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Q&A: Professor Paul Younger speaks to Rhiannon Garth Jones about the UK's energy mix, and where our R&D focus should be.

Professor Younger took a BSc in Geology and read his PhD in Groundwater Engineering at the University of Newcastle. He gained first-hand experience of the groundwater and hydrocarbon industries as a Harkness Fellow from 1984–86, based in Oklahoma. His current research focuses on low-carbon geo-energy and minimising the environmental impacts of unconventional gas development.

How do you see the future of fossil fuels affecting the UK energy mix in the future?

In the absence of any large-scale storage technologies - which don't yet exist at anything like the right scale or cost - we're going to have an ongoing dependence on natural gas, certainly, to make sure we can match demand to supply. Whenever you raise the need to match these with renewable energy enthusiasts, they respond that storage will sort it, but the only grid-connected large-scale storage we have in the UK at the moment is pumped-storage hydropower and we've only got five such stations. If we were going to use that technology, which is the cheapest and most secure grid-scale storage technology that we currently have, we'd need 200 stations. So we'd have to look at other forms of storage but none of the rest are mature, or even remotely as economic. Until they are, to ensure that demand is matched by supply, we'll need fossil fuels for decades to come, I believe.

Being dependent on gas is much better than coal, because the carbon emissions are much lower. Obviously, the lowest carbon emissions from fossil fuels will come from indigenously produced gas but, since North Sea gas production has been in steep decline for years now, our onshore sources of gas is where we should be looking – predominantly shale, but perhaps also coal-bed methane. There is also the prospect of a new subsea industry producing synthesis gas from coal by *in situ* gasification, with reinjection of the CO₂ to decarbonize the process.

Do you think there's been any significant change in the debate over shale?

There certainly has in Scotland, although I think in the UK overall the shift has been a more gradual one, towards a qualified acceptance, subject to safety caveats and other concerns – none of which are more significant than those for offshore oil and gas, really.

In Scotland, though, the debate was politicised after the Scottish referendum. Looking for a new issue over which to have a fight with Westminster, the 'yes' lobby rapidly transferred their attentions to unconventional gas, including shale and coal-bed methane. The SNP Government has picked up on that, and I think there is now quite a poisonous atmosphere around the debate in Scotland – nobody would seriously consider trying to develop such an industry in Scotland.

As regards the EU, the previous positions, which I think were extreme, have softened and governments that had previously ruled it out altogether, such as Germany, are

now more open-minded about it. Poland has always been quite keen to look at shale gas and we're doing some work with them now, within the SHEER Project (www.sheerproject.eu).

What role do you think hydro energy could play in the UK energy mix going forward?

There's a lot more potential for hydro energy in Wales and Scotland – in my lifetime, there's been a 50% increase in annual rainfall in the north and west of Scotland so our hydro resources have been increasing as the climate has changed.

We would, however, need a bit of leadership from the Government to solve the contradictions in policy between protecting upland landscapes on one hand and providing reliable electricity on the other. Although hydro electricity is time-variable, it is much more reliable than wind or solar, and it is more available in winter, when demand is higher.

There is a general assumption out there that we could only have small-scale schemes and that the most we could increase output by would be 50%. But, considering how much progress Norway has made with it, I think we could do much more than that.

What role do you think geothermal energy could play in the UK energy mix going forward?

I think geothermal energy has large potential. Obviously, for deep geothermal energy, some parts of the country are better than others but some of those parts are quite substantial. I'm looking at it in Glasgow and Newcastle, and I know others are looking at it in Manchester and Bristol, among others. Heat pumps, of course, are very widely applicable.

Often, in the energy debate, the discussion is reduced to electricity, but that's less than 20% of the energy we use – more than half of final energy use is for heat. So decarbonising heat should be the priority. For some reason, the focus is always on electricity.

I think there's serious potential for both deep geothermal and the shallower-sourced heat pumps. The work I've been doing recently in Scotland, for instance, suggests that the deep geothermal potential there could provide half the heating needs of the entire country.

Solar thermal energy can't really do much for your heating, although it's okay for hot water. There isn't enough solar radiation to provide for heating in the depths of winter, though, and the most efficient solar panels in the world won't change that much. If the Government really wanted to change the way we do domestic heating, the first thing to do would be to put in district heating, because it's far more efficient. Then we could move from gas-fired district heating to geothermal. But also, where district heating isn't possible, it would be great if the Government

committed to helping everyone install heat pumps – that would make a huge difference. They could pass a law to simplify the planning, and subsidise the costs of employing people to get rigs out there and drill the holes for everyone who wants them.

That's a personal vision but, if we were really serious about changing how we use energy in the UK, that would be a great place to start and we could do it now. Sadly, we choose not to.

What role do you believe nuclear should have in the UK's future energy mix?

The biggest single problem with nuclear is the diabolical PR in the early days – it's never recovered from that. Being tied up with the Cold War did nothing for the public impression of civil nuclear power. I, like many other people, was quite happy to think of nuclear power being done with a decade ago but now, when we're faced with problems of base-load supply, I think we don't have much choice. Like it or loathe it, its low-carbon status and the necessity of base-load energy outweigh the other concerns.

It isn't cheap, but it's comparable to the projections for fossil fuels with carbon capture and storage, as well as for onshore wind. I think we have to recognise that, in order to decarbonise our energy, we're going to have to get used to paying more – as people in other European countries already do. Our politicians seem to want to convince us that we can have low-carbon, secure energy at lower prices than we pay now, which is demonstrably untrue – on the government's own figures.

Given the costs, I think nuclear fits neatly with decarbonised fossil fuels and renewables, and will provide a bedrock for the time-variable inputs from renewable energies such as solar and wind. There are also other nuclear options that we haven't seriously looked at yet in the UK but that Norway and China are considering, such as thorium, which doesn't have the same waste or safety issues, but has been ignored so far. Small modular nuclear reactors would be another option, as they are much safer and don't have the same decommissioning problems. They can also provide district heating. There is a lot of scope for fresh thinking with nuclear.

Given the Government's recent withdrawal of funding for CCS, what do you think its future in the UK is likely to be?

I've expressed my disgust in the press already about the Government's withdrawal of funding for carbon capture and storage (CCS) R&D. We were on track to being the first country in the world to have CCS coupled with biomass, which would have been carbon negative, and also the first to couple it with gas, which is crying out to be researched. There was no consultation, no explanation about its cancellation, and I think it's such an own goal. The Government's attitude seems to be that we're okay for the next carbon reduction target and they're not thinking beyond that – but 2020 and 2030 are just milestones, not the end of history!

We've abandoned this research like we abandoned our nuclear research and training, and we now have to buy the expertise in from other countries. It's a crying shame, because we're ideally placed with the North Sea – there's storage potential there for most of Europe's carbon emissions for many decades to come. It's criminal that we're not taking a lead on that. If you're serious about decarbonisation then CCS has to be a part of that. The Grangemouth project seems to me to be the only remaining hope for CCS at the moment.

Is there anything else you think has a role to play in the UK's future energy mix?

If we can get the costs down on tidal energy, that would be fantastic because it's so reliable and we have amazing resources. I think we have a better chance of reducing the costs of tidal than wave energy – I think that's a rather forlorn hope. Obviously, there are cost issues but the La Rance tidal barrage in France, which was put in during the 1960s, is now producing the cheapest electricity in Europe. If they'd used present-day economic thinking at the time it wouldn't have happened because the upfront costs were high but those costs were paid off over 20–30 years and now it looks like a brilliant investment – especially because tides are so reliable.

Of course, there will be incremental improvements in solar and wind but I think tidal is much more likely to be a game changer. There is no one silver bullet – it will have to be a mix of all these things – but tidal is definitely something to look at.

Do you think the UK has enough focus on R&D?

Absolutely not. We have pitiful R&D in geothermal, next-to-nothing in hydro, nothing worth speaking of in alternative nuclear cycles, insufficient in tidal. Much of the Government money for energy R&D (e.g. through ETI) is tied up in intellectual property for large companies, which I think is wrong. We should have a much broader, much more intense, much more open R&D strategy that embraces new technologies and encourages inventive SMEs.

What do you think is the single best thing that could happen within the UK energy mix for the future?

Take heat seriously, and have a national initiative to deliver domestic low-carbon heat.