HYD0023

Written evidence submitted by Colin Megson, in my capacity as an Energy Analyst and Consultant.

- Green hydrogen is produced from water in electrolyser plants powered by electricity. Green hydrogen is a zero-carbon technology which, if produced using low-carbon sources of electricity, is the most effective combination of technologies able to get the UK to its mandatory target of 'Net Zero by 2050'.
- The production of brown hydrogen and every other 'shade' of hydrogen from hydrocarbons, result in the emission of greenhouse gases, requiring (for other than brown hydrogen) extra and substantial investment in an infrastructure of CCuS technology, still unproven at scale.
- Hydrogen can replace the use of natural gas for heating in buildings and industry. It can replace the use of petroleum in all forms of transport and industry and can also replace other fossil fuels uses in a range of industrial sectors.
- Intermittent solar and wind power are both low-carbon technologies. 24/7 nuclear power is an acknowledged low-carbon technology, while 24/7 biomass burning is still seriously questioned as a low-carbon technology.
- Internationally, current developments in green hydrogen production are all linked to the supply of electricity from intermittents. The wind and solar industries recognise hydrogen as the only – the one and only – storage technology capable of 'solving' the **intermittency problem**. But humongous quantities of hydrogen have to be stored in salt caverns to correct for diurnal and seasonal variations in demand.
- The stored hydrogen has to be 'returned' to electricity through a backup Power-to-Gas-to-Power (P2G2P) infrastructure of hydrogen-powered gas turbines and peaker plants. The 'round trip' efficiency is 40%, so substantial extra capacity of intermittents is required to make up the missing 60%.
- 24/7 nuclear power plants (npps) do not suffer intermittency problems. A nuclear power/green hydrogen combination would require a modest percentage of extra stand-by capacity to cover for planned and unexpected plant outages. This is how electricity grids have operated at virtually 100% effectiveness, for the best part of a century.
- From the beginning of the year, the reported investment going into green hydrogen production plant now, and planned for the near future, has accelerated to the point where the impression is that of an unstoppable juggernaut. It is happening all over the world, but particularly in developed, wealthy nations and states with substantial build-outs of intermittent solar and/or wind. Germany is at the forefront.
- 10 June 2020. Germany's 'National Hydrogen Strategy' was announced. Peter Altmaier, Federal Minister for Economic Affairs and Energy: "…Today we have to set the course for Germany to become number 1 in the world in hydrogen technologies……. As the energy source of the future, it will make an important contribution to achieving the climate goals both in Germany and worldwide…"
- The Federal Minister for Economic Cooperation and Development, Dr. Gerd Müller: "…Green hydrogen and its secondary products such as methanol can become tomorrow's clean oil. Countries in North Africa in particular are suitable production locations because the sun shines almost indefinitely here. Together with Morocco, we are now developing the first industrial plant for "green hydrogen" in Africa…"
- April 2020. NIRAB Report "…3.4.2. Hydrogen - The hydrogen economy is predicted to be a major part of a net zero energy system, with the potential to decarbonise transportation, heating, industry, aviation and agriculture. There are multiple routes to the production of hydrogen from nuclear energy, from which synthetic fuels and ammonia for fertiliser can also be manufactured. …"
- 13 June 2020. "…Rolls-Royce triggers £250bn nuclear race: Huge boost for economy if UK consortium gets go-ahead to build fleet of mini reactor plants……. Tom Samson, interim chief executive of the [Rolls-Royce] consortium…….told The Mail on Sunday: 'We could be looking at locations and beginning to build factories as soon as next year with modules [to build the reactors] starting to come out of the factories by 2024 or 2025…"

So, here we are; bang up to date this month. And the message is loud and clear – go straight for green hydrogen and forget the mishmash of interim 'solutions', involving 'subtracted-value' CCuS, that the CCC and others are recommending

It seems obvious that Germany's chances of meeting their carbon goals are dim; drastic action deemed necessary to get back on track. That drastic action is to avoid the wasted time and the waste of capital investment in any 'interim', brown/grey/blue hydrogen production and infrastructure and leap straight into investing only in the production of green hydrogen.

The UK could so easily be left trailing in the wake of Germany if it goes the stuttering route being recommended by the CCC and others. The economical expedient of producing hydrogen by Steam Methane Reforming (SMR), with the added expense of CCuS, is the plan for first adoption. Green hydrogen production trickles in much later, to just manage a foothold by 2050.

By that time, Germany will be so far ahead of the UK there will not be the slightest possibility of attracting any investment of significance to add a green hydrogen production 'sector' to our manufacturing industry. Germany, in typical fashion, are set to steal the industrial thunder of every other manufacturing nation 'this side of the pond', unless the UK takes the same bold dive into green hydrogen production now.

"…Countries in North Africa in particular are suitable production locations because the sun shines almost indefinitely here. Together with Morocco, we are now developing the first industrial plant for "green hydrogen" in Africa…". This quote, from the bullet point above, about Germany's green hydrogen push, speaks volumes about Energiewende: Euros by the billions upon billions spent on intermittents and the politicians now realise it's impossible to litter Germany's land and sea with sufficient of them to produce the massive quantities of hydrogen they need to decarbonise. So, let's craftily dump it on a less developed nation, shut down every last nuclear plant and pretend Energiewende has all of the answers.

And yet, if the CCC and National Grid have their ways, the 'Germanification' of the UK's landscape and near-shore seascape will occur. Sadly, 90% of our hard working, brain-overloaded MPs have far more constituency problems and 'pet projects' to think about than the minutiae of energy technology. The powerful, well-funded and ultra-effective lobbying machine behind intermittents, comprises of manufacturers, industry bodies such as National Grid, NGOs like renewableUK and, quite overtly, the CCC. Combined, they have bamboozled Parliament into picking intermittents as the low-carbon 'winners' worthy of a maze of incomprehensible subsidies.

This financially committed matrix of support for intermittent technologies, informs us daily of reductions in cost to the point where, soon, it will become too cheap to meter. But paradoxically, with every percentage increase in the penetration of renewables into our electricity network, the higher go the electricity bills for households, commerce and industry. Producing green hydrogen is seen as a way out of this confounding mess; the inability of intermittents to supply when demand is high and supply too much when demand isn't there. This pattern of obfuscation isn't just manifest in Germany and the UK, it's heard across the rest of the intermittents-committed nations and states of the world.

Electrolyser plant manufacturers are extolling the virtue of how rapidly electrolysers can respond to changes in power supplied to the plant. So rapid in fact, that electrolysers can correct frequency 'drift' as well as 'flattening' the characteristic saw-tooth generation from intermittents. They can allow intermittents to deliver genuine 24/7 electricity day to day. But the intermittents/ electrolyser combo cannot escape the massive level of extra capital investment required to cover seasonal variations in demand. That requires the storage and P2G2P infrastructure detailed above. Parliament must not be suckered into believing this is the silver bullet to right all of the wrongs of saw-tooth electricity generation from intermittents.

The present-day 22 GW of installed wind power capacity peaks at 12 GW of generation and, regularly drops to, effectively, 0 GW of generation. The largest short-term 'swing' experience over the past year was 10GW. This variation is taken up by natural gas-fuelled CCGT plants, with all of the attendant GHG emissions. The greater the build-out of intermittents, the higher will go the GW peak value, but there will always be a period of zero generation; the short-term swings will get bigger and bigger. This is sure to result in the requirement for investment in more CCGT capacity until the infrastructure network of hydrogen production/salt cavern storage/P2G2P is up and running. That may not happen at the capacity required for some decades.

We are less than a decade away from the answer to completely decarbonising all of the UK's energy use by 2050, brought about by the dream combination of nuclear power and electrolysers. The combined 6.4 GW of Hinkley Point C and Sizewell C, represent the last involvement the UK will have with 'big nuclear'. They will operate at 100% availability to generate base load, 24/7, low-carbon electricity to the tune of 16% of the UK's demand. The Rolls-Royce consortium are to supply 16 of their 440 MW nuclear power plants by 2050, adding a further 7.04 GW of capacity to generate 17.5% of demand. The combined 13.44 GW of nuclear power can generate 1/3rd of the current UK electricity demand

Onshore wind farms are by far the most cost-effective of the intermittents, in terms of electricity generated per £1.00 of capital investment. Their typical 2 years build programme carries an early promise of income and earnings. But the Rolls-Royce npp can, at the very start of a learning curve, be built in 4 years. The cost-of capital burden carried by 'big nuclear' from financing an 8-years build programme, will be substantially mitigated for these smaller npps.

The capital investment for the First-of-a-kind (FOAK) R-R npp is £1.8 billion, which is calculated to drop by 1/3rd, to £1.2 billion for the Nth-of-a-kind (NOAK). Assuming a capital investment of £1.5 billion, the capital investment content for every unit of electricity generated by a 440 MW npp, operating at 90% capacity factor (cf), for a 60 years lifespan, is £7.21/MWh. The 240 MW South Kyle Windfarm, which is the very latest one to be given the go-ahead, requires a capital investment of £320 million and will operate at 30% cf, for a lifespan of 25 years; the capital investment content for every unit of electricity generated is £20.29/MWh.

Adding on the other significant cost factors for the R-R npp – Operation & Maintenance (O&M); fuel fabrication; waste fund; decommissioning fund – the cost rises to £32.31/MWh. Adding in the other significant costs South Kyle Windfarm has to bear – O&M; decommissioning - the cost rises to £35.84/MWh. The cost-of-capital for the extra 2 years of build programme for the R-R npp will probably not take it above the wind farm figure. Advanced npps compete for investment with the best of the intermittents.

The same calculations applied to offshore wind, based on the Dogger Bank A;B;C Windfarm reveals a 'significant cost figure' of £41.33/MWh (15% higher) and for solar farms, the figure for Cleve Hill Solar Park works out at £40.35/MWh (12.5% higher). This simple single figure comparison will not be lost on investors and most Investors will consider a consortium led by Rolls-Royce, the UK's manufacturer of nuclear reactor since the 1960s, as the safest bet of all for sinking their funds into nuclear power.

But the 'pull' on investment goes way beyond that because the number of MWh generated by npps relates to a 60 years lifespan as compared to 25 years for wind and 30 years for solar. The total number of MWh generated by npps is 7.2X greater than onshore wind; 4X greater than offshore wind and 16.8X greater than solar. Against any given wholesale electricity price, the income less significant costs – the potential to pay dividends - is very much higher for the R-R npp than any of the intermittents and 'pays out' for 60 years, which is 3 generations of a family.

There is a distinct possibility that, by 2030, private (green) investment could be drained from intermittents and be placed with SMR manufacturers like Rolls-Royce. NuScale, will have their FOAK operational in 2026 and GE-Hitachi's FOAK BWRX-300 SMR will be operational in 2027. GE Hitachi's SMR is a particular threat to R-R as the capital investment required per MW is 1/3rd less than that for the R-R npp. This may not be so in the UK, as there is likely to be some political jiggery-pokery to opt for UK manufacture, but the export potential for the R-R npp might be completely undermined. A policy to encourage Rolls-Royce to manufacture the BWRX-300 under licence, to become the source of supply 'this side of the pond', ought to enter intro Government thinking.

The capital investment content per MWh of electricity generated by a power source is a pure indicator of the materials and resources needed to get a power plant to the stage of generating that electricity. Before a single unit of electricity is generated, the capital investment needed accounts for the amounts of materials used and (currently) the fossil fuelled energy and labour costs, from: Mining/quarrying/extraction; transport; processing; manufacture; site preparation; installation; commissioning. Regarding the UK figure for the R-R npp as base-figure 1: Onshore Wind's figure is 2.8; Offshore Wind's figure is 2.9; Solar Park's figure is 4.2.

With over 200 nation states signed up to the Paris Agreement, an accelerating 'chase', by most or all of them, for materials and resources, must reveal itself before this decade is out, or the Paris Agreement will be in danger of transforming into a simple 'wish list' instead of effective 'demands' on participants. In anticipating a rapidly growing demand for materials and resources, it has to be hoped that signalling by governments will inspire the private sector to finance the expansion of plant and equipment, factories, labour and energy provision ahead of time. A decade from now to say the international competition for materials and resources will be intense, may be an understatement.

In such a scenario, it would behove any nation to consider reaching their (in the case of the UK – mandatory) goals by selecting technologies with the least demand on materials and resources. This is clearly nuclear power, in the form of Small Modular Reactors. For any government to wilfully turn away from nuclear power as the most significant contributor to meeting zero-carbon goals, will be a display of energy-illiteracy and a display of gullibility regarding the Siren songs of the spin-doctor machinery behind the intermittents' industry.

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"…We aim to have diverse panels of Select Committee witnesses…"

I would like to stake my claim for appearing as a witness before the Committee:

I am 81 years old and retired at the age of 70, after 54 years of an uninterrupted career in engineering. I have experience in every aspect of engineering, from down in the dirt, with a spanner in my hand, through qualifying as a mechanical design engineer. Among other design jobs, I spent 5 years in the design department of Rolls-Royce (nuclear), back in the 60s. For the last 30 years of my working life, I was involved in the design, procurement, sub-contract placement, quality control, manufacture (as Works Manager), installation and commissioning of high-pressure hydraulic equipment.

I maintain I am better placed than most (certainly Members of the CCC) to 'run by' a piece of power generating technology and comment on its value for money. And I can support my opinions with facts and figures and references to primary data. I feel that make me a good candidate.

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