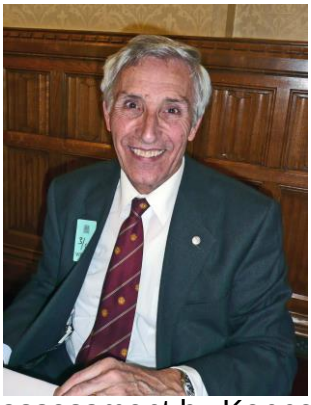
KEEPING THE LIGHTS ON
Or
"I WOULDN'T START FROM HERE"



A personal assessment by Kenneth Fergusson
Honorary Vice President of the Combustion Engineering Association
Full article

EVENTS, DEAR BOY...

In London, 23rd January 2017 dawned windless, foggy and frosty. 100 flights were cancelled at Heathrow. The BBC reported that the conditions were widespread across the country. Looking at the weather map, I remembered an article written back in November 2003, when major UK wind generation capacity was only an aspiration, but RWE in Germany already had 13GW in service. It was written by Dr. Helmut Alt, retiring director of RWE, who had been responsible for their grid operation, and described the difficulty of incorporating highly-variable wind power into their system. In one winter period of 48 hours, the entire contribution from wind had been just **two percent** of its nameplate capacity. So, I looked on the National Grid / Stephen Morley website – and the contribution from our much-vaunted wind in UK at that moment was – **TWO PERCENT**. Major supplies were coming from nuclear (17%) and gas (52%), but **nothing** on the interconnector from France which, I believe, was a source on which we had been hoping to depend for up to 5%, until technical issues forced the shutdown of several French nuclear reactors. The UK system was being kept afloat by **22%** generation from coal – our half-century old, superannuated coal-fired stations.

UK ENERGY POLICY, 2001 – 2017

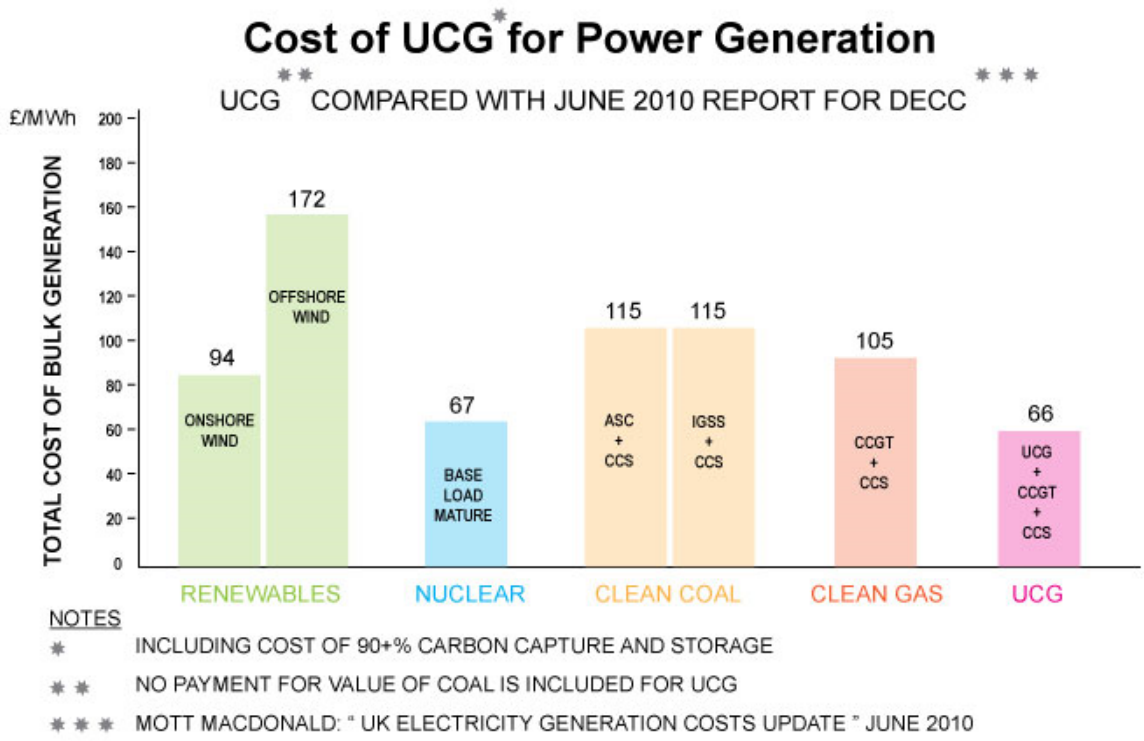
In 2001, I retired after four years as Chief Executive of the Coal Authority. I was invited to become President of the Combustion Engineering Association, a role which I relished for four years. During that time, UK energy policy was being reformulated, and, for the first year, I acted as a consultant to DTI on the subject of "clean coal", for which carbon capture and storage (CCS) was a prerequisite, and the

appropriate generation technologies were “ultra-supercritical” (USC) or “integrated gasification-combined cycle” (IGCC). In parallel, at the Coal Authority, I had been instrumental in setting up a study of the feasibility in Britain of “underground coal gasification” (UCG), which is effectively IGCC without the need to mine the coal.

The Energy White Paper was duly published in 1983, and recommended over-promotion and over-subsidisation of wind, with an afterthought on nuclear power. Clean coal did not feature. My personal reactions were contained in my President’s messages in the CEA Yearbooks of the time. Then, in 1994, the promising study on the feasibility of UCG in Britain was published, with no action to support its ongoing development. In fact, an annex to the report, outlining the recommended next steps, timing and funding, was deleted from the published version, without reference to the editorial board. My views on that are still unprintable. For the next ten years, however, I gave my support whenever I could to promoting the potential of UCG, and tried to keep abreast of developments around the world. I was convinced, and still am, that UCG, exploiting our unmined domestic coal in the coastal fringes and offshore, could provide a clean, dependable, affordable source of power. Sadly, events have not moved that way, and UCG has been wrongly compared with fracking and subjected to an ill-judged moratorium in Scotland and Wales, where exploratory projects were being evaluated. A project in Northumberland has been dropped. I have had to accept that UCG is not realistically going to contribute to keeping the lights on in Britain.

RANKING THE CHOICES

In 2009, I was invited to write an article on UCG for “Modern Power Systems”, for which I prepared a comparison of the generation cost of offshore wind, nuclear, USC and IGCC, gas CCGT and UCG; all the fossil-fuel cases included 90+% CCS. To my knowledge, at that time, there was no such published comparison. I had to rely on many published sources and unpublished studies, but was confident of the resulting figures within +/- 15 – 20%. A year later, DECC (successor to DTI) published a report by Mott MacDonald on the life-cycle cost of power generation by every means they could think of (but excluding UCG, for reasons that still do not bear examination). I looked at how they had defined the life-cycle cost, and I adapted my 2009 UCG cost to the same methodology. The resulting comparison is now 6 years old, but the relationship between the processes still basically valid.



COST OF CLEAN* POWER GENERATION

Two methods of generation were not included at that time – biomass and photo-voltaic. Neither is competitive, without heavy subsidy. The most important biomass application in UK is, of course, the partial conversion of Drax to firing with wood pellets shipped from USA.

A LAMENT FOR COAL?

Let me be clear – I am not singing a lament for coal, just pointing out that we are throwing the baby out with the bathwater, by excluding potential clean, secure, affordable ways of gasifying it to provide a substitute for natural gas in power generation (and chemical feedstock).

NUCLEAR

Hinkley Point was eventually signed off at £93/MWh, well above the Mott MacDonald figure predicted in my 2010 comparison (which was three quarters of that), and most other published predictions of the cost of new nuclear, at least until Fukushima. These lower estimates are also claimed for small modular reactors (SMR's), and I still believe them. Two major risk and cost items in nuclear generation are (i) the disposal of waste and (ii) decommissioning. In the 1970's, triggered by the negotiations of power supply prices to the new aluminium smelter at Anglesey, where both of these items were points of contention, and also aware of the importance for the ongoing development of nuclear power, to which it was a major supplier of uranium oxide, RTZ (now Rio Tinto) looked at the feasibility of setting up a commercial organisation to provide these two services. It was concluded that any contract opportunity lay far in the future and the work was shelved. It is only now, after the setting-up of the Nuclear Decommissioning Agency, that definitive work on the costing of these major items is being undertaken, but the bidders for new nuclear

stations are nevertheless required to include it within their own project lifetime costs. No doubt a heavy contingency provision has been included by EdF in their Hinkley Point contract.

GAS – FIRED GENERATION

This is viewed as the most dependable means of countering the variability of wind generation. In that role, a gas-fired station will be constrained in its number of operating hours, since wind will be given priority. There are huge subsidies to compensate wind generators if they are capable of delivering and are prevented from doing so, due to the grid being fully provided. A new gas station has to bid, recognising that it will not be free to operate at all times, but being rewarded for the ability to come on line quickly. That significantly increases the cost of power from gas in the future, compared to the past, but that penalty should rightly be ascribed to the policy obsession to promote wind.

At present, for economic and environmental reasons, the UK fleet of gas stations are all “Combined-Cycle Gas Turbine” (CCGT), where the gas turbine is followed by a heat recovery steam cycle, which virtually doubles the thermodynamic efficiency, into the high-fifties %, but requires a start-up time from cold of several hours. There is an alternative of a very quick start-up, by running the gas turbine to atmosphere, “open-cycle”, but the efficiency will be lower and the exhaust composition will be higher in NOx than normally acceptable. (In the past, this quick standby capability was provided at coal-fired power stations by liquid-fuelled aircraft-type turbines, which could be brought online within minutes rather than hours, but were expensive.)

The carbon emissions from a CCGT are half those from an unabated coal-fired station, hence the easy-gain of improving national GHG amounts by switching from coal to gas. All coal-fired capacity is mandated to be closed by 2025. But our national targets under international agreements cannot be met by unabated gas, and decarbonising a CCGT exhaust (termed “post-combustion”) is even more expensive than a coal-fired exhaust, because the CO2 content is lower from the gas turbine. However, there is an elegant long-established alternative, to decarbonise the natural gas fuel (“pre-combustion”) by reforming the carbon to CO2 for removal, leaving a hydrogen fuel. This is the method that was foreseen for gas from coal, making UCG a clean technology, and was also intended at the Hatfield IGCC. The overall cost of CCS by this means on the process of coal gasification was estimated to be less than a fifth of the cost of post-combustion CCS on a coal-fired station. It would be similar to the cost of pre-combustion CCS for a gas-fired station. However, there is little experience of firing a gas turbine with hydrogen, although it is technically feasible, and this would require development.

The track record of CCS development around the world is abysmal, particularly since much of the attention has been given to uneconomic flue gas scrubbing. The underground disposal of CO2 is well-established for enhanced oil recovery, but there are only a handful of places (most notable Sleipner) where the CO2 is permanently stored. Britain is well-endowed with potential disposal sites.

Norway, Canada and USA are the western countries most engaged with the development of CCS. After much trumpet-blowing that we were world leaders, Britain has virtually opted-out of commercial-scale projects, with the abrupt cancellation of a repeatedly-delayed and protracted “competition” for government funding. The formulation of a gas-fired station with CCS will therefore depend on technology from elsewhere, but that is no different to the gas turbine itself, where there is no longer any domestic capability in building large machines.

NATURAL GAS SUPPLIES

As production from the N. Sea declined, Britain has taken steps to increase pipeline links to Europe and to build import facilities for liquefied natural gas (LNG). What we have not done is to build gas storage capacity to compensate for the lower level of secure, diverse gas production. Britain has only one large reservoir (Rough), giving capacity of about two weeks national demand, and we went into this winter with Rough only part-full, due to emergency engineering work last summer. A proposal a few years ago by British Gas, to adapt a second large depleted field as storage, was not pursued, because it seems there was no financial mechanism for rewarding the value of storage – a classic example of how free markets do NOT deliver. In contrast, both Germany and France have storage capacity for several months’ consumption.

AH, but we can be reassured for the future by the huge prospectivity of domestic shale gas supplies, can’t we? As an object lesson in how to mis-manage the evaluation and public education of an opportunity, our record on fracking would be difficult to beat. After the one-in-a-million misfortune of the fracking test near Blackpool triggering a discernible earth tremor, the glare of public attention was increased by the next trial being planned in a highly-sensitive location, at Balcombe. When I asked a question about that choice, in contrast to the careful selection of coastal sites for UCG which could be well-monitored to build up operating data, without environmental risk, I was told more-or-less forcibly not to query things I did not understand... So, the environmentalists have run wild, purveying fears of gas coming out of water taps, contaminated water courses, methane leaks to atmosphere and public health damage, quoting incidences in the US. Now, the daily news items of the Parliamentary Group for Unconventional Oil and Gas are 90% made up of reports of protests, appeals and obstruction to shale gas development. Public support, in the face of this largely-uncontested stream of negative publicity, has slumped. I weep when I compare it with my personal experience as part of the team which planned Anglesey Aluminium in 1968-9, aware of the risks to sheep farming of fluoride deposition on grassland, and other issues. We provided full access to the then Alkali Inspector, to see the experience around the world and collaborate in devising an enhanced version of the existing US best practice, which has allowed the plant to run for a lifespan of 40 years, without any trouble to the dentistry of local sheep. What a contrast to the mismanagement of the development of shale gas, where there has been no early compilation of a dossier of bad examples elsewhere, and rebuttal of the possibility of it occurring here. Yes, the data is gradually getting published, but there is now huge public scepticism, fed by outrageous mis-information from activists, implacably opposed to fossil fuels.

CONSISTENCY AND CLARITY

In my early career, I was taught that the least dependable party to a contract is a government; they don't have to declare Force Majeure, they just change the rules. I could cite the case of an excellent aluminium smelter in Ghana, which I visited in 1969, which was financially successful, powered from a hydro-electric scheme, but was progressively squeezed by later governments "until the pips squeaked", and eventually had to close.

The Energy White paper never predicted that we would be holding "capacity" auctions to try to keep the lights on a few years ahead, with the perverse resulted of installing standby diesel generators in preference to new gas-fired stations (the last of which has been abandoned, having failed to win a contract for winter 2020). It has also given a temporary extension of life to old coal-fired stations, whose mandated closure by 2025 had naturally led their owners to cut back on maintenance and, in some cases, to bring forward a closure decision on an otherwise still-viable station.

On nuclear, a decade ago, we sold our major UK-owned capability, Westinghouse, for short-term fiscal reasons. Now it is seen that small modular reactors could have the advantage, but Rolls-Royce, amongst others, are apparently being given no encouragement to develop them.

In another industry, solar, having been induced by over-generous subsidies, there has been loud protestation at the reduction of subsidies, which has now undoubtedly damaged the sector. But I feel continual annoyance at seeing so many British roofs already festooned with ludicrously-uneconomic photovoltaic panels, bringing their owners profit at my expense, as a consumer.

Then there is the woolly thinking over biomass, which was barely on the horizon at the time of the White Paper. Drax has had a very chequered on-again, off-again experience in getting government support for converting three units from coal to biomass. Their persistence and achievement are commendable, but the whole status of biomass, in qualifying for subsidy as a legitimate climate-change mitigation process, is arbitrary, and could be altered, like so much else, by political whim.

I won't mention other fashionable concepts of current energy policy, such as demand management, smart meters and distributed generation, none of which will add a single kilowatt of generation, but only spread the available capacity more thinly. I don't see how they contribute to a "secure" national system. Other developments such as electric vehicles and "decarbonising" heat are only going to increase the demand for electricity.

Where is the consistency and clarity of government policy in all of that?

"I WOULDN'T START FROM HERE"

Like this answer given by the Irishman when asked the way to the Town Hall, I have tried to explain how that describes my feeling if asked about UK energy policy, and the state of our power supplies. I cannot see how we can be assured of clean, affordable, SECURE supplies without many gigawatts of on-demand load balancing,

to compensate for the variability of wind. Previous government estimates defined a case for 19 new CCGT's. We are currently on course to build NONE within 5 years. I believe that gas is the prime contender to provide dependable load-balancing, and that a contractual basis apart from Capacity Auctions MUST be found to allow the rapid start of work on, at least, double-digits GW of new capacity. The case for some of this to be rapid-start (i.e. capable of open-cycle operation) should be examined.

There are other possible techniques coming along, such as tidal barrages and increased pumped storage. Decades ago, in RTZ, we looked at underground pumped storage, where the surface reservoir is the upper level, and a mined chamber the lower one. It looked interesting, but no one has taken it up. Other concepts look at pressurised gas reservoirs in underground cavities. One day, maybe, there could be a high-capacity, heavy-load battery capability for storage of electricity, but at best it is still a long way off, if ever. In my opinion, none of these ideas diminishes the case for urgent authorisation of new gas-fired capacity.

Otherwise, the consequences of an inevitable recurrence of the weather conditions on 23rd January 2017 may be less benign.

End. Full version