

Scottish Affairs Committee

Oral evidence: [The future of the oil and gas industry](#)
, HC 996

Wednesday 10 October 2018

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Members present: Pete Wishart (Chair); Deidre Brock; David Duguid; Hugh Gaffney; Christine Jardine; Ged Killen; John Lamont; Ross Thomson.

Questions 162 - 203

Witnesses

I: Professor Jim Watson, Director, UK Energy Research Centre; Professor Corinne Le Quéré, Director, Tyndall Centre for Climate Change Research, University of East Anglia, and Member, Committee on Climate Change; Professor Stuart Haszeldine, OBE, Director of Scottish Carbon Capture and Storage, and Professor of Carbon Capture & Storage, University of Edinburgh; and Dr Richard Dixon, Director, Friends of the Earth Scotland.

Written evidence from witnesses:

- [Scottish Carbon Capture and Storage](#)
- [Friends of the Earth Scotland](#)

Examination of witnesses

Witnesses: Professor Jim Watson, Professor Corinne Le Quéré, Professor Stuart Haszeldine, and Dr Richard Dixon.

Q162 **Chair:** Can I welcome you today to the Scottish Affairs Committee? We are grateful to you for helping us out on our oil and gas inquiry. Just for the record can you say who you are, who you represent and anything by way of a short introductory statement? We will go left to right, as is traditional, and start with you, Mr Watson.

Professor Watson: I am Jim Watson. I am Director of the UK Energy Research Centre and Professor of Energy Policy at UCL.

Professor Haszeldine: I am Stuart Haszeldine, Professor of Carbon Capture and Storage at the University of Edinburgh. I am also representing Scottish Carbon Capture and Storage, which is a grouping of academic research organisations.

Professor Le Quéré: I am Corinne Le Quéré, Professor of Climate Change Science and Policy at the University of East Anglia and Director of the Tyndall Centre for Climate Change Research. I am also a member of the UK Committee on Climate Change, and it is on behalf of the Committee that I am here today.

Dr Dixon: I am Richard Dixon. I am Director of Friends of the Earth Scotland. If it is all right, I did have some introductory remarks.

Chair: No, please. You were invited to give them.

Dr Dixon: I thought we could not start today without mentioning the big IPCC report that came out early on Monday morning. It talks about 1.5 degrees, the ultimate Paris goal that we should all be striving to achieve. It says that that is still possible, to stabilise at 1.5 degrees, but it is very difficult. It talks about rapid, far-reaching and unprecedented changes needed in society.

To me, that means for the oil industry and the future of oil and gas, if we are in a world that is taking this seriously, that there are only two possible futures: there is a future in which we like deep coal mining, and Government and market forces lead us to a chaotic collapse, where workers and communities suffer, and leaving an environmental legacy that the public purse has to pick up, or—much my preference—we have a planned decline in output and no new exploration, and we have time to build up the alternative jobs so that we have a just transition for the workers, and perhaps for the companies themselves as well to make a transition.

The industry will tell you there is a third scenario, based on carbon capture and storage and hydrogen, which will give them many more decades, but I do not see that future practically or economically being the sensible way to go.



Q163 **Chair:** Grateful, thank you for that. I presumed that you would be mentioning the IPCC, and I suppose, given that we have the four of you here today, it is quite timely that this was introduced this week. My first question therefore is just what the tensions are between the support for the oil and gas industry, which is a major plank of this Government's industrial strategy, and trying to meet what we have agreed in the Climate Change Act. Will there be issues for the Government's clean growth agenda and emissions targets as we go forward? We will maybe start with you, Ms Le Quéré.

Professor Le Quéré: First, I would like to say that the UK has committed to at least an 80% reduction in emissions by 2050, and Scotland to at least a 90% reduction. This is with the background of addressing climate change in order to limit climate change to any degree. To stop the climate from warming, the emissions have to go down to net zero, so any emissions need to be offset by reduction or removal of carbon from the atmosphere. The UK has backed the Paris Agreement, with temperature goals that go further than the temperature goals that were behind the objective of 80%. The Paris Agreement mentions well below 2 degrees—pursuing efforts to achieve 1.5°—and having the highest possible ambition, with net zero in the second half of this century.

The Government have said they will ask the Committee on Climate Change for advice on the implications of the Paris Agreement, but they have not yet asked for the advice. Therefore, we have not done the work for the implications, so anything that I will say is mostly informed by the pre-implications of this Paris Agreement. The trajectories that we have, the projections that we have for the future of the energy system in the UK at the moment, are mostly those that have informed the pre-Paris Agreement. When we do this work, we will be in a position to say what the implications are.

One thing that is clear from our scenario, that we have repeated on and on, is that for the cost-effective path to this current ambition, we need the technology of carbon capture and storage. We need this both to reduce the emissions from the production of oil and gas itself, and to offset the hard-to-abate sector—so emissions in other sectors that we cannot bring absolutely to zero. This is from industry, agriculture and aviation in particular. This is the cost-effective path, and without the development of CCS, the pathway for oil and gas would need to decarbonise much faster and the cost would be a lot higher. Maybe I will stop now.

Chair: I am grateful, thank you for that. Mr Watson, what do you think?

Professor Watson: I wanted to add something on the global context for this. I think whether we are talking about 1.5 degrees or we are talking about a 2 degrees scenario, they both have major implications for the fossil fuel industry generally globally. There was some work done by my colleagues, Paul Ekins and Christophe McGlade, published in *Nature* a couple of years ago, which basically looked at the amount of reserves for



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coal, gas and oil around the world. These are economically recoverable reserves at current prices and technology—the data are a few years old—and it basically showed that if you are going to go to 2 degrees, whether or not you have CCS available as a commercial option, you are leaving quite a large proportion of reserves in the ground.

It hits coal most, so 80% plus of reserves stay in the ground if you want to meet it, but even for oil and gas the percentages are quite significant. I cannot remember off the top of my head, but I can supply details to the Committee if you wish. It does have implications for producers of oil, gas and coal around the world, and there are specific implications for Europe, as there are for the middle east and other places that produce a lot of oil and gas.

That is one of the things that is particularly important, even with the carbon capture and storage. There is a tension here, both nationally and globally, between oil and gas development and climate change mitigation, which Governments—whether they be in Scotland, the UK or around the world—will have to deal with pretty soon.

Q164 Chair: Mr Dixon, I imagine you have a few things to say about this. Just looking at our briefing, 91% of the UK's total emissions are due to fossil fuels. Those are the figures we have here. Is that your understanding of what the figures are?

Dr Dixon: That sounds too high.

Q165 Chair: That sounds too high? You can maybe tell us what you think and where we are in terms of some of the tensions around this.

Dr Dixon: If I could pick up on something that Jim Watson talked about, that study from UCL about how much of the carbon reserves in fossil fuels we can burn, it is really useful to try to begin to apply this to our industry. The figures were, as he said, 80% for coal, 50% for gas and 35% for oil. What they were looking at is what we need to do for a world that stops at 2 degrees, so the Paris Agreement is stronger than that, because it is well below 2 degrees, with efforts towards 1.5 degrees, so we need to do even better than that. Those percentages are of economically recoverable assets, the 2P reserves.

There is a lot of talk in some of the papers and the sessions you have had about there being 10 billion or 20 billion barrels of oil left out there, but the 2P reserves are smaller than that. The 2P reserves are about 6 billion barrels of oil equivalent, so it is oil and gas; it is a bit more oil than gas, but not far off 50:50. If you apply those percentages from that UCL paper, where 50% of gas has to stay there and 35% of oil has to stay there, that says of that nearly 6 billion that we have in 2P reserves, we should be able to take only 3.4 billion out if we are playing our part in the global picture.

At the current rate, that is between 10 and 15 years more extraction. We do not necessarily have to go at the current rate, of course, but that is



the kind of horizon we should start thinking about and the kind of limit we should be thinking about. Instead of maximising economic recovery, we should be mature enough to say, "It would not be a bad idea to not take out as much as we possibly can because of climate change, and these are the kind of limits we should start to talk about".

Q166 Chair: We have heard CCL being mentioned in some of these contributions. Mr Haszeldine, what is your view about the general tension between climate change and oil and gas?

Professor Haszeldine: I agree with all three of the previous types of statement, that these efforts are entirely contradictory to each other, because what drives climate change is the total mass of extra carbon in the atmosphere and ocean, so that the more that is extracted from underground and put into the atmosphere and ocean, the more climate change is driven. If the oil industry in and around the UK and globally wants to continue extracting oil and gas, that is a continual negative driver to drive climate change.

I agree with Richard Dixon, the extractable commercial reserves around the UK have been completely overstated by the oil and gas industry. There is 20 billion barrels of oil potential there, but historical trends since the North sea began show that we are going to get very little of that out.

Even the recent trends, with an uptick in the price, an uptick in technological development and the cheapening of technology, simply extend the lifetime of the oil and gas industry for a few years. The oil and gas industry is heading towards its terminal phases in the UK. We may be lucky enough—or commercially lucky enough—to extract 2 billion or 4 billion barrels, but that is a fraction of what is claimed by the oil industry. Just to put that in context, recently Total announced a large gas discovery west of Shetland, and that has been well blazed in the press, but in oil equivalent, that is about 160 million barrels, compared with 20 billion or 30 billion barrels that have been produced, so it is a tiny extra amount.

The rate of discovery worldwide is fading, the oil industry is living off diminishing resources, but we should also think very carefully before we want to get the rest of that out, because it is going to have consequences. Every tonne of CO₂ we extract is going to cost to put back into the ground.

Q167 John Lamont: My question is to Dr Dixon. You have been quite critical of the Scottish Government's Climate Change Bill, and you described it as being "weak and a missed opportunity". I wondered what you would like to see in that Bill that the Scottish Government have not included as it currently stands.

Dr Dixon: I think there are many sensible technical measures in that Bill about reporting, when Ministers have to come to Parliament and say what they have done, and how we deal with changes in the science, so the



technical stuff in there is good. The big argument we have is about the ambition there. The proposal is that we will have a 66% cut in all greenhouse gases from 1990 levels by 2030 and a 90% cut by 2050. That 66% by 2030 is almost exactly the same number you would get by applying the current 2009 Act, so we are nearly 10 years later, the Paris Agreement has come along and we are supposed to be aiming for 1.5 degrees, and yet we are still sticking to targets that are based on an Act that was based on achieving 2 degrees, not even well below 2 degrees.

The short-term target, which is the one that drives immediate action, is much too unambitious. In terms of the long-term target, 2050 is a long way away, but it is still symbolically really important what you say you are going to do in 2050. You may come up with a plan today for what you are going to do in 2050, but by the time you get there, you will have done a lot of things completely differently, obviously, because things will have changed—principally technologically. But, still, it is, symbolically, about what that number is.

We in Friends of the Earth are calling for a net zero target, so it is net zero—there will be absorption as well as emissions—but net zero for all greenhouse gases by 2040. We are part of a coalition that is calling for 2050 for that date, as are two of the parties in the Scottish Parliament. We are unhappy with the Bill as it is in Parliament at the moment, but of course we have about nine months to go. We will have the report from UKCCC, which will include some information for Scotland, about what Scotland should do as a result of the 1.5 degrees report. Just like in 2009, when it was not so good to start with, but it ended up being really good, I am hopeful that we will get to a place where we have a very good Climate Act in Scotland, but thank you for asking what we would like.

Q168 Chair: Can I just ask about maximising economic returns? It is claimed that is a means to reduce the carbon footprint of the oil and gas industry. Do you think there is enough in that to satisfy some of your concerns? If not, what more should the Government be doing in order to try to ensure that this meets some of their climate change objectives? I saw you vigorously shaking your head there, Mr Haszeldine, so we will start with you.

Professor Haszeldine: I read with interest the submission by the oil and gas interested parties, including the main organisation. To me it seemed very much like, "We want some Government help to reduce our costs of extraction so we can extract more oil," but there was nothing at all about how we enable a carbon reduction with that; there is nothing at all about how we enable ourselves to transition into a different way of operating; there is nothing at all about how we move into diversifying our skills in our industry to develop renewable energies offshore or to use the same technologies to develop hydrogen storage offshore or carbon dioxide storage offshore. The oil industry is being very isolationist and is really continuing in a business-as-usual type of mentality. That seems to apply to all the submissions I read from the oil and gas interested parties.



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Q169 **Chair:** We are talking specifically about MER?

Dr Dixon: Yes, so maximising the economic recovery of course is a good way of trying to make more profit out of our existing oil and gas and make that last for longer, so I can see there are commercial reasons, but as we have discussed before, those are head-on in conflict with our climate objectives. If the price of oil has now increased again to \$70 or \$80, I am quite surprised that the oil industry feels it is not making enough profit out of that, so I would ask why they can't invest their own profits into maximising economic recovery.

Q170 **Chair:** Ms Le Quéré, is there anything that you have seen in MER that can be done better?

Professor Le Quéré: Yes, I would like to make a couple of points here. First, on the CCS, which I have mentioned before, the Committee on Climate Change has said that the Government needs to put up a plan by the end of this year for the deployment of CCS that separates the capture from the transport and storage.

Chair: We have some detailed questions on CCS, so we will maybe just leave that aside, but I am keen to know your views about MER.

Professor Le Quéré: It comes to the plan itself, that it had a lot of detail on the recovery and very little detail on CCS.

Another point that I would like to make is that there are emissions associated with the production of oil and gas. Although we have not looked in detail at the additional exploration and exploitation of oil and gas in the North sea, we have looked at it in the context of the shale gas industry, and we have said that additional exploitation of oil and gas is not consistent with meeting the UK carbon budget unless it meets three conditions. The first one is that the emissions must be strictly limited during the development, production and the decommissioning, so this is stronger for shale gas, but it also applies in this case here.

The second one is that the overall gas consumption must remain in line with the UK carbon budgets and therefore displace exports rather than increase gas consumption here.

The third one is that the production must be accommodated within UK carbon budgets. This is a very important point, because currently the emissions from the production of oil and gas in the UK are 33 megatonnes of CO₂, and that is 7% of the UK emissions. There is very little information or examination of how these emissions could be reduced, and in a context where the overall emissions of the UK decrease, this percentage will of course increase. If we are talking here about increasing the production, so these numbers for year 2016, to increase the export, then that further puts a burden on the UK carbon budget that needs to go within the allocated budget.



Dr Dixon: Two things: maximising economic recovery, as it is currently formulated, cannot possibly be consistent with climate change policy and the need to make our contribution to the Paris Agreement. If we were to really take out 20 billion barrels of oil—and Stuart has suggested that is not very likely—or even a figure approaching that, that translates into about 9 billion tonnes of CO₂. I have tried to work out how I could express that in something more understandable than billions of tonnes, and that is the equivalent of building 20 new coal-fired power stations and running them continuously for 50 years, so that is the scale of emissions that all of that oil will produce, so we cannot take that out.

I said maximising economic recovery as it is currently formulated, so “economic” depends on the price of oil. If the price of oil reflected the true cost of burning that oil to society, then we would have a very different equation in working out what maximising economic recovery was. The current price today of a barrel of Brent crude is about \$85. In 2006, when Lord Stern produced his tome on “The Economics of Climate Change”, he said that a tonne of carbon was costing society about \$85, so an extra \$85 per tonne of carbon.

A barrel of oil is just under half a tonne of CO₂ when you burn it, so using his number—which is a very old number—you would say that a barrel of oil coming out today may cost \$85 to buy, but the cost to society added to that would make the total cost \$110. That would not be the oil industry getting \$110, that would be the oil industry getting whatever the market says, if that is \$85, but there would be another bit on top, which would be going to make up for the damage that burning that oil was doing. That is using a very old figure.

There are recent papers that say that the damage from a tonne of CO₂ is more like \$400, so there are a whole range of numbers, but certainly a barrel of oil being used costs society much more than the actual price of that barrel of oil. If you were to reflect that, then there would be a very different set of economics for the industry and a different calculation for what maximising economic recovery means. Of course, Mark Carney has been warning about this for at least three years, talking about stranded assets, so if we ignore this as a country, at some point it is going to become more and more real, and the price of oil is going to start to reflect the damage that burning that oil does.

It would be much better for us to be ahead of that curve and to be planning for an industry that is profitable for the length of time that it exists, can run successfully and builds up enough money to help with the decommissioning costs, rather than let it fall over a cliff with stranded assets.

Q171 **Chair:** Mark Carney also talks about stranded carbon and potentially destabilising the markets if this asset was left unrecoverable. Do you have any concerns about the general economic impact if they were to pursue that type of approach?



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Dr Dixon: That is why we need to plan this carefully. We are in a situation where the oil industry, as has been commented on, does not really talk about climate change in any of its submissions, and so it is in denial. You are leading the country in some way. It is up to you to encourage them to be thinking about the future in a more sensible, constructive way, where we map out a path where they can continue to be a profitable industry for a certain length of time, and we include them in discussions about the transition—are they part of the transition; their workers definitely should be part of the transition—but we do not sit and deny that this problem is coming.

Chair: I will come to you in a minute, Mr Watson, but I know that Mr Dixon's comments have caught the attention of a couple of my colleagues. We have David Duguid and then Ross Thomson.

Q172 **David Duguid:** Dr Dixon, I was trying to follow what you were saying there. You have come out with a lot of numbers and a lot of assumptions. The total tonnes of CO₂ based on the 20 billion number, how much was that again?

Dr Dixon: About 9 billion tonnes.

Q173 **David Duguid:** That is what you equated to 20 coal-fired power stations operating for 50 years?

Dr Dixon: Running for 50 years, yes.

Q174 **David Duguid:** But then you referred to this additional \$25 per barrel, the cost to society based on 2006 numbers, which you said yourself was an old number, and there are a range of different numbers that you could apply to that equation. Has any consideration in those calculations, or in any of the panel's calculations of the effect on society, taken into account improvements in efficiency and cleaner burning of fossil fuels, which is still happening, and which has been taking place over recent decades?

Dr Dixon: In terms of some of those more recent calculations—the \$400 per tonne figure I was referring to was a very recent paper—that is looking at the picture today. That is looking at if, by burning fossil fuels, you create a tonne of CO₂, what does that do in terms of its financial impact on society? In some countries it is much higher. If you are in a low-lying country being affected by rising sea levels and big storms, that is doing you lots of damage. If you are in a nice rich country where you can build seawalls and protect yourself, then it is probably costing you less as a society.

That \$400 is a global average, and it is not equitably distributed. There are a number of countries across Europe, and some outside of Europe, that have used a shadow price of carbon, so that is again trying to think what is the social cost of a tonne of carbon. They have used that in policy-making. The average cost of that in 2014, which was the latest figures I could find, was \$56 per barrel, so that is not per tonne of carbon, that is per barrel of oil. They are saying that—



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Q175 **David Duguid:** Just to clarify, that is per barrel of oil or per barrel of oil equivalent? Because obviously you are going to get a different effect if you burn a barrel of oil versus a barrel of oil equivalent.

Dr Dixon: You are indeed. I believe that is barrel of oil equivalent, so you cannot then directly say what that means for a barrel of real oil.

Q176 **David Duguid:** I am not denying the effect of climate change. I must say I worked 25 years in the oil industry before I was elected last year, so I must declare that. I am not denying climate change or anything like that, but would you accept that there are so many variations and variables and assumptions that it is very difficult to tie down exactly what the impact is, even today, never mind the future?

Dr Dixon: I am certainly not saying, "The figures are exactly these, and this is what the Government should therefore do as a result". I am saying that we are currently not taking into account the social cost of burning oil and gas. We need to start doing that, because if we do not, the market eventually will start doing that, and that will be chaos for the industry. Let's get ahead of that, let's put the industry into a framework where it understands what is going on over time and it can make its own sensible decisions about what it does in the future, rather than stranded assets, carbon bubbles et cetera.

Q177 **Ross Thomson:** Mr Dixon, in relation to your answer to the previous question to the Chair, I think it is slightly unfair to say the industry do not have any concern for the environment or have not produced any submissions, given there is an environmental impact report provided every year by Oil & Gas UK. In that, they are quite clear that although production has gone up in a mature basin, the downward trend for CO₂ emissions is clear, due to efficiencies that they have made in the industry. Being an Aberdeen representative, I know that the industry takes its responsibilities very seriously when it comes to the environment. Do you not see that there is scope, with the development of new technologies—the Oil & Gas Technology Centre that this Committee visited itself—where we can see increased production with efficiency, which lowers its carbon footprint, because it is a decarbonising carbon industry?

Dr Dixon: I think it is nibbling at the margins, so you are producing a barrel of oil that is producing 430 kilograms of CO₂ and you make that slightly more efficiently. Of course the industry is working on efficiencies, and that is partly because they feel the pressure on environment, but it is partly because, of course, it makes economic sense to use less energy getting a barrel of oil out of the ground. They are doing that, so there is progress on that.

If you reduce the amount of energy you use by 10% to get 1 billion barrels of oil out of the ground, then that is helpful, but you are still going to burn 1 billion barrels of oil, and they are still going to have that impact. Of course I welcome any progress in the industry that is about



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doing things more efficiently, but the core thing is that they are doing something that causes climate change. The product they produce is the problem, not so much how they produce it.

Just to clarify what I said about what is in the submissions, I was talking about the submissions to this Committee and the two sessions you have had previously with the oil industry. In all the papers I read from the oil industry and from people associated with them, there is very little; there is not really anything meaningful about climate change. There is a little bit about what you have talked about, which is increasing the efficiency of production. That is obviously well worth pursuing, but that is not the big picture of, "We are producing the worst product there is for creating climate change. We are taking that seriously and doing something about it". I do not see that message anywhere in any of that.

Chair: I think we will give Dr Dixon a break, but thank you for that. I know Mr Watson was very keen to come in on this, and then we will move on.

Professor Watson: Just a couple of other perspectives on the maximising economic recovery. Clearly this is not just an issue for Oil & Gas UK. If you listen to speeches by oil companies around the world, oil-producing nations around the world, they will often talk about climate change, but then talk about it as if it is not going to affect the production of their oil and their gas. The implication is somebody somewhere else in the world is going to have to leave more of their resources in the ground. The question is about equity, about how you share out this leaving it in the ground issue.

That links back to the paper by my colleagues that I mentioned. There is not a flat figure for how much oil and gas you leave in the ground in every country. It depends on production costs of that oil and gas in different countries, so the amount that ought to be left in the ground in Europe for oil is much lower than the average, for example, because we are in mature basins, and they have things like Arctic oil in there, which is a very high number that should be left in the ground. I think it is an important bit of context, that we do not just keep passing the buck around, and if we say, "We can maximise economic recovery in the North sea," the implication really is that somebody somewhere else is not using their resources and therefore not getting the wealth that they need from that.

The final point I would make is that if you go back to some of the fundamental economic theory on resource extraction, which I taught for quite a long time—and this is irrespective of climate change—there is a very good rationale when you are extracting some of that oil and gas that is finite, taking the returns and current expenditure and economic growth, as you do, to reinvest some of the proceeds in alternatives. The tax take that the UK has had has not been invested in alternatives historically, like the Norwegians have done, but there is still time, should UK, Scottish and other Governments want to do it, to say, "While we are



in this transition period, use the proceeds, especially if oil prices are high, in order to reinvest in the low-carbon future in a more direct way than we do already”.

Q178 Ged Killen: I think you have both covered quite a lot of what I was going to ask, but I might have missed a figure, and I just want to go back to check. If there are between 10 billion and 20 billion barrels of oil remaining, how much of that can be realistically extracted if the UK is to meet its emission targets? What is the financial impact on the stability of the industry if the companies are not able to fully exploit that?

Professor Haszeldine: As has been explained before, we can treat this as a percentage of the economically extractable oil, as Richard Dixon outlined, in which case we may produce 2 billion or 3 billion barrels of oil by conventional means, and that would be your decreasing and declining limit. That leaves 2 billion or 3 billion barrels of potentially economic oil in the ground, plus another 15 billion or so barrels of non-commercial oil. But what I also want to say is that I think we have to be clear on this, perhaps, confusion about the carbon cost of the operations of getting oil out, which some oil companies are trying to reduce with maximising economic recovery, plus the inherent carbon that puts into the environment by the product itself.

There are ways of trying to mitigate that carbon impact of the product. If you wanted to use carbon dioxide, for example, and put carbon in the ground to help extract the oil, or if you wanted to use carbon dioxide to dissolve oil that is otherwise unrecoverable, those can be ways of trying to balance that carbon equation. None of these submissions have looked at that at all, whereas in Norway, for example, there is a very live engagement with the Norwegian company, Equinor, also with Total and Shell, about the possibility of doing that, partly as a way of extracting additional oil but partly also as a way of balancing that carbon equation by putting carbon in and taking carbon out.

However, in the submission from the sector deal team, which you have had in this inquiry, the limits of their ambition are to work with the industry to provide input to the Government, to provide some management secondees and to work with stakeholders to establish a vision. For an oil industry starting in the early 1970s and operating until the present day, that seems remarkably naive and unambitious in climate terms. I think the oil industry is in its ivory limousine heading for the cliff edge.

The analogy I would make is that the coal industry in Britain did not close because of lack of coal. There is still plenty of coal underground. It closed down because the environment surrounding it changed, both in price and in the environmental consequences of burning coal. Unless these large corporations take notice of how the world is changing and we help them to take notice, then it will not change.



I will make an analogy that when the car manufacturers in the United States were in a lot of financial difficulty, they went to the Washington Government and said, "Could we have some financial help?" and the Washington Government said, "Yes, you can have some financial help, but as part of the deal we want you to double the fuel efficiency of your cars". They managed to do that within a few years. Just giving out money to oil companies to continue business as usual does not seem a sensible strategy to me.

Professor Le Quéré: In the Committee we have looked at the demand for gas. These are scenarios that date to 2016, in part aligned with the projections from the OGS—oil and gas sector. We looked at demand for gas in the power sector and the heating industry, and in the power sector we have just this year had to revise our scenario because of the very rapid decrease in cost of renewable energy. The demand for gas has decreased.

Nevertheless, in the scenarios that were valid in 2016, there was still a large demand for gas going to 2030 and then rapid reduction afterwards. The reductions in the scenario at the moment are dependent on the future of heating our homes, and the decisions for this will come in the early 2020s. For the scenarios up to 2030, which I have in front of my eyes, there is now—as you probably know—a supply gap in gas in the UK because we import gas. We import more gas than we export. As long as this production of oil and gas replaces the supply from export then, for UK carbon budgets, this can be met locally, considering also the production. That is notwithstanding the international implications that we have discussed and the very real implications of having further carbon emitted to the atmosphere.

Q179 **John Lamont:** My question has been touched on already, but how reliant is the UK on gas as a proportion of its energy mix, and how do you see that changing if we are to meet the 2050 emissions targets?

Dr Dixon: I will just say something briefly on the Scottish picture on that. Gas has been a useful transition fuel at the UK level. Gas-fired power stations have appeared as coal-fired power stations have disappeared, because gas has less CO₂ in it. That is a good thing, but it is a transition thing.

In Scotland, that is not really what has happened. We have closed our two coal-fired power stations, but we have not replaced them with gas. We have one gas-fired power station left, which is at Peterhead and may struggle on until 2030 or may close quite soon, because we have replaced that with renewables. The two coal-fired power stations produced about 3.6 gigawatts between them. In terms of renewables, we now have just over 10 gigawatts of capacity. Of course the renewables are intermittent so that is not three times as much every day, but it is a very strong contribution to replacing those coal-fired power stations. Gas has played quite a different role in Scotland, or in fact not really any role, in the electricity transition.



Q180 **John Lamont:** Just to go back to that, to the figures there and the capacity point, what is the actual production from renewables? You said 3.2 gigawatts from—

Dr Dixon: It was 3.6 gigawatts, I think, from Crockenbie and Longannet. On a windy day, about 86% of all the electricity generated in Scotland will be coming from renewables. Because we quite often export, that means close to 100% of what we need could be coming from our renewables, but on average it is approaching 60%. Across the year, about 60% of the electricity used in Scotland is provided by renewables. It is a slight fudging, pretending that we send all the nuclear electrons down south and we keep all the green electrons, but the reality is that if we had no nuclear, 60% of our electricity would be coming from renewables.

Q181 **John Lamont:** Just to be clear, if nuclear did not exist? I am just trying to understand the figures here. You said that if there was no nuclear, 60% would come from renewables. We do have nuclear so that is not a fair comparison, is it?

Dr Dixon: There are two different figures. There is, "How much electricity do we generate every day in Scotland?" That is bigger than, "How much electricity do we use in Scotland?" because we usually export. Sometimes we import, but we usually export. The Scottish Government likes to suggest that the nuclear electricity is exported and it is the good stuff we keep, in their eyes, but that is also the important figure. How self-sufficient is Scotland? The answer is that about 60% is coming from renewables in Scotland in the last official annual figures, and that is going up pretty steeply. Of course we have a target for that to reach 100% by 2020, which the Government and the industry do not believe we will quite reach, for various reasons about planning and things moving more slowly, but we will get quite close by 2020 and meet it quite soon after.

Chair: I know that Mr Watson wants to come in and Mr Haszeldine. We will take Mr Watson first.

Professor Watson: Just talking more generally—we are in the weeds on power generation here, I think—the general picture is that gas is very important for the UK and for Scotland if you take industry, heating and everything. I think the figure is somewhere between 30% and 40%—again, I can get the precise figure. It is important to recognise in a historical context that the role of gas has been increasing since about 1970, and for most of that period that trend has been at the expense of coal and sometimes at the expense of other things, first in the domestic sector, then through industry and then in the 1990s through power generation as well. That has had some benefits in terms of CO₂ emissions reduction. Gas has played quite a positive role in the UK-wide story on emissions reduction.

Gas demand and use in the UK peaked probably about 10 years ago, and it has declined pretty sharply over the last few years. It is now at about



80 billion cubic metres UK-wide. Going back a few years, it was 100 billion. It is already on the decline, and that is the context in which we then have to look forward and see what the role of gas might be in the future. It is important to recognise that context because I do still hear comments from the gas industry in particular, and sometimes Government, about the role of gas as a bridge towards a low-carbon future. The point for the UK—this is very much a UK point—is that we have already travelled just about all the way over that bridge. We are about to get off it. The bridge is not ahead; it is behind us.

Professor Haszeldine: I agree with Professor Watson that gas is a very important fuel now and in the immediate future. That is both for generating electricity through gas-fuelled power stations, but also, of course, continuing to generate heat for industry and for 80% of dwellings in the UK. I agree that gas has often been displayed as a bridge to the future. We have crossed that bridge, we are now in the future and we now have to face the consequence that gas still has lots of carbon emissions associated with it. How are we going to go from the bridge into the green fields of zero carbon we talked about earlier on?

That is where we are going to have to make some very difficult choices in the UK. Those choices are: do we continue to extract gas from our own part of the North sea and from west of Shetland and import gas from Norway? Are we going to continue to burn that? If we do, then we will have to install carbon capture and storage to take the carbon emissions away from that so we can still have the benefit of the fossil fuel, but without the carbon emissions. We have to get on very rapidly, immediately now, and start developing that carbon reduction strategy, because we have been sitting on our hands, going around in circles—to mix metaphors—for 15 years on that.

The benefit of doing that is that we can also store energy from summer into winter. At the moment we use lots and lots of gas in the winter by extracting more and more out of the ground, but if we want to decarbonise our gas and perhaps turn it into hydrogen, we are going to have to do that in the summer and use that in the winter. There is a factor of between four and six difference in the energy consumption in the winter and in the summer from gas. If we do not do that, we are going to have to build unprecedentedly large amounts of renewable electricity for clean, zero-carbon electricity. At the moment we do not know how to store that between summer and winter economically, in my opinion.

In neither of those circumstances does production of additional oil really figure. Production of gas and decarbonising that gas figures large. Again, it is disappointing to see that the oil industry has not recognised that imperative.

Q182 **David Duguid:** Many of the answers raise many more questions, but I will just go back to the one question that sprung to my mind when I



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caught the Chair's attention. Does the panel recognise Oil & Gas UK's estimate that the UK will still have two thirds of its primary energy source from hydrocarbons by 2035?

Professor Haszeldine: It depends on the pathway we take through the future. If the decarbonisation pathway is enacted as the Committee on Climate Change proposed, then we should be well underway for a transition to low-carbon vehicles, both cars and heavy goods vehicles powered by electricity and potentially by hydrogen; we should be well started on decarbonising heat to people's houses and to industry; and we should have increased our capacity for generating renewable electricity. Therefore, the proportion of fossil fuels in the mix for all energy should be decreasing rapidly.

Professor Watson: The time horizon, 2035, is quite interesting because that is the time when the futures do start to diverge quite significantly. Part of the reason that they might diverge is whether you have CCS in the mix or not. The endpoint in 2050 is starkly different for a CCS scenario and a no-CCS scenario in terms of meeting your 2 degrees and your climate target. Around 2030 to 2035 is when those two scenarios start diverging. I can see futures where what they say is probably true, but it probably depends on us having started down the CCS path more than the no-CCS path.

Q183 **David Duguid:** Do you think that is why the Oil and Gas Authority have called this "Vision 2035" rather than a "Vision 2050", because that is about as far as—

Professor Watson: You need to put both visions together, otherwise you might get a false sense of security about how much oil and gas we can have. Pretty soon after 2035 you might find it dies pretty rapidly. If you look at the National Grid scenarios, the most recent ones, that is when you see those divergences coming in.

Q184 **Deidre Brock:** It is interesting that you mentioned, Professor Haszeldine, the role that hydrogen energy will play in the UK's future energy mix. I know it is most commonly created using gas, but I visited EMEC in Orkney recently and was fascinated by the production of hydrogen energy and then storage through marine renewables, and I noticed that France recently piloted a boat using a hydrogen fuel cell. I would be very interested to hear your thoughts on what part that can play.

Professor Haszeldine: This is a big potential opportunity that is currently being researched, costed and investigated. If hydrogen can be produced from diverse sources, then it can replace a lot of the uses for fossil hydrocarbon we have, as methane gas or providing hydrogen into fuel cell vehicles. Again, on the Clyde, we are building the first hydrogen fuel cell ferryboat in the world. That is something tangible in the UK.

How that happens as a pathway remains to be decided in the dance between costing and pricing and the dance between Government policy and regulators. If that went in a sensible direction, you could see a rapid



opportunity to produce hydrogen from methane gas by chemically splitting methane into carbon dioxide and hydrogen. You would then have to take away the carbon dioxide, store that below ground and put the hydrogen into fleets of vehicles, or into spiking into the gas grid, and progressively decarbonise the use of methane gas in that way. That also has the advantage that you can store the hydrogen underground from summer to winter. Again, you can in principle get around that inter-seasonal storage problem.

As an example of that, you may be familiar with prospects for the Hydrogen 21 project from Northern Gas Networks to decarbonise Leeds by putting hydrogen into the gas grid, or for Cadent Energy to decarbonise north-west England. Today in Aberdeen there should be an announcement by Scottish Gas Networks about starting a project based around St Fergus in north-east Scotland, where one third of the gas supply comes onshore, to generate hydrogen at that site of import, take away the carbon dioxide offshore for storage and feed that hydrogen into the gas grid for Aberdeen. That is an example of how the future is knocking on the door right now. We do not need to wait for these things. They are waiting on UK Government policy being more certain.

Professor Le Quéré: The Committee on Climate Change is currently writing a report on hydrogen as a fuel source. It will be published at the end of November. I do not have conclusions for that, but it does look at the demand for hydrogen in the heat industry, HGVs or trucks, and buildings. It looks at a range of scenarios in hydrogen. From this report, I cannot give the outcome yet, but it is clear that carbon capture and storage is an absolutely critical part of this. Without this, there is no hydrogen economy at all. It is also clear that hydrogen can be deployed in industry earlier than in heating, for example. Heating would be in the 2030s—that would be the start of deployment of that. It does not change the picture ahead of the 2030s, but it potentially could make a huge difference in the demand for gas, for hydrogen, beyond this.

At present, we have looked also at a way to convert to hydrogen. Gas reforming is the cheapest way, but it is not the only way. There is also the potential to produce hydrogen from bioenergy in the UK, to produce hydrogen elsewhere in renewable energy and to import it in the UK.

Q185 **Deidre Brock:** Yes. Electrolysis.

Dr Dixon: It seems to me that the Government continues to back two horses, but one of them is becoming more and more untenable. Hydrogen, to me, seems like a dead end. There may be some specialist uses, and the inter-seasonal storage that Stuart Haszeldine has mentioned may be an important application for hydrogen. That hydrogen could be coming from renewable energy—renewable electricity doing electrolysis. You could have your wind turbines spinning away in the night when no one wants that electricity. You might store that for the next day, but you might be storing some for the autumn.



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Q186 **Deidre Brock:** Or indeed the highs and lows of tidal, which is the example I was thinking of.

Dr Dixon: There may be an application for hydrogen there, but in terms of the two other big applications that you might think of for hydrogen, in transport we have a commitment by both the UK and the Scottish Governments to do away with the need for petrol and diesel cars and vans, in the Scottish Government's case by 2032, and in the UK Government's by 2040, but the Committee on Climate Change have asked them to do that sooner, so that may change. There is no need for hydrogen there because electric vehicles are getting to the stage where they can replace pretty much anything in the car and van range.

Some years ago, the UK Committee on Climate Change talked about hydrogen being very important for HGVs in the future because electric vehicles would not be up to that for a very long time. Next year, Tesla will sell you a lorry that can pull 40 tonnes from here to Edinburgh. Already we are ahead of that prediction from some years ago, which was not Corinne's fault at all—things move on. We are going to see electric HGVs. Of course, they are going to be terribly expensive to start with, but the technology is pretty much there. The scale of the vehicle and the mileage you might want are pretty much there from next year, and Volkswagen and Mercedes are also producing these kinds of vehicles in a smaller scale.

Buses are another application where you might say hydrogen is the future. There are hydrogen buses on the streets of Aberdeen and Dundee, but there are electric buses on the streets of Glasgow, Edinburgh and Inverness. Again, there are two horses. Government continues to try to back both, and it seems to me that we should not. We should just go for electric because it is getting to be good enough.

The other application, just very briefly, is heating homes. If we replace natural gas with hydrogen, just as we did when we went from town gas to natural gas, you have to change the systems. You have to change appliances, either refit them or completely replace them. That is a very large effort, and hydrogen is more explosive, so you have to do more on safety. Why do that when every house already has an electricity connection that could be doing your heating for you? A big transition to electricity seems much more sensible than hydrogen.

Deidre Brock: I do not know if Professor Haszeldine wanted to come in there, because I was looking at—

Chair: What we are going to have to do, because we have lots and lots of questions, and I know that a lot of people are desperate to comment on all the points—though we are very grateful—is just cut down on the repetition, if we can. If somebody has said something already, we will leave it at that. We will maybe just move on, Deidre. I know you have another question.

Q187 **Deidre Brock:** I wanted to ask next, shifting on from that particular



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topic, about the opportunities that the energy transition offers the oil and gas industry. There has been quite a lot of talk so far from witnesses to this Committee, and I wanted to hear about this in terms of skills transfer and diversifying the supply chain. What are your thoughts on that? What are the possibilities and opportunities there?

Chair: We will let Mr Haszeldine come in first with that one, given he did not get in the last time.

Professor Haszeldine: Clearly there are multiple opportunities, should the oil and gas industry as an industry wish to take them or should individuals wish to take them. The first thing I want to mention is the opportunity for reusing infrastructure from the oil and gas industry. If we go down one route, we could make the oil and gas industry take away everything immediately—rigs, pipelines—so that as soon as they are finished those have to be decommissioned and dismantled. That is an expensive route. I am aware there is an emerging strand of work that argues that some things may be environmentally better to be left in situ. I am not personally an expert on that, but I acknowledge that exists.

What I want to focus on is the opportunity to reuse the pipeline networks that are ramifying offshore. In particular, some of those pipeline networks can be really useful if we want to develop carbon capture and storage because we can reduce the entry cost and the capital cost of developing the pipelines offshore, and we can use existing geological structures for storage of CO₂ offshore. We can use the knowledge and we can use the pipeline networks to do that. As an example of that, the Acorn project in north-east Scotland calculates that, by reusing the pipeline, we could develop transport offshore for about £30 million or £40 million, whereas if they have to build a new pipeline from scratch, it might cost £200 million.

What bothers me is that the Oil and Gas Authority has the responsibility for doing this, but seems to be fairly slack on looking for these alternative uses. There is no intermediate body trying to enable sensible reuse and recycling of this infrastructure, and that is a huge problem for developers trying to develop carbon capture and storage.

On the topic of individuals being skilled up and transferring their skills, clearly that is possible. There are lots of skilled people in the North sea. I will defer to Professor Watson, who I had a chat with earlier on before we came in, who has some information on that and is better placed to answer.

Professor Watson: Thanks, Stuart, that is very kind of you. Yes, I would agree there is a lot of scope for skills transfer, particularly with the growth of offshore renewables, among other things. It has been talked about in generic terms for a long time, but when you get into the detail it is probably a combination of how many of those skills are transferred, what is similar, and to what extent Government and industry are



supporting skills transfer by specific schemes. Sometimes it is not just a case of saying it is possible; you have to help people to transition.

I was just looking up some of the figures from one of the schemes that is in place, which I think is called TTF. I cannot remember what the acronym stands for. On the website it said it had helped several thousand people in terms of retraining in the oil and gas industry, which looked impressive, but if you dig into the detail, the number who have moved from oil and gas through that scheme into the renewables sector is in the few hundreds—I think 300 or so. It is making a contribution, but at the moment my impression, at least from that scheme, is that it is relatively small.

Of course one of the things that makes a difference to that is how much demand there is on the other side of the fence for job creation in the renewables and the low-carbon industry. If you look at the Scottish energy strategy, the contrast is still quite stark. I think the numbers in Scotland are around 58,000 in the low-carbon and renewable industries directly and in their supply chains, and 115,000 for the oil and gas industry plus supply chains and so on. There is a two to one difference. That illustrates the fact that you need to do the supply push on skills and help people with transfer and retraining, but you also need to do something about the demand in terms of growing the market for the renewables industries as well.

Dr Dixon: There is a potentially virtuous trio of initiatives in Scotland that may move this forward. One is the Just Transition Partnership announced recently, which has a chair but no other participants yet. It will probably start working early in the next year, and it will work for two years to advise Ministers on how to do a just transition in Scotland—not just in the oil industry, but that will no doubt be a big part of their work. The industry will feed into that, workers will feed into that and unions will be sitting around the table. That is a very important initiative—one of the most advanced in the world in terms of that subject.

We also have the commitment to have a Scottish national investment bank. That is some billions of pounds that could go into useful things, which will create some of those opportunities for people who are in a transition. Then we have the prospect of a publicly owned energy company—again a company that is commissioning actual energy schemes and that, again, could be doing the right thing.

There are three things that could, if they are done right, work well together to make something of a reality of a just transition in Scotland, but the key thing that will make that succeed or fail is UK Government policy on renewables. The clean growth strategy has some enthusiasm for offshore wind. That is very helpful. As Jim Watson said, there are lots of transferable skills from the oil industry in that. That is good, but UK energy policy is desperately unenthusiastic about onshore wind, about solar, about community-level schemes and about tidal and wave energy.



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Even if only in Scotland, through UK policy, there was more of a focus on those, that would help with the transition. Perhaps the Committee could urge the UK Government to look at geographical differentiation of energy policy and the energy market support mechanisms so that Scotland can be an example of just transition, even if it is slightly different policy from the rest of the UK.

Q188 Deidre Brock: Can I just ask a very quick question about marine renewables and their place in the industrial strategy the UK Government is currently working on? Are you aware where they are on that particularly—what place they are at?

Dr Dixon: The feedback we get is that offshore wind is a high priority, but for wave and tidal, wave is clearly some time off. That is not a priority. It needs money for R&D. It could be absolutely huge, but you have to invest the money to get the machines to survive out there in the harsh seas, basically. Tidal is doing quite well, but again it is not a Government priority. There is not money going in to make it a commercial reality, even though the test machines are doing really well. Again, there is quite a bit of good potential for tidal schemes that could be done environmentally sensitively and produce very significant amounts of energy, but there is not really a mechanism.

The final part is energy storage. We have some very good pump storage schemes in Scotland, where water is pumped up the hill when there is spare electricity, comes back down and makes electricity. It is very important, and it is the quickest thing you can switch on to fill a hole in the National Grid, but it is very expensive and there is no mechanism in the current market system to incentivise building any more, yet it is exactly what we need to complement intermittent renewables.

Q189 Christine Jardine: I wanted to go back to something you mentioned. Forgive me, there may be a very sensible, clear answer to this, but like Ms Brock, I am interested in hydrogen. You talked about electric cars rather than hydrogen cars. What is the balance between the energy that is needed to produce the hydrogen for hydrogen cars and the electricity that needs to be produced in terms of CO₂ emissions from power stations and so on to power electric cars? Are we still having to produce CO₂ in order to have cars that run on electricity, which we would not have to produce if we used hydrogen?

Dr Dixon: If that is addressed to me, I will start with that one. The energy balance is probably quite similar. Electric cars are very efficient compared to an internal combustion engine, in which something like 20% of the energy in the fuel is getting to the wheels and moving you along. In an electric car that is more like 85% or 90%. Hydrogen could be the same level of efficiency. It depends how you do it.

If you make hydrogen from natural gas, you then have to deal with the CO₂, so you have the big infrastructure of thinking about CCS as well. If you want hydrogen as your main transport fuel, you have to create a new



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network across the whole of the UK so that every petrol station becomes a hydrogen station. That is a huge investment that I cannot see happening, because you can just buy an electric car and you can plug it in at home or you can plug it in at any petrol station. That seems like it is not going to happen.

In energy terms, they are kind of similar, but you are quite right, if you are having electric cars, you need to have enough renewable electricity to make sure that the climate consequence of those vehicles is as low as possible. We might also want fewer cars so we have less congestion, but we certainly want cleaner cars.

Q190 **Christine Jardine:** What about the grid? What is the capacity of the grid to cope if you use electricity for absolutely everything?

Dr Dixon: There is no doubt that, in many cases, local grids would have to be reinforced. The grid is there to provide a bit of heating, a bit of lighting and to run your TV. It is, in general, not there to charge up cars overnight and to provide all your heating and water heating, which is what we might want it to do in future. In many cases, local grids will have to have money spent on them to improve them to the state where lots of people can plug in their car overnight.

Chair: I know that Ms Le Quéré is keen to come in and Mr Haszeldine. Is that all right with you, Christine?

Christine Jardine: That is fine, yes.

Professor Le Quéré: It was on a different topic. It was on your question here about the opportunities, if I may just come back quickly to make a point that there is an issue of timing with the decommissioning of wells in terms of capturing the opportunity for CCS. The moment that the well is decommissioned is the opportunity to do a cost saving in terms of conversion to CCS. The well itself can be capped and maintained for a while, but the pipe needs maintenance and there is a window of opportunity to do that. This has to be looked at in terms of capturing the opportunity so that it happens at the right time for a variety of decommissioning locations.

Professor Haszeldine: If I could come back to Christine Jardine's question, I am somewhat more cautious about the optimism of electrifying everything, because we have to think that, in our overall energy use in the UK, let us say roughly a quarter of all our energy is electricity and another half is heat. If we are trying to electrify heat, we need to generate a huge amount extra. We need to double or treble the amount of renewable electricity to feed into our heat supply, and we also need to overcome this huge imbalance between the seasons of winter and summer. For the electrification proponents, that is still quite an unsolved problem.

We also should not underestimate and should realistically cost the cost of reinforcing and increasing the electricity grid. At the moment, we have a



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gas pipe going down the street you live in and we have an electricity cable. The electricity cable provides heating for maybe a few houses, not very many, and it provides light and may provide cooking. But if we have to replace the gas pipe with an electricity cable, we need not just a thin electricity cable but a much bigger electricity cable to power people's houses. If we then add on the power for transport, which is another quarter of our energy use, and we are trying to charge up our electric cars overnight, that becomes very difficult without huge reinforcement of the electricity national grid and also the distribution system.

I have seen cost estimates comparing the cost of putting hydrogen through an existing pipe network at very little extra cost with the cost of increasing the electricity distribution network and there is a factor of 10 difference. Hydrogen is 10 times cheaper to convert than the cost of electrifying everything. Both are viable in terms of low carbon, but the cost of the least-cost transition is quite different.

Chair: Quickly, Mr Watson, because we do not have much time left.

Professor Watson: Just as a contradiction to Stuart—we are not going to agree with each other, for a change—if you look at some of the heat decarbonisation scenarios done for the National Infrastructure Commission and the Committee on Climate Change, they show the electrification route and the hydrogen route are very similar in terms of cost nationwide.

Q191 **Hugh Gaffney:** There is a lot of talk about carbon capture and storage. Can you outline broadly how it works, Stuart?

Professor Haszeldine: In essence, it is simple. In detail, it is difficult. In essence, it is about taking a fossil fuel, whether it is coal, oil or gas, but let us just focus on gas for the UK. At the moment, we burn that to methane gas, which is carbon and hydrogen. The products of that combustion, being carbon dioxide and water, go into the atmosphere. Both those gases can cause warming of the earth, acidification of the oceans and therefore rise of sea level. All those are really bad consequences. What carbon capture and storage does is try to capture the carbon dioxide and reduce that emission rate into the atmosphere so we can have the benefits of the fossil fuel without most of the side effects. That is how it is conceived in terms of power plant, heating and so on.

I will also go back to what I think Professor Le Quéré mentioned right at the start, that we are also going to need to recapture carbon from the air to reduce the carbon already emitted. If we recapture carbon dioxide from the air, we are going to have to put that underground as well. It is a similar process, but sieving carbon out from the air, not just sieving carbon out from flue gas.

Q192 **Hugh Gaffney:** What changes when it comes to Scotland, particularly in the oil and gas industry?



Professor Haszeldine: In Scotland, we have done work over the past 15 or maybe 20 years now to show that what is needed for carbon capture and storage is a willingness or ambition to carry on using fossil fuel, but to decarbonise that fossil fuel. If you decarbonise it, you have to build the equipment. We have some engineering capability. Scotland has firms and companies who can do that. The UK has firms and companies that can do that with their own supply chains.

You then need to transport that carbon dioxide, for which you need to build pipelines. As I mentioned earlier on, we have the opportunity to reuse existing pipelines. For example, there is a former gas pipeline in Scotland, the Feeder 10 pipeline, that heads from central Scotland up to St Fergus. We can reuse that. We can reuse pipelines from St Fergus out to storage sites beneath the North Sea. We can transport CO₂ through those pipelines and then inject it into geological pore space reservoirs, where there are microscopic spaces between sand grains. The carbon dioxide can stay there for thousands of years into the future, which is the timescale necessary for the climate to return to its pre-human condition.

That is the simple pathway to do it, but of course that means joining up industries and businesses. The key thing that is missing is making a market for storing CO₂. There is no profit to be made by businesses and industry out of storing CO₂ at the moment, unless we put prices on carbon, for example, or a mandate, as was discussed earlier, or make companies clean up the consequences of their production. The oil industry has a huge part to play, but it is disappointing that only very few companies take any sort of interest in that.

Q193 **Ross Thomson:** Very nicely following on from that last point, we have heard as part of this inquiry from other witnesses that it is not currently commercially viable to deploy carbon capture and storage technology on scale. Do you agree with the assessment that they have made?

Professor Haszeldine: It is not viable because there is no price on carbon dioxide in the way we price carbon and fuel extraction at the moment. As Dr Dixon outlined much earlier on, if the damage that does to the environment was properly priced into the fuel to reflect the true cost of using that carbon fuel, then carbon capture and storage would be viable immediately and companies would immediately find ways of doing that, either making money or saving money, depending on which way you look at it. That is a serial failure of UK Government policy to set either an adequate price on carbon or to put a mandate on asking or forcing companies to store the equivalent amount of carbon. At the moment we are in the realm of special projects and special grants, and there is no long-term business there. Companies have to trust the UK Government will do what they say, and serial events over 15 years or so show that that trust is sometimes difficult to guarantee.

Q194 **Ross Thomson:** On that point, the CCUS Taskforce recommendations were for a stable, long-term and supportive policy environment to facilitate that investment. From your point of view, given that Scotland



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has two Governments, the Scottish Government and the UK Government, what could they do together to help create that environment?

Professor Haszeldine: I think you will find the Scottish Government is very keen to try to act on carbon capture and storage as part of its overall climate policy, but the Scottish Government does not hold enough of the financial levers to pull that forward and guarantee a reliable industry for 15 years of development for the first projects and an industry that is going to carry on for 40, 50 or 60 years of transition. There is lots of scope for both Governments to work together.

One example I could give you just now is that, over the years in Scottish carbon capture and storage, we have worked to get UK projects recognised by Europe as part of the Connecting Europe facility, which builds infrastructure for pipelines for gas, electricity or carbon dioxide around Europe. We have the only project in Europe in that at the moment, which is the Acorn project I mentioned earlier on, going from St Fergus to storage offshore. We could start that project immediately. We could have carbon dioxide in the ground in 2022 or 2023. It would be the first operating project in Europe at scale. The Scottish Government have put money into that. The European Commission have indicated they will give us the first slice of money to cost that out and plan the engineering of that.

What we are waiting for is a very small amount of money, a small six-figure sum from the UK Government. Every time the project goes to dialogue with the relevant Government Departments in Westminster, more questions are asked and more evidence is asked for. Eventually the UK Government has to make a decision on doing this, otherwise time runs out. These projects have a finite life. By packaging all this together, we could effectively get this first project for half price or a quarter of the price by bringing in these extra moneys. Unless UK Government acts on that within the next few weeks, we fail and we lose the project.

Chair: Thank you for that. I know Mr Watson has to go because he has a flight to catch. Is there any contribution you want to make on the CCS issue?

Professor Watson: Yes. Thank you very much for that, and I apologise for having to leave at 11.30 am promptly. I agree with a lot of what Stuart said. This has been going around in circles for a long time. We have had opportunities to invest in CCS, and they have fallen through, often at the last minute. This is a challenge we share with many Governments around the world. The number of projects that have not left the drawing board is very large if you look at Australia, North America and the rest of Europe. It is not just a UK problem.

The issue is that these are very capital-intensive projects. They take a lot of money. They require public money, and they require public policy change, and there is not, as others have said, a market or a commercial proposition unless that is done. Yes, by all means let us price carbon, but



even then you would need to price it in such a way that it would be high enough for long enough to give investors certainty.

A lot of other people think you need some sort of public agency to get involved and develop infrastructure for clusters, and then you could maybe have a competition for people to build the plants and give them a target price to meet. I would recommend the report from Ron Oxburgh and the Cross-Parliamentary Group on CCS, which came out with some pretty good and innovative ideas about how you could structure institutional reform and policy in order to get some of those clusters off the ground. The recent taskforce was fine, but it sat on the fence about a lot of this and did not take us forward.

David Duguid: Professor Haszeldine, St Fergus is in my constituency, as is Peterhead. I am not going to take up too much time talking specifically about how the Acorn project could do—maybe another time. I am in the process of trying to set up some time to find out more about it.

Professor Haszeldine: Thank you very much.

Q195 **David Duguid:** I was hoping to do so before this session, but unfortunately I was not able to. I was just trying to Google there, because my understanding was that there was UK funding already allocated to this project. Is that not the case?

Professor Haszeldine: All these projects proceed in steps. To achieve the destination, you need to ascend the whole flight of stairs to get to the next level. Yes, the Acorn project has benefited from co-funding between the Scottish Government and the UK Government. That has got it to the state it is in now, where the project knows exactly what pipeline it wants to use, what equipment it wants to use, what the destination is and when it wants to start. There is a proto-plan for exactly how to construct that and when, which is why I can assert that it could be working by 2023. The next step the project—it is not my project—is now seeking funds for again involves co-funding between the UK Government and the Scottish Government, and it is trying to bring in this European money, which is a unique opportunity.

With Brexit, unless we act now to acquire that money, we will lose that money. It can be worth many, many tens or even hundreds of millions of pounds, ultimately. The next step only requires a few hundreds of thousands of pounds to do the more detailed engineering design and to start on that costing profile, which is a standard type of process for an engineering project. That is what we are trying to do, but unless we take the next step, we do not ascend the staircase.

Q196 **David Duguid:** I am sure that will come up when I talk to the Pale Blue Dot guys.

The main question I was going to ask next was in terms of CCUS. I would like to get the word “utilisation” in there, because that is a very important part of it. One of the CCUS Taskforce recommendations was to separate



the business model for the capture of CO₂ from the transport and storage. Can you explain the thinking behind that recommendation?

Professor Haszeldine: Yes. I was on the CCUS Taskforce and on the Oxburgh report, which Jim Watson mentioned before he departed. The idea of separating the capture from the transport and storage is there are different types of companies doing different types of business. What we are trying to do is recognise that the enabling of this is through a network of transport leading to storage. That is the pathway, and then we are asking individual sources of CO₂, individual companies or businesses, to lock into that network. It is a bit like having a gas pipe network or a telephone network is very useful as a network for transporting stuff, but just having a telephone on its own or a computer on its own is much less so. The capture part is the computer or the telephone; the enabling part is the network.

Both of those reports took an analogy with existing networks, whether it is the phone network, whether it is the gas grid or whether it is a Tube line network in London. There is a skill and a benefit in developing the network that is separate from the high technology part of doing the capture. Linking those together, as the UK tried to do in its first carbon capture and storage projects, is very difficult in terms of business, and in terms of money and who takes what risk. Separating them out means they can develop separately and in a more cost-effective way to reduce the cost of the overall projects. That is the ultimate objective, to bring the cost of the projects down to half or a third of what was originally stated in 2011.

Q197 **David Duguid:** That is good to know. That is as good a reason as any—to improve the cost-effectiveness. I looked up the National Audit Office report on CCS from January 2017, which explained why there were the two competitions that were launched and then abandoned in 2007 and 2012. There is a summary here that it was all about cost, essentially. There were a few technical issues, but it was mostly about the cost to consumers through the Contract for Difference funding mechanism that would have found its way on to our energy bills, and other cost issues. Obviously it is almost two years ago now that this report was written. Have steps other than what you have just described been taken to improve cost-effectiveness even further?

Professor Haszeldine: Again, numerous analyses have been done on this serial times, and there are different ways of reducing costs. You can reduce cost in the technology of the capture process, and that is a slower technological development, which is a global development. That will continue to reduce costs of carbon dioxide capture from, let us say, £70 a tonne of capture maybe down to £30 a tonne, or even £20 a tonne in some places. The real big benefits of short-term cost reduction in the UK are clearly in terms of sharing this infrastructure, sharing this pipeline network, sharing the compression facilities to make the CO₂ into a dense liquid, sharing the offshore pipelines and sharing the destination for that. That is why this concept of clusters of capture, leading to shared



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transport, leading to clusters of storage has been developed, because that is the way of reducing costs by almost 50%. That is where the oil industry has a large part to play in the offshore transport and storage part.

David Duguid: I am very interested in this idea of clusters as well, but I think someone else is going to ask a question.

Q198 **Chair:** Yes, we do not have much time. This is all to you, Mr Haszeldine, because we are very interested in CCS, and it is obviously a key part of the type of thing we are looking at today. We know that the Government are currently producing another development pathway for CCUS. I was in the House when the Government cancelled the last opportunity to look at this, and there was profound disappointment in that. We were all led to believe that this was going to be a reality and we would be leading the way, ground-breaking, an international example, and it all fell apart. Particularly in the north-east of Scotland, I remember elected representatives at that point expressing deep disappointment. What lessons have we learned from the previous failures to deliver this, and will the new pathways offer a way to secure it? We will come to you in a minute, Dr Dixon.

Professor Haszeldine: The first point is to recognise that, in most analyses—perhaps not all from Friends of the Earth, but in most analyses—the imperative to store carbon is an essential part of the least-cost transition pathway to achieve our climate objectives. We also know that decarbonising in the UK creates jobs and creates wealth, so investing in new methods of operating low carbon is a wealth-creating opportunity as well. We have also done a report on the east coast network to show that, to 2050, if you invest £30 billion, you create wealth of £170 billion. These are wealth-creating opportunities.

Government in Westminster needs to be firmly aligned with that policy. What happens is the policy is there, but then at the last minute the costs emerge and people get frightened of making that decision for developing the first one. This is really about still putting the first footsteps on the pathway. That is the difficult bit psychologically, it is the difficult bit in financial terms and it is the difficult bit in confidence terms. There are several other carbon capture and storage projects operating around the world, not huge numbers, but there are 10 or 15 projects operating. We are not the first doing this. We can gain confidence that these things work elsewhere. However, unless we have that reliability of commitment, nothing will ever happen.

Dr Dixon: I think it is hard to be confident much will come of this third go—third time lucky—of the Government being enthusiastic about CCS. When the first one came 11 years ago in Scotland, we had two coal-fired power stations. One of them nearly won the competition, but then did not quite. When the second one was running, at some time during that period we closed one of our coal-fired power stations, but Peterhead nearly won. We nearly, as you said, had two really important things happening, but



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we did not. The £1 billion in both cases turned out to be rather fictional. I have little faith that the next process will be any more productive.

More fundamentally, in most scenarios for CCS to work, it has to be coupled with enhanced oil recovery. Here is a technology that is supposed to be reducing emissions, but as a by-product of doing that process, you are creating more oil and therefore more carbon emissions. Then we can argue about what the balance would really be, but that, logically, seems like a silly thing to do.

In terms of the economics, again if you have a power station that you have attached to CCS, then because of the economics, you will be incentivised to run that power station as much as possible. CCS does not make your power station zero emissions because CCS does not capture all of the CO₂. It might be 85%, it might be 90%, but there is still a residual. If what we are aiming for is zero carbon dioxide emissions in not that many decades' time, CCS is not good enough, because it cannot get you to zero and yet you have invested in fossil fuel power stations or industry because you have CCS.

Q199 Chair: Would it be right to characterise your view on this, then, as sceptical and that this is possibly not very helpful as a means to try to meet some of our climate change ambitions?

Dr Dixon: Again, it is backing two horses.

Chair: I know Mr Haszeldine is desperate to get in. I will leave it at this time because I know Mr Gaffney has a question that might accommodate this too.

Q200 Hugh Gaffney: In a similar vein, the proposed oil and gas sector deal has CCS as one of its areas of focus. Given what you have just said, do you think the deal is an effective way of supporting the development of CCS? Maybe Stuart can answer that one.

Professor Haszeldine: I will agree that CCS is mentioned in the sector deal proposal, but as I stated before, it is basically three lines of associating the oil industry with other developers that are going to take that forward. What I am struck by is Pale Blue Dot, who is the company that David Duguid mentioned earlier on, where engineers have worked in and are coming from the oil industry and see a different way to apply their skills, talents and knowledge in developing carbon capture and storage, and the transport and storage part in particular. The oil industry can do that sub-surface part. It is accustomed to organising large and complex projects.

Where I differ from Dr Dixon is that the proposition that CCS can offer is not just in power, but also low-carbon heat and decarbonising industry. All of those sectors have huge CO₂ emissions across the economy that are difficult to decarbonise in other ways. The projects I described earlier on, about making hydrogen to put into the gas grid, are very different ways of seeking to develop carbon capture and storage, because the



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hydrogen distribution organisations are the gas companies, which are Northern Gas Networks, Cadent and Scottish Gas Networks in Scotland, who are customers for clean hydrogen. They want to buy clean hydrogen, which can be made by splitting methane gas, and part of that purchase price for clean hydrogen includes the CO₂ takeaway and storage.

Q201 Chair: We are trying to get through a few more questions, but I am interested in Ms Le Quéré's view on this and what the view of the Committee on Climate Change is on CCS.

Professor Le Quéré: The Committee on Climate Change has always said that the cost-effective pathway to decarbonisation needs CCS for a number of reasons—decarbonising difficult pathways. In order to reach net zero emissions—the Scottish Government have said they want to have a net zero emissions pathway, but there is not at the moment one that is technically feasible—carbon capture and storage is essential, associated or coupled with greenhouse gas removal from either biomass energy or direct air capture. These two technologies have the potential to fill the gap between the residual emissions in 2015 and net zero emissions. Therefore, the development of this technology is, in terms of the cost-effective pathway, essential.

If you look at the global picture as well, the Paris Agreement calls for a net zero common balance in the second half of this century. The lower the warming, the more we need to rely on this greenhouse gas removal. There are pathways that do not rely on greenhouse gas removal coupled with CCS, but they have really drastic reduction in emissions now, which is very difficult to achieve. They are not cost-effective pathways.

In terms of the lessons learned from the stop and go in projects, one is that is very damaging for trust—to stop and go. We have said this in the Committee. Separating the capture from the transport and storage allows us also to separate, or to think more carefully about, the share of the risks in the long-term longevity and reducing the leaks or monitoring the leaks, and it enables the capture element of the technology to be developed by more actors.

This is a reasonable way forward. The Committee has recommended this year that the Government publish by the end of 2018 a detailed plan of what they plan to do with carbon capture and storage, with the ambition that there are clusters of carbon capture and storage already in the early 2020s and that deployment already upscales in the early 2030s.

Q202 David Duguid: I could talk about this stuff all day. Apart from the fact that Peterhead and St Fergus are in my constituency, I come from the oil and gas industry, and I am a recovering chemist as well, so it is a fascinating subject.

I wanted to ask a very quick question, Professor Haszeldine, about what you were saying earlier about the use of existing infrastructure, and pipelines in particular. Obviously these existing pipelines were used for oil



or a mixture of hydrocarbon gas—mostly methane. In terms of all of a sudden using that for CO₂, which I know to be corrosive to what these pipelines are made of, has that been considered, and the fact that these pipelines have already been there for 30 or 40 years in some cases?

Professor Haszeldine: That is a perfectly good question. That is a very astute question, of course, because safety is the priority in all of this. The particular pipelines I am exercised around at the moment are going from St Fergus to the site of the previous Atlantic field, and the site of St Fergus to the previous Goldeneye gas field. As happenstance would have it, both of those fields contain methane gas, but with a mixture of carbon dioxide and a mixture of hydrogen sulphide. Those particular pipelines were built only a few years ago. They are perhaps 10 or 15 years old, so they are quite new, but they were built to be corrosion-resistant. They are especially suitable for reuse and redevelopment as carbon dioxide transport pipelines.

If the UK lets this opportunity slip, it is negligent, it is increasing the cost and it is delaying the capture of carbon dioxide, which we need—as we saw from the IPCC report—to be leading on and to be doing as fast as we can. Here is a golden opportunity, that will not occur again for the UK, to take genuine global leadership rapidly—almost instantaneously. Claire Perry in BEIS has an international carbon capture and storage meeting in Edinburgh at the end of November, and that is an ideal opportunity to announce Government backing to support that project at that time.

Q203 **Chair:** Thank you. To wind up, I have a wish-list question. We always try to end with a question like this. We have had the tensions between the Government's efforts in terms of climate change ambitions and the activities in the oil and gas sector. If there was one thing that the oil and gas industry could do to make sure that it could be much more compliant with what we are trying to achieve with climate change targets, what would that be? We will start with you, Ms Le Quéré.

Professor Le Quéré: To develop carbon capture and storage would be the one thing, which we have re-emphasised and mentioned already today.

Chair: I am grateful. That is very precise. Mr Haszeldine.

Professor Haszeldine: To develop and enact carbon capture and storage at an increasing percentage of its product every year, to store 1% of the total carbonate it produces, store 5% and then store 10%, progressively increasing until it reaches 100% by 2050.

Chair: I suspect I am going to get a different answer from you, Dr Dixon.

Dr Dixon: The industry obviously knows that there will be an end at some point, because we will not be able to get any more oil and gas out. I think it needs to acknowledge that the end will come before it actually runs out and to engage enthusiastically in making sure that, while it still



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exists, it is a good industry for everybody but there is a plan to do something else better.

Chair: That is great. That is a really positive incentive. Thank you all very much. If there is anything else that you feel that you could usefully contribute to this Committee, please make sure you give us further submissions. I am grateful for your contributions today.