R&D

Priorities for UK energy research

In last month's interview, EI President *Malcolm Brinded* CBE FREng talked about the huge improvement in the availability of energy to populations globally, as well as the continuing challenges for the most vulnerable and those in growing urban centres. In this second instalment, *Energy World* editor *Steve Hodgson* asks about priorities for the UK energy research community.

Malcolm, I'd like to discuss UK energy research priorities in the global energy context. To increase access to energy while simultaneously addressing climate change, where should the UK prioritise energy research?
Research and innovation must be our first ports of call for the biggest energy and climate challenges the world faces, especially where our trajectory to a solution is still unclear. And I should acknowledge up front the UK's proud history in energy research and innovation – some of the most significant advances have been made in universities and company laboratories in Britain.

Building on this, we should ensure we have a good understanding of **global** challenges – and then focus our research where we have some intrinsic, differentiated and sustainable capability, and have a chance of turning successful research into real national competitive advantage.

To what particular challenges should the UK energy research community address itself?
Let me start with the UK's own energy and climate challenges. Power and light vehicle transport often seem to claim 90% of the air time – and I guess almost as much of the research effort. But it's becoming easier to see the pathways to lower carbon at reasonable costs in both these areas. So I suggest the two highest priority challenges for researchers to focus on for the UK are **heat** – that's residential, commercial and industrial – and **the built environment** – and, within that, energy poverty.

In both these areas, the technical and policy solutions are much less clear.

What do you see as the biggest challenges within these two areas?
First, energy poverty. I find it shocking that 2.5mn households in the UK are fuel poor – which means at least 6mn people live in fuel poor homes; and that percentage has not materially changed in the last 15 years. This especially impacts the more vulnerable in our society, where 23% of households of lone parents with dependent children live in fuel poverty.

Progress has been made in the past few years with the increased number of fuel poor who are now in Energy Performance Certificate Band D housing – which I would suggest could be defined as 'pretty bad but not terrible'. But the 2030 target of all fuel-poor being in reasonably efficient homes at Band C or better is still a very long way off.

Solutions could include lower-cost insulation of new homes, easier insulation retrofit to old homes, or more efficient, lower-cost boilers and heat pumps. I don't know the answers – but very little R&D seems to be focused on this chronic issue.

Malcolm Brinded CBE, FREng, EI President

How about the other big challenge you mentioned, decarbonising heat?
Heat is responsible for around a third of the UK's greenhouse gas emissions. More than 80% of that heat today comes from gas, coal and oil – so this is not immediately helped by decarbonising power.

Residential sector heat is only one part of the picture – business and industrial heat decarbonisation will be key to reaching the UK 2050 carbon target. Again, this is an area where the winning technologies are less clear than for power and cars.

For example, it's clear that heat pumps, low carbon district heating and decarbonising the gas grid will all feature, but the right mix is very uncertain. What's vital, in developing technologies and evaluating options, is to take a system-wide view, recognising that artificial intelligence (AI) and big data enabled control systems, innovative business models and regulatory and pricing signals could all play as big a role in triggering impact at scale as getting the right core technology.

I don't know the pathways that will win – I just know that decarbonising heat needs more intense R&D focus.

Are there any pathways that seem particularly promising to you?
One is the potential for substituting hydrogen for natural gas in our existing gas network. I'm impressed by the studies by Northern Gas Networks and its

partners into the potential for converting the UK network to hydrogen – first the H21 Leeds City Gate project and then the more ambitious H21 North of England report. Decarbonising gas with hydrogen has potential cost and practical advantages to other heat solutions, which are worth exploring in detail.

Looking further afield now, what do you see as promising areas for UK research to have significant global impact?

Let me first stress that UK researchers should put much more priority on the challenges of low and middle-income countries – because that is where the largest impact on the climate challenge can be achieved **and** where the biggest business opportunities will lie. That said, decarbonising freight and aviation are challenges for the entire world.

Freight transport already causes 8% of all global greenhouse gas (GHG) emissions; of which three-quarters comes from trucks and one-quarter from shipping, with both growing very fast. These are areas where it is much more difficult to displace oil than in light vehicle transport.

On trucks, the International Energy Agency did an excellent review of road freight transport in 2017. Their headline reference case states that, with major efficiency and fuel mix improvements, GHG emissions would 'only' increase by 55% by 2050. I say 'only' – but that's pretty hopeless when a 2°C world needs at least a 50% **reduction** - not a 50% increase!

They then studied options to radically reduce from this reference case – such as less truck activity via AI-enabled logistics management; higher truck load factors and consolidation to bigger fleets; the use of advanced biofuels and electrification; and the introduction of ultra-efficient vehicles, with autonomous driving enabling very close proximity convoys.

How about one of the most difficult areas to decarbonise – aviation?

Absolutely. Aviation is especially challenging – and although representing only 2% of global GHG emissions today, this is set to triple by 2050, even allowing for very significant fuel efficiency increases.

There is also concern around non-carbon dioxide warming effects of aviation, from ozone and vapour trails, which potentially more than double the warming impact compared to just the carbon dioxide. So the aviation sector needs radical change – to improve aircraft fuel efficiency and to accelerate the shift to alternative fuels. In fuels, advanced biofuels seem the most promising, but are little used so far. Turbine adaptation and materials technology will presumably also be key. Surely these are prime areas for UK researchers?

The challenges of meeting global energy demand and averting dangerous climate change will require herculean effort. Do you think the UK has the right approach overall?

I am truly optimistic about what innovative technology and business can together achieve, given the right enabling policies and financial support. Let me stress, we are surely right to want the UK, the EU and the OECD to maintain their records of improving energy efficiency and reducing GHG emissions at pace. However, that's almost a sideshow in terms of where the world's climate future will be played out.

Look at the IEA forecasts. Even on its 'New Policies' scenario, the world's energy demand is still expected to grow by over 25% by 2040, driven by development in Asia-Pacific, Africa and South America. The real priority is to find lower-carbon routes for this growth, which surely represents a major opportunity for UK research and for UK-based entrepreneurs and investors.

I gave evidence last month to the Commons Science and Technology Select Committee on just this point. That the government's industrial and clean growth strategies could achieve more for the UK economy and for overseas development, and much more in terms of cost-effective global GHG emission reduction, by setting their sights beyond the UK's shores and supporting early-stage innovative start-ups focusing on the energy and transport challenges of lower and middle-income countries.

And what are your thoughts on how the IPCC 1.5°C report fits into this?

It sets out unequivocally that a 1.5°C ecosystem is much better than a 2°C one – 99% of coral reefs dying in a 2°C world is the starkest call-to-arms one could have.

However, nearly all the IPCC pathways to achieve 1.5°C assume massive and very rapid short-term drops in GHG emissions – which seem to me distinctly over-optimistic, given the backdrop of human aspirations in emerging economies and less developed countries that I described in my interview last month (**bit.ly/2ROCxAC**). This adds to the urgency to focus on low carbon solutions best suited to meet the needs for such economies whose energy usage is increasing so rapidly.

All IPCC pathways rely on the significant use of GHG removal this century and achieving net negative emissions from around 2050 onwards. I think the significant overshoot pathway is probably more plausible.

As the recent Royal Society/ Royal Academy of Engineering report said, the most suitable GHG removal measures to focus on are probably afforestation and reforestation; land restoration and soil carbon sequestration; and bioenergy with carbon capture, usage and storage (CCUS).

The IPCC report perhaps underestimates the contribution that CCUS could play in reducing GHG emissions from coal and gas-fired power generation, and from industrial processes in the period to 2050. This would enable the costs of CCUS technology to be driven down. But of course, this requires rapid roll-out of not just demonstration or one-off CCUS projects, but of CCUS on an industrial scale.

What are your takeaways from all these challenges? And where does UK energy research fit in?

In prioritising UK energy research, we must look at **global**, not just UK, needs, and at where energy usage and emissions are set to grow most rapidly. We should focus on supporting early-stage entrepreneurs with genuinely disruptive and scaleable solutions which address the challenges of emerging economies. And I would again reinforce the significance of CCUS – where the UK has the potential to be a pioneer, developing a whole-system capability that could be a significant export, particularly given the major need for CCUS for a 2°C, and especially a 1.5°C world.