only two were approved. The Acorn project met the criteria but, for some reason, the Treasury decided that it would not fund it. Again, I have to declare an interest, in that I am a resident in Scotland, but it seems to me that the Acorn project involves lower risks and lower potential incremental costs, so the approach is much more manageable. However, it is for the Treasury to make such decisions.

I am sorry—I cannot remember the rest of your question.

Collette Stevenson: Does Erik Dalhuijsen want to come in? Does he have knowledge on that?

Erik Dalhuijsen: I have very little knowledge of how funds are distributed, as I am usually on the receiving end.

Collette Stevenson: What more can be done to ensure that the Scottish Cluster goes ahead in phase 2? What can be improved? In what ways did the Scottish bid not have the advantage? We have touched on how the project could not proceed, but Stuart Haszeldine's paper included something about it commencing without BEIS support. Will you touch on that?

The Convener: I ask for a brief answer, please, because we are running out of time.

Professor Haszeldine: I touched on that issue briefly in an earlier answer. We can choose to take part in the BEIS track 2 competition. We do not know what the rules are yet, but the track 1 competition rules significantly disadvantaged the Acorn project, because they focused on a large total tonnage of CO_2 and disallowed its being shipped in. If we wanted to advantage Acorn, we would be lobbying for the rules to be slightly different, specifically to include the shipping of CO_2 so that Acorn could bring in a large tonnage of CO_2, thereby encouraging the total tonnage to be restored and decreasing the cost per tonne of CO_2.

Collette Stevenson: Would Erik Dalhuijsen like to come in on that?

I am sorry—I see that Stuart Haszeldine wants to come back in.

Professor Haszeldine: Am I live on screen?

Collette Stevenson: Yes.

Professor Haszeldine: I will briefly mention the other route, which would involve simply being a provider of CO_2 storage as a business. We know that, as well as cleaning up CO_2 emissions from the UK, we could help to clean up emissions from Europe through CCS. We could import CO_2 into

Scotland by shipping from countries such as Denmark, Germany, France and the Netherlands around the North Sea, and from Finland and countries around the Baltic Sea, and we could make money by charging for the provision of safe and secure storage.

However, we would not only need to invent our own business; we would need BEIS to provide the economic licence for us to take on the regulatory provision and the underwriting of long-term liability and ownership for CO_2 into the infinite future.

Erik Dalhuijsen: My main concern is that CCS might create a continuation of fossil fuel use where it should not be necessary. Although I support the principle of CCS and finding a way in which it works—I agree that shipping in could well be a logical way of doing that—there are risks with storage. Having a limited number of well-controlled stores could well be a better outcome than having a lot of small stores distributed in different places.

Liam Kerr: I will be as brief as possible. I have two direct questions for Erik Dalhuijsen. First, Oil & Gas UK's "Energy Transition Outlook 2021" reports that there is a total capacity to hold 78 billion tonnes of CO_2 under the North Sea and the Irish Sea. As I understand it, that is approximately 190 times greater than the UK's annual emissions of 400 million tonnes. Even if we were to accept all the concerns that you have raised, given those figures, ought we to be not only exploring carbon capture, utilisation and storage but ramping it up, rather than holding back?

Erik Dalhuijsen: I come back to my introductory comments about the context for the numbers. The figure of 78 billion tonnes is a first-pass estimate of where geological storage could be available. I have worked on two earlier projects, one of which, from 2012, turned out not to be feasible because of the absence of a secure store. That project is still part of the volume of 78 billion tonnes.

With regard to whether that number represents the total geological store, I discussed in my submission the issue of whether one in 10, or one in 1,000, of the storage spaces would be viable, and I stated that we would not know until detailed investigation had been done. That investigation is now happening; Acorn has been working on it for some time. We can find out how it works and decide how we respond. The 78 billion tonnes of capacity—OGUK does not use the word "capacity", but refers to it in a different way—is not the amount of CO_2 that we can store. That is the long and the short of it.

11:45

Liam Kerr: Moving on, I will focus on figures again, because that seems to be what we have to work with. We have spoken a lot about hydrogen and your concern about creating fossil fuels. The International Energy Agency has various scenarios in which it anticipates that hydrogen will meet 10 per cent of global energy consumption by 2050. The IEA seems to suggest that 40 per cent of that hydrogen will come from natural gas facilities that are equipped with CCUS—that is, blue hydrogen. If that is right, does it not suggest that the technology must proceed to ensure that we get to the hydrogen economy that I think most of us are looking to get towards?

Erik Dalhuijsen: First, let us be clear that the IEA has given scenarios and that about 80 per cent of those scenarios—not all of them—involve the use of carbon storage in order to arrive at net zero. Once the parameters of a model have been set, those are what it will use. Let us be clear about the background of the IEA: it is the historical oil industry lobbying group, or its technical support group—whatever we call it. If you assume that CCS will be viable, that blue hydrogen can be produced with substantially reduced emissions, and that methane leakage upstream is of relatively little value, that is how the model will be built.

Those models are based on an input, so they can be built in any way we like. Scotland and Norway are the two highest net producers of green hydrogen. Therefore, if we want to produce dirty hydrogen, as I call it, Scotland might not be the ideal place to do that, but if we want to store carbon from unabatable residual emissions from elsewhere, using Scotland is perhaps not a bad idea. A valid approach would be to import carbon from cement production by ship for CCS and to then work on finding out whether we can make the carbon stay there—there is huge uncertainty about that. However, paying now to move up our gas and source emissions in order to achieve that shows a bias towards certain inputs, if that makes sense. The IEA model and a lot of other models are biased towards that assumption, which is the result of very hard lobbying from the global CCS industry.

Liam Kerr: Thank you.

The Convener: That brings us to the end of the session. I thank Professor Haszeldine and Mr Dalhuijsen for joining us and for sharing their fascinating and expert insight into the area. That was very much appreciated. I will suspend the meeting briefly to allow for a change of witnesses.

11:48

Meeting suspended.

11:49

On resuming—

The Convener: I welcome our guests for the second panel: Colin Pritchard, energy business manager, Ineos; Alan James, chief technology officer, Storegga Geotechnologies; and Mike Tholen, director of sustainability, Oil & Gas UK. Thank you for joining us. Sorry—we are running slightly behind schedule.

Sir Ian Wood was invited to join the panel. Unfortunately, he cannot attend but he has provided a helpful written submission, which has been published with the committee papers. We thank him for that submission.

I will start with a general question. How important is CCUS to achieving Scotland's transition to net zero?

Mike Tholen (Oil & Gas UK): There are three main aspects to its importance to the Scottish economy. First, as you heard from the speakers in the previous session, CCS is part of the mechanism for decarbonising the UK and the Scottish economies. Without it, it would be much harder, if not impossible, to get to net zero—by 2045, in Scotland's case.

It allows us to address those industries that are hard to decarbonise while we find solutions for them and capture that carbon in a way that allows us to get ahead in the net zero game, without which we would damage Scotland's economy in a pretty dismal way. Therefore, it can help Scotland to decarbonise like nothing else.

Secondly, it allows Scotland's supply chain, which is a huge asset, to learn the technique and the technology at home and help to build competence. That will allow us to transfer those skills abroad and build on our North Sea heritage, so it will be a great advantage to Scotland in decarbonising and in skills development.

On top of that, it allows us to get ahead in relation to understanding the broader aim of helping Europe to decarbonise as well. Climate change is a global problem; it is not just a problem for Scotland or the UK. We will be bringing the biggest solutions to the market.

The Convener: Thank you, Mike. I put the same question to Colin Pritchard. [*Interruption*.] Can we arrange for Colin's microphone to be switched on? We cannot hear him at the moment. [*Interruption*.]

Colin, we are having a bit of an issue hearing you, so we will try to get broadcasting to fix your microphone. While we do that, I ask Alan James to address the same question.

Alan James (Storegga Geotechnologies): Thank you, convener. Is my mic working okay?

The Convener: Yes, it is.

Alan James: Excellent.

It is fair to say that, without CCS in the Scottish Cluster, the net zero ambitions for both Scotland and the UK would be extremely difficult and expensive and perhaps impossible to achieve. Also, without it, an opportunity to initiate significant export revenues for Scotland could well be missed.

The three key areas to focus on are the decarbonisation of industrial emissions, manufacturing and energy supply, plus the jobs that go with that; the decarbonisation of heat, of which there has already been significant discussion by the previous panel; and, importantly, the enablement of net negative emission technologies such as direct air capture, which enable some of those technologies that we simply cannot electrify—such as aviation and many aspects of the business sector—to decarbonise and eliminate their emissions.

CCS is the foundation that all those things will rely on and we need them for net zero.

The Convener: Thank you very much. We are still waiting for Colin Pritchard to log back in, so I will move on to my second question.

I think that you were all listening to the first panel. We had quite a broad discussion on the technical, financial and environmental risks associated with CCUS. It would be useful if we could get your perspective on some of those issues. I will start with Mike then move to Alan, and if Colin is on, we can bring him in.

Mike Tholen: The first session amply covered the issue. In summary, the technology for the most part is well understood. It has been proved in aspects of the North Sea and elsewhere. The capture techniques are also well understood, and they are well used in a whole variety of contexts, not least in the North Sea through the UK sector. The question is how do we build on that, together with our ability to manage the plants and the processes? Again, through the expertise in the North Sea through the North Sea's—[*Inaudible*.]—capabilities, we understand infrastructure management, pipeline management and process plant management. We can add to that our focus on and knowledge of things such as methane and methane abatement. Our understanding means that we can get on top of the whole package.

Of course, there will be learnings, but the skills and knowledge base means that we are starting from a unique perspective, of which others are jealous.

The Convener: Thank you, Mike. I will bring in Alan on the same question. In a recent article in *The Scotsman*, I saw that you made the comment

that the cluster sequencing programme has been "successful" and has helped to galvanise

"the Cluster formation for Scotland".

In addition to the technical issues, could you also touch on that comment as well?

Alan James: Yes, of course.

I agree fully with Mike Tholen that technology is not an issue. In Scotland, we have been operating carbon capture projects for 30 years. There has been carbon capture operating in St Fergus for 30 years for a different reason—it is not for climate protection, but for cleaning up our natural gas from the North Sea. There is a huge amount of knowledge base in that, and it simply a case of modifying it so that we can route the emissions out and back underground into the rocks of the North Sea, rather than simply venting the CO_2 into the atmosphere, which is what we need to avoid.

Cluster sequencing has galvanised compared with just a few years ago in Scotland, when industry had largely stepped back from the carbon capture and storage space. The efforts made by the industry, supported by NECCUS in Scotland, and the cluster sequencing have brought that together, such that industry and investors have been significantly mobilised and are now ready to move to execute and build the plants and reduce emissions.

We have challenges in the area of cost support mechanisms, particularly for those companies that will operate carbon capture plant. Previously, without that, emissions would be released to the atmosphere; now, there are additional costs to capture the emissions, part of which can be offset by not having to buy carbon EU allowances, or emission allowances. It is those costs, which are supported by the Government business models, that the track 1 clusters now have an opportunity to bid for. Those items are the key challenges. However, Scotland has a significantly mobilised industry and investment, and it has key resources, skills sets and a workforce that is ready to do it. Importantly, 64 per cent of the UK's underground offshore storage resource lies in Scottish waters. There is a huge opportunity for Scotland to make use of that.

The Convener: Thank you, Alan. I will hand over to Fiona Hyslop, to be followed by Jackie Dunbar.

Fiona Hyslop: It would be helpful to know through the chat bar whether we have Colin Pritchard back, because I have specific questions for him.

First, I will ask Mike Tholen how important the Acorn project is in Scotland, what its importance is to the drive to net zero, and what needs to be done to ensure that it moves ahead as quickly as possible.

12:00

Mike Tholen: The Acorn project is key not only to helping Scotland's economy to decarbonise but to solving the immediate challenge that you face in Scotland with high carbon-emitting industrial activities. We have to find a way for industry to transition in Scotland, instead of simply cutting it off at its knees. That journey would allow a broader economy to mature and adapt to the change in a way that is effective for society.

Coupled with that, the skills and knowledge base in Scotland now can adapt and grow, based on the learnings from the Acorn project, in a way that, as was mentioned earlier, will develop export capability potential unlike anything else. I am lucky enough to work overseas, and when I go around the world, I see us folk—not least in the gas and oil industry—working in pretty much every application of the industry globally. The lessons and learnings from Scotland, hopefully in carbon storage, will be transferable skills abroad.

Fiona Hyslop: I come to Alan James. As we have just heard, the storage capability of Scotland is enormous, if not unique. Is it somewhat peculiar that the phase 1 criteria that was used by BEIS in its assessments did not involve the storage capability of Scotland for carbon capture and storage? Should that be revisited? Mike Tholen, you might want to come back in on that, but the question was specifically for Alan James.

Alan James: It is fair to say that the criteria for evaluation did not include the magnitude, quantum and potential of the storage resource available. As Professor Haszeldine said, track 1 focussed largely on the large volumes from emitters.

However, this is track 1—it is a start. We have to be very careful, because not accessing track 1 does not mean that there is no future for CCS in Scotland. It simply means that we will—[*Inaudible*.]—behind track 1. One of the advantages that we have in Scotland is that we have offshore pipelines already in the water, ready to be reused. We have the potential to build plant and infrastructure faster, and we can do a lot of catch-up through that process.

We have spoken about the importance of CCS for net zero. What is now needed with speed is clarity about the forward process with the UK Government and more detail about what reserve status really means with respect to the procurement process.

Fiona Hyslop: Mike Tholen, do you want to comment briefly on that?

Mike Tholen: This is one case where we simply cannot rely on the two current solutions to meet the UK's needs. Those solutions may be slightly ahead, but this is not a single-track train line. We need all of these projects to happen, and to happen at scale. There is the unique opportunity of the Acorn project in addressing Scotland's needs, but there is also, as Alan James mentioned, the offshore infrastructure, the capabilities and the knowledge from St Fergus. Those are things that, in any external competitive analysis, surely have to stand out as part of the long game.

I have no doubt that the UK Government is thinking very hard and that investors in the Acorn project are challenging the UK Government to look at the longer term solution here. As Alan James says, this is not the end of the road for the project—it is a small setback. You have so many advantages that it is simply inconceivable that the UK and Scotland will not see that project go ahead. It is a case of waking up and getting on with it.

Fiona Hyslop: So it is a long game—

Mike Tholen: Yes, but it is a game that you have got to win.

Fiona Hyslop: Thank you—and thank you, Colin Pritchard, for being so patient and for reconnecting to the meeting. I hope that we can hear you now. I want to ask you how important carbon capture and storage are to Ineos and to give you the opportunity to make your opening remarks, which you were unable to do previously. May I bring you in now?

Colin Pritchard (Ineos): I hope that you can—can you hear me okay this time?

Fiona Hyslop: Yes.

Colin Pritchard: Brilliant. On the context for carbon capture and storage from an Ineos perspective at Grangemouth, we have pledged to achieve net zero by 2045—reducing our emissions on the site here. A key point that plays into the conversations about energy transition is that we want to do that while we continue to make products that will help others to reduce their emissions, too, and products that are essential to our lives. Personal protective equipment, vaccines, ventilators and ethanol for hand sanitiser are some recent topical examples. The last element is that we want to play our role in leading the clean hydrogen revolution.

There are a few elements to unpack within that with regard to removing emissions from the central belt of Scotland. I heard the first panel discussing fossil fuels. A lot of the CO_2 that we would look to capture beyond Grangemouth would be from the cement industry and biomass combined heat and power generation. Even within our operation of the gas cracker, carbon capture will come in for the emissions that are not directly fuel related. It is essential for us to be able to reduce those emissions by 2045 and, as I say, there is the element of just transition—continuing to make products to help other people and enabling the hydrogen revolution in order for us to be able to get carbon capture and storage going within Scotland.

Fiona Hyslop: Do you want to say anything on Acorn in particular?

Colin Pritchard: Access from Grangemouth to Acorn will be by far the most efficient way to remove those emissions. The plans that we have for moving material and further reuse of national grid infrastructure to get CO_2 up north from the central belt of Scotland will provide probably the most cost-efficient route to decarbonise that area. It is important to remember that, actually, if the costs of permits continue to go up and up, as was discussed this morning, although the commercial imperative for carbon capture will become more relevant, those are burdens on the business that the business cannot necessarily survive while still producing an internationally traded commodity. Therefore, until such time as policy allows those costs to go to the consumer, we will need support with the ongoing costs of carbon capture and storage.

That means that, if it is going to cost us more to abate carbon emissions and do CCS, we will be looking for help from Government with that cost through those support mechanisms. The Acorn project provides the lowest cost options by reusing infrastructure for abating these carbon emissions, particularly in the central belt of Scotland.

Fiona Hyslop: Thank you.

Jackie Dunbar: I know that we are short for time, convener, so I will ask just one question. Having heard from both sets of witnesses today, I think that we can all agree that Scotland has a huge asset in the Acorn project. Therefore, what do you think St Fergus and the Scottish Cluster can do to evolve and adapt in the short to medium term, to ensure on-going investment and to secure jobs? I know that I asked the same of the first set of witnesses, but I would like to hear the answers of the second set of witnesses, too, starting with Colin Pritchard, please.

Colin Pritchard: I can talk about what we in Ineos are doing at Grangemouth. We are continuing with all our engineering work and studies exactly as we would have done, had we been in track 1, and that is because we see this as imperative. The UK and Scottish Governments' net zero targets and especially the interim 2030 targets cannot be met without the Scottish Cluster

going ahead, so we are absolutely committed to supporting that and are continuing our engineering efforts to support the Cluster in delivering.

Jackie Dunbar: How difficult is it to do that, given that you do not know whether the Scottish Cluster will go ahead?

Colin Pritchard: There are several levels to that question, but the main answer is that you have to continue on the understanding that the Scottish Cluster has to go ahead. It is not a question of whether this is going to happen but a question of timing, and that is how it has to be addressed.

Jackie Dunbar: I am sorry if I put you on the spot there. I wonder whether Alan James wants to comment.

Alan James: The key issues are maintaining momentum and confidence in industry and working as hard as possible to encourage clarity from the UK Government on the follow-on pace with regard to the process. It is important to bear in mind that the Scottish Cluster has been fortunate in being the recipient of UK Government funding through the industrial strategy challenge fund, and works in that respect are scheduled to continue until perhaps the middle part of 2023. There is a lot of work to be done to move that forward, and I trust and hope that we can achieve clarity from the UK Government on the follow-on pace well ahead of that, and hopefully in the first part of next year.

Jackie Dunbar: Does Mike Tholen wish to comment?

Mike Tholen: Alan James and Colin Pritchard have captured the challenge as provider and customer of the project, but with regard to the broader context, the supply chain in Scotland has line of sight of the opportunities and wants to find a way of building them into business plans in years to come. As has been said, there is no doubt that this is a matter of when, not if, and it would be preferable if it happened sooner—certainly not later. That message is getting back very loudly to the Scottish and UK Governments. Investors are certainly continuing to focus on the Acorn project as a vital part of the long-term decarbonisation strategy for Scotland and the UK.

Jackie Dunbar: Thank you very much. I will hand back to you, convener, as I know that we are short of time.

The Convener: I call Mark Ruskell, to be followed by Monica Lennon.

Mark Ruskell: I was just reflecting on the comments by Professor Haszeldine in the previous evidence session about the Government in effect requiring the oil and gas industry to store carbon emissions on a compulsory basis as a licence requirement, and I wonder whether Mike Tholen can give us the industry's view on that. Specifically, given that there are 6.6 billion barrels of oil and gas in the North Sea, how much of that carbon can be captured and stored? On what timescale can that happen?

Mike Tholen: Part of the issue here is the total demand for oil and gas in the UK. Over the next 30 years through to 2050, somewhere between 15 and 18 billion barrels of oil and gas will be needed to meet the UK's energy needs. There is therefore a demand for energy, part of which comes from hydrocarbons—oil and gas—that will have to be addressed in the most carbon-effective fashion. In that context, CCS will allow us not only to capture emissions from some of those products, but to do so in a way that will be vital to the overall economy. The emergence of a carbon storage business will allow the UK—and, similarly, Europe—to take a position on how it wants to use CCS to abate the use of hydrocarbons and the pace at which it will do so.

12:15

Mark Ruskell: You talked about there being a demand of not 6 billion but 15 billion to 18 billion barrels, so I come back to my question: how much of that carbon could be captured under the Acorn project or future projects, and what would be the timescale for that?

Mike Tholen: That depends on those projects emerging. The total demand for hydrocarbons, as pictured by the Climate Change Committee, is around 15 billion to 18 billion barrels. Within that, it is thought that, by 2050, CCS will be operating on a scale of between 100 million and 170 million tonnes per year. The Acorn project is a small part of the much bigger scale-up of projects that is needed to capture CO_2, and only when that scale-up emerges can we abate the use of hydrocarbons through such a process. That process will accelerate over the next two or three decades.

Mark Ruskell: But how much of that carbon can be captured by 2030, given that the next eight years will be critical to climate change? Let us go back to the 6.6 billion figure. How much of that carbon can be captured through carbon capture and storage schemes and buried under the North Sea between now and 2030? What proportion of that—

Mike Tholen: I apologise—I did not mean to interrupt.

I am struggling to answer the question precisely in the way that you have put it, because the capture projects are not yet in place. It depends on the scale of the projects as well as the scale of ambition. I think that the British Government's aim

is to have capacity of 30 million tonnes per year by 2030, and that will start to abate the use of hydrocarbons across the broader economy.

Mark Ruskell: I have a quick question for Alan James. Last week, the UK Climate Change Committee said that there should be a cut-off point of 2023,

"beyond which efforts should be increased in other areas if commitments on CCS infrastructure ... are not secured."

How confident is the industry that you will get that cast-iron guarantee by 2023 and that, as a result, we will not need a plan B?

Alan James: Unfortunately, cast-iron guarantees are few and far between in industry and commerce, but given the imperative of deployment at scale and the scaling-up of CCS, I have a large degree of confidence that we will continue to motor forward with the project's development and that we will contribute to storing CO_2 through the Scottish Cluster from 2027, which is the year that BEIS in its guidance has indicated for track 2 activities.

Mark Ruskell: I know that time is short, convener, so I will hand back to you.

The Convener: Liam Kerr has a brief supplementary in this area.

Liam Kerr: My question is for Mike Tholen. Mark Ruskell asked about putting carbon under, say, the North Sea, but there was some disagreement between members of the earlier panel about what happens to it once it is there and, indeed, the integrity of anything that you put under the sea. It might come out, or it might not. Can you reassure the committee that, once carbon has been captured and sequestered properly, it is not going to come back out again or have certain negative consequences that we heard about earlier?

Mike Tholen: [*Inaudible.*]—Stuart Haszeldine portrayed. With regard to knowledge of the North Sea's geology, not least in the Acorn project, we have a unique understanding of the formations in the Goldeneye reservoir, so we are starting with a good advantage and know what we are working with.

The science and knowledge around modelling and migration are well understood, and there are always opportunities—[*Inaudible*.] The consequences of a subsequent release are also being understood and imaged as part of the on-going work around CCS. The risks are known and manageable, the modelling technology is there, and research is going on all the time on the methods of detecting and modelling at a practical level.

We are as well equipped as we are ever going to be for a technology that is part of a long-term gain. Without it, we will not meet net zero in 2050; with it, we have the time to make a measured reduction in CO_2 emissions from the global economy and indeed the Scottish economy, which is what we are all after.

Liam Kerr: I am grateful for that.

The Convener: I bring in Collette Stevenson, who I believe has to leave the meeting early. She will be followed by Monica Lennon.

Collette Stevenson: Thank you, convener; I apologise for that.

Good afternoon. I would like to ask about the direct air capture facility. How does the UK Government's decision impact on the development of new technologies such as direct air capture? What scope is there for DAC projects at other clusters?

Mike Tholen: Direct air capture is still very much an emerging technology, and there is a lot of research and work being done on it at the moment. I will defer to Alan James, who is working on it in practice at St Fergus, other than to say that the Net Zero Technology Centre in Aberdeen is doing some excellent work with him to get to the heart of the technology. It opens up some hugely exciting opportunities.

Alan James: We are moving to develop a direct air capture project, which we are planning to locate in the north-east of Scotland. It will provide a service to emitters all over the UK to extract up to a million tonnes of carbon dioxide directly from the atmosphere each year. It will support customers in all kinds of different businesses, including airlines, financial services and professional service firms.

We are hopeful that the first plant will not need any Government support or business model from the UK Government in order to move forwards. However, we need a route for transport and storage of the CO_2 out into the North Sea, and we will need an economic commercial licence from the UK Government in order to do that. At the present time, that will be available only to track 1 cluster storage sites.

With regard to moving the direct air capture system to other locations, the technology that we are working with is from a Canadian company called Carbon Engineering. We hold a UK licence for that, and we are now considering options for setting up additional plant in the north-west of England and in the north-east of England, around the East Coast Cluster.

Collette Stevenson: What are the implications of not having the project at a track 1 cluster, given how much progress you have made on it?

Alan James: For building the direct air capture plant itself, we need to have a functioning transport and storage system. The capture piece and the transport and storage element are two separate components. The transport and storage system needs an economic and commercial licence in order to operate. That comes from BEIS, and it is only available for track 1 businesses at the track 1 clusters at the moment. That work is therefore on hold until we can move things forward.

That is an example of where we are not dependent on the money from the UK Government per se to move the work forward; we are dependent on the economic licence and the provisions for long-term storage liability, which the UK Government has as part of its track 1 process.

Collette Stevenson: Have there been any talks as to when that is likely to go ahead and you are likely to get that licence?

Alan James: [*Inaudible*.]—been hard to get clarity on what happens to the follow-on regions, such as the Scottish Cluster, after track 1. We hope that that is going to come forward very quickly.

Collette Stevenson: I will go to Colin Pritchard. Has there been any impact on you?

Colin Pritchard: Not directly. However, Alan James has made the very valid point that the conversation is about net zero; what we need to control is the concentration of CO_2 in the atmosphere. We can do that in two ways: by not emitting CO_2 and by taking it out of the atmosphere. We should be doing both at the same time, because some of the points of emission are going to be very challenging for us to stop. Therefore, we should be trying to develop any technology that would result in negative emissions, such as direct air capture, CHP, capture from the distilling industries and, arguably, biomass.

Collette Stevenson: I have no further questions. Thank you for letting me in, convener.

Monica Lennon: Good afternoon. CCS is not new, yet despite the provision of billions in support over the past decade, it remains largely unproven and untested at scale, globally. What are the main reasons behind that? Why are companies not putting more investment into CCS? Members of the public ask about the extent of the public subsidy that is being sought. Could the Scottish project proceed without large-scale Government subsidy?

Mike Tholen: The CCS business model is still emerging. Part of the challenge over the past 10 or 15 years has been to do with how CCS can be mixed in as part of a broader industrial activity. In the past, there were discussions about whether CCS would work with coal at Longannet power station, for instance. Clearly, we have moved on from that. The emergent business models have been part of the challenge. We know that CCS is a solution, but how we frame that solution more widely has changed a lot over the past 10 or 15 years.

What is unlocking the conversation is people's understanding that the major industrial sources are the ones to pursue and that the technology marries well to that. In the UK, that is coupled with the opportunities for a more mature carbon market, where the price signals from carbon are again making the business model one that works for society in the first place. On the back of that, the timing is suitable for reusing and making the most of depleted and finished-with assets, such as pipelines and reservoirs in the North Sea, in a way that is economically efficient for society.

Alan James: I would push back on the idea that carbon capture and storage is largely unproven. It has been operating successfully in the North Sea, in Norway, for more than 25 years, at the Sleipner gas field. The technology is fully proven; it works. It has not scaled up and taken off because most parts of the world, including the UK, have not had the business model or the commercial justification, if you like, that some parts of Norway have had for taking on the extra expense of implementing it.

On whether the Scottish project could proceed without Government support, the transport and storage system that we have designed specifically for Acorn has no interest at all in fossil fuel production. Our current feeling is that there is an option to initiate that without Government support to emitters, using emissions points such as the first direct air capture plant, which we have just spoken about, and the voluntary market. There is a small direct air capture plant operating in Iceland, which has recently been in the news. The one in Scotland would be Europe's biggest plant and would operate on a much bigger scale.

12:30

The other part of the picture is Europe. There are large industrial emitters in Europe right now that are in receipt of European Union innovation funding that will need to contract their storage service by this time next year. If Scotland is not contract ready to support that, it is very likely that those emissions and that business will go to Norway and not Scotland.

There are some options for moving forward there. That would put infrastructure in place that Scottish emitters could plug into when the UK Government is minded to move forward and award contracts for difference to Scottish emitters.

Monica Lennon: Thank you.

The Convener: Do you have any other questions, Monica, or are you finished?

Monica Lennon: I was waiting for broadcasting to move to Colin Pritchard. I have one more question for the panel after that.

Colin Pritchard: Do you want me to go through your previous points, Monica?

Monica Lennon: Yes.

Colin Pritchard: I largely agree with the observations from Alan James and Mike Tholen. Technologically, CCS is proven. We know how to capture; we have been doing that in processes for decades. In America, thousands of kilometres of pipeline are transporting CO_2, and the examples from Norway clearly demonstrate the ability to sequester CO_2.

The chief barrier is the commercial and/or policy framework beside that. My business is effectively taking a globally traded commodity feedstock and turning it into a globally traded commodity product. There is a finite margin between those two aspects that is set by the global markets. Wherever producers are in the world, they will try to make their profits from there. Their profit margin has to support their return on capital, and support them to pay their staff and energy costs.

In that gap, we currently have the cost of carbon. I go back to my earlier comment about how simply driving up the cost of carbon does not make it any more likely that people will invest in an option that costs slightly less than the cost of carbon. I have a business in which my margins are being eroded between the globally traded feedstock and the globally traded product.

What would happen is that the business would go somewhere else in the world where it does not face either of those two costs or policy drivers. That has been seen with the principle of offshoring. In that particular area, I recommend the work of Professor Karen Turner at the centre for energy policy at the University of Strathclyde. She has done a lot of work in that area and can demonstrate the principles of what is happening.

That brings us to the point that we need, at least initially, to have the support of a mechanism that largely covers, or helps to cover, the cost of carbon from the business, until such time as we can develop the policy to ensure that the costs are transferred to the consumer. The ideal would be a global trading scheme, because then every product, everywhere in the world, would have the full embodied cost of carbon in there and consumers would have the decision. Practically, however, that would be difficult to produce, so we have to scale back our ambition to something that tries to produce the same effect.

As an industry, we would say that we need that initial support so that we can start to get carbon capture and storage working as a way to decarbonise. However, we feel that, over time, that needs to transition to a policy of, in effect, seeing the costs transferred to the consumer. In that way, we will have that as a margin, to allow us to continue to operate and employ people in the area without being dependent on a Government support mechanism. To be honest, in the long term, that would probably make us feel as nervous as it would the Government.

Monica Lennon: I could ask lots more questions, but there is not a lot of time. How reliant is the business model on continuing the policy of maximising the economic recovery of oil and gas? Does it rely on projects such as Cambo coming on stream? I am asking partly because the public are not fully convinced that CCS is the right climate solution, especially when they hear that some of its main supporters also want new oil fields such as Cambo. How do we address those concerns for people who are not fully convinced and who feel that there are mixed messages and, perhaps, vested interests? As Colin Pritchard is on the screen, I will ask him first and then come back to the other witnesses.

Colin Pritchard: I do not believe that the business models that we are working out for CCS are completely dependent on or even would necessarily support continued extraction of fossil fuel. There are the process emissions that we discussed earlier, such as those from cement. Support is required for extracting energy from waste and potentially for direct air capture of other biomass-type or biogenic sources of CO_2. It comes back to that same approach: we can tackle the problem by reducing emissions or by taking carbon out of the atmosphere and, actually, it should probably be “and” rather than “or”—we should do both.

I listened to the evidence session with the first set of witnesses, and there was a lot of conversation about whether blue hydrogen or green hydrogen is right. Do you know what? Both are probably right. Is electrification of heat in homes right or is hydrogen in homes right? Again, both are right. To be honest, part of the challenge for Government in setting the policy is that you will hear a lot of people saying that this approach is right and that approach is wrong. At the moment, we need to progress all the options together. I am sorry because, in some ways, that is not the best of answers, but, actually, any decision that in any way reduces the CO_2 in the atmosphere must be a good thing.

Mike Tholen: There are a couple of facets to the question, including, as has been mentioned, the public’s acceptance of carbon capture and

storage. Society is going to face a lot of change in the next 30 years, and we need public acceptance of charging electric vehicles, air source heat pumps and those sorts of things. We will collectively take ourselves and society through enormous change in years to come in the energy transition of the nation. In every aspect of that, we must act responsibly and focus on the environmental impact and on the consequences for society of doing it and of failing to do it. The role of CCS as part of that broader context is irrefutable if you want to ensure that the economy of Scotland stays strong through that transition and that it happens in the most carbon-efficient and effective way.

On the role of the North Sea in providing oil and gas, of which Cambo is a totemic part at the minute, as Stuart Haszeldine mentioned in the earlier evidence session, we can ensure that the hydrocarbons that we produce at home are at the top of their environmental game, are produced in an environmentally responsible way and are better than imports. As a consequence of that, we will be able to contribute to society through the activity, jobs and the skills that allow us to keep going through the transition in a way that meets the UK's needs, rather than simply importing and doing nothing for society in the UK. Therefore, it is a combination of both. MER—maximising economic recovery—walks hand in hand with a net zero strategy. The two work together for the Oil and Gas Authority and the UK. It would be utterly irresponsible for us to work otherwise, and we are not even considering that.

Alan James: I have been working in carbon capture and storage since 2007, when I left the oil and gas industry. If I was concerned that CCS was simply a reason for continuing fossil fuel production, I would probably have stopped way before now. As far as I am concerned, CCS does not rely at all on a MER strategy, Cambo or other developments. The two are disconnected.

We need to do what we need to do. We need all the tools that are in the toolbox at the moment. As many folk have said, it is a climate emergency. We need blue and green hydrogen, CCS, renewables and heat pumps—the whole lot.

There really is no connection between CCS and MER. Even if we were to stop oil and gas production tomorrow—which we will not, cannot and should not—we would still need CCS to take the carbon out of the air. How would we manufacture the huge volume of wind turbines that we will need for renewables? CCS is all about tackling emissions and is not really connected to MER and Cambo.

Monica Lennon: That is helpful. Thank you.

Liam Kerr: I will be brief and direct a question to Alan James, who just talked about emissions. In Erik Dalhuijsen's written submission to the committee, he said that we need

"98% to 100% capture efficiency … to achieve net-zero emissions when dealing with fossil carbon."

He suggested that capture efficiency was currently running at about 60 per cent. Is he right on one or both of those assertions? In any event, how might we anticipate efficiency improving over time?

Alan James: My definition of efficiency is the amount of carbon that a plant releases compared to the amount that you capture from it. Therefore, a 95 per cent efficient plant would capture 95 per cent of the emissions and allow only 5 per cent to go into the atmosphere. On all the capture projects that I have been looking at, capture efficiency is in excess of 90 per cent and, for some of them, it is approaching 95 per cent. Negative-emission technologies, such as direct air capture, can then mop up the last 5 per cent by taking the CO_2 out of the atmosphere so that it balances off. I do not recognise the 60 per cent number.

Liam Kerr: You mentioned direct air capture. I met Carbon Engineering Ltd last week and it introduced me to that idea. I found that pretty exciting, because it sounded as though, in effect, you take excess carbon emissions from the air and sequester them. Is that right? If so, is it not game changing for what we can achieve in keeping heating as low as possible?

Alan James: [*Inaudible.*]—game-changing technology. It is not a replacement for fitting carbon capture on to Colin Pritchard's plant at Ineos, the SSE plant or any industrial plant. That should be done. However, direct air capture technology can remove directly from the atmosphere the last 2 or 3 per cent of CO_2 that the carbon capture plants cannot get to.

The other important point is that direct air capture provides us with the ability to time travel and take out the emissions that we put into the atmosphere three years ago when we were allowed to fly on holiday. Those are the things that we will have to do to reduce the climate warming effect on a global scale.

12:45

Mark Ruskell: I will ask Colin Pritchard about hydrogen. My understanding is that it will be a precious energy commodity that we will need to decarbonise the hard-to-abate sectors, such as steel. Is there a need to deploy a hydrogen hierarchy, whereby we prioritise the use of hydrogen for the hard-to-abate sectors and perhaps deprioritise the decarbonisation of the way that we heat our homes, or do we just need more of everything?

Colin Pritchard: The “more of everything” probably came from my previous answer.

Mark Ruskell: I am sorry if I mischaracterised that. My question is, basically, who gets the hydrogen?

Colin Pritchard: I do not mind the “more of everything”. Different applications will have different requirements. It is easy to see hydrogen of any colour or origin having a key role in industrial heat provision, because of the quantity and nature of the heat that you need. In some places, ground-source heat pumps will be highly applicable. In Scotland, they are an obvious solution in areas that are off grid but, in the centre of Glasgow, where there are flats, they are not an obvious solution and hydrogen boilers might be far more appropriate in that application.

Your question speaks to the challenge: there is no single solution that will deal with achieving net zero. We need to look at the application and think about the most appropriate solution. It is a bit of a simplification to say that hydrogen is precious and only a certain sector of the domestic market gets it. We have to examine each and every application and work out the best approach. It might even be different for the same industry in different locations.

The Convener: That brings us to the end of questions. I thank Mike Tholen, Colin Pritchard and Alan James for sharing their expertise, perspectives and insights across a number of areas. We started a bit late, but we have caught up on a bit of time. We will no doubt return to the topic of CCUS. Next week, we will take evidence from the Climate Change Committee, when the issue will be on the agenda for discussion. I hope that the witnesses enjoy the rest of their day.

I close the public part of the meeting.

12:48

Meeting continued in private until 12:53.

Published in Edinburgh by the Scottish Parliamentary Corporate Body, the Scottish Parliament, Edinburgh, EH99 1SP

All documents are available on
the Scottish Parliament website at:

www.parliament.scot

Information on non-endorsed print suppliers
is available here:

www.parliament.scot/documents

For information on the Scottish Parliament contact
Public Information on:

Telephone: 0131 348 5000
Textphone: 0800 092 7100
Email: sp.info@parliament.scot

The Scottish Parliament
Pàrlamaid na h-Alba