nuclear
consulting
group

Scotland's Energy Future has no need for Nuclear

Prof Steve Thomas, Emeritus Professor of Energy Policy, University of Greenwich.
Prof Tom Burke CBE, co-founding Director and Chair of E3G.
Dr Paul Dorfman, Honorary Senior Research Fellow, UCL Energy Institute, University College London.

1. Royal Society of Edinburgh (RSE) Report: 'Scotland's Energy Future'

The recent RSE Report suggests, quite correctly, that Scotland faces difficult, complex and costly decisions when it comes to securing its future energy supply amid ongoing efforts to fight climate change, at a time when public finance is under severe pressure.

The Report also acknowledges that large reactors are expensive, radioactive waste remains a key and unresolved problem, and that there are significant uncertainties associated with the SMR (small modular reactor) concept. However, the Report provides other conflicting, confusing and, at times, almost disingenuous messages when discussing nuclear.

For example, whilst the Report acknowledges that the nuclear fuel cycle (mining, processing, transport, operation and waste) imposes significant carbon emission burdens, the 'take-home' Executive Summary states: *"Nuclear power has zero carbon emissions at point of generation and could play a major role in helping Scotland meet its climate targets".*

The Report states: *"Compared to the carbon emissions of a combined-cycle gas turbine power plant, the Scottish nuclear power stations collectively saved 6.22 MtCO*$_2$ *in 2016"* - but fails to note that all nuclear is significantly more carbon intensive than all renewables.

The Report states: *"Nuclear energy could be consistent with pursuing a low-carbon energy strategy"*, without providing any concrete evidence to support that supposition.

The Report states: *"The material requirements for compact nuclear power are substantially lower than for diffuse renewable generation"* – a statement that is clearly without any factual evidence-base. Indeed, it is widely acknowledged that new renewables are and will be significantly cheaper than any new nuclear[1].

The Report states: *"It has been suggested that a credible pathway to achieving a target of having 50% of energy from low-carbon sources in Scotland by 2030, could involve electricity generation from a mix of one-third nuclear, one-third renewables and one-third gas-fired plants across the UK as a whole by 2035"*. Unfortunately, that 'suggestion' comes from the French nuclear corporation EDF, and is not backed by any evidence base.

The Report states that: *"Molten salt- and sodium metal-based SMRs such as PRISM and MOLTEX, which can deliver 300 MW, may also be able to utilise and 'reprocess' existing UK plutonium stocks as a fuel and vastly reduce its radioactivity, thereby improving the acceptability of nuclear energy in the long term"*. Perhaps astonishingly, RSE fails to take into consideration the UK NDA's (Nuclear Decommissioning Authority) current position on the issue, which states, that for those experimental reactors: *"Studies undertaken by NDA with GEH over the past few years have shown that a major research and development programme would be required, indicating a low level of technical maturity for the option with no guarantee of success. At this time, it is noted that the cost, scope and extent of work required to progress Fast Reactor options, such as the GEH PRISM, as well as the timeframe for these options to become available, means it is not credible for the NDA to develop these options, or have them available for implementation within the next 20 years. Therefore no further work with GEH has been funded by NDA"*[2].

[1] https://www.sciencedirect.com/science/article/pii/S0301421508001997

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/791046/Progress_on_Plutonium.pdf

Thus, all in all, the Report tends to demonstrate a disappointingly poor grasp of the realities of the nuclear issue, coupled with a disquieting dose of, what can only be described as, a certain level of disingenuous information dissemination.

2. A Short History of Large Nuclear in the UK

Despite more than a decade of concerted effort, only one of the 11 reactors (16GW) the UK government forecast would be on-line by 2030 has started construction, the plans for seven have collapsed and two more are in doubt. This failure is the result of the high and escalating costs of nuclear, the unwillingness of financiers to lend money for nuclear projects, the collapse of utility interest in nuclear power, the financial failure of the two major reactor vendors, and the appalling record of the technologies chosen elsewhere.

The scope for and attractiveness of alternatives is increasing. Cost-effective energy efficiency measures could more than replace nuclear, while the cost of renewables – offshore and onshore wind and solar PV – has plummeted and is far lower than nuclear.

The Hinkley Point C project has seen huge delays and price escalation even before construction start. In 2008, the UK government White Paper on nuclear power[3] forecast that the construction cost of the two reactors planned for Hinkley, would be £4 billion. This was the 'overnight' cost excluding finance charges, which might add an additional 50% to the overnight cost. In 2012, EDF, the company leading the consortium to build Hinkley estimated the overnight cost would by £12 billion. This increased to £14 billion in 2013, £16 billion in 2015, £18 billion in 2016 and the most recent estimate (June 2018) was for £19.6-20.3 billion. In 2009, EDF claimed first power from Hinkley would be in 2017 but its most recent estimate is 2025-27. The contracted price paid for power (strike price) would be £92.5/MWh (2012 money) index-linked to inflation for 35 years, nearly double the most recent bids (2017) for offshore wind (£57.5/MWh 2012 money) despite off-shore wind projects only being given 15-year contracts and nearly three times recent wholesale electricity market prices (£40-50/MWh in 2019 money). First structural concrete for the first Hinkley Point reactor, the conventional date marking the start of construction, was poured in December 2018 and, given that experience elsewhere is that delays and cost escalation occur primarily in the construction phase, there is ample scope for further delays and cost increases.

The high price to be paid for power from Hinkley Point made the deal so unpopular even with nuclear power enthusiasts that the government determined that new financial models would be needed that would appear to produce lower prices. The commonly quoted additional cost to consumers for Hinkley is £30 billion[4], though this, oddly, is actually the net present value (discounted) of the total subsidy to Hinkley to be paid by consumers over the 35 years[5]. The actual additional cost to UK

---

3 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/228944/7296.pdf

4 https://www.nao.org.uk/report/hinkley-point-c/

5 The strike price is index linked which makes the discounting puzzling. At 2012 prices Hinkley adds over £1.0 billion/year to consumers' bills.

consumers could be as much as £100 billion in today's money. This commitment on behalf of consumers is being made despite the fact that there is no reason to believe that the costs of subsequent projects, notably construction costs, will be any lower. The only way the strike price can be significantly reduced is by reducing the risk to the developers and financiers, which will reduce the cost of capital at the expense of consumers and taxpayers.

For the collapsed Wylfa project, the government was proposing to take a significant equity holding (33%) and provide low-cost loans for all the finance required. For subsequent plants, the government is proposing a Regulated Asset Base (RAB) model but details of this are still vague. An offer of a substantial UK government equity stake in the RAB model cannot be discounted is investors do not come forward. It is clear the RAB model will only be viable if the vast majority of the technical (cost escalation and poor reliability) and economic (the power is too expensive to sell) risk is borne by the UK public either as taxpayers underwriting sovereign loan guarantees or electricity consumers being forced to accept higher than expected costs being passed on as higher prices. The lower projected strike prices promised will prove an illusion when these extra costs are passed on to consumers. Furthermore, RAB financing is more usually applied to projects where there is a natural monopoly, such as the Thames Tideway where Thames Water is a monopoly provider of water and sewage services to the ratepayers who bear the burden of the additional cost. Clearly, applying a RAB to a specific project in a competitive market would raise difficulties with the need to ensure that only those ratepayers who would benefit from the additional cost of a nuclear RAB would incur the additional cost. It would be difficult to explain to consumers on non-nuclear green tariffs why they were being compelled to pay an additional cost for generating capacity that was offering them no benefit.

Even if this assurance of minimal risk to investors is offered, it is not clear whether the investors targeted, for example, pension funds, sovereign wealth funds and investment funds, will be willing to invest the huge sums required. Such investors have never invested in nuclear projects so the RAB model may fail simply due to lack of investors.

3. Large Energy Utilities Have Lost Interest in Nuclear

The construction and operation record worldwide of nuclear power projects is so poor that financiers will not lend money for nuclear projects unless they are insulated from these risks by taxpayers and consumers, for example, via sovereign loan guarantees as were offered for Hinkley Point, or guaranteed pass-through of costs to consumers as will be offered in the RAB model.

Large utilities have lost interest in nuclear power. Utilities are probably the only companies with the financial size and strength to own a nuclear power plant. When the UK programme was launched in 2009, three consortia were set up based on seven of the largest European utilities. These were EDF and Centrica for Hinkley & Sizewell, RWE and EON for Wylfa & Oldbury, and Iberdrola, Engie and Scottish & Southern for Moorside. All except EDF withdrew leaving the Wylfa and Moorside consortia in the hands of the reactor vendors Hitachi and Toshiba respectively. The reactor vendors are an order of magnitude too small to own a nuclear power station and they were simply hoping to sell reactors, relying on other investors coming in to take over ownership of the plants before they were completed. When it was clear these investors were not going to materialise, the projects collapsed.

The nuclear vendors are in financial disarray. Areva, the French vendor offering the EPR for Hinkley and Sizewell, and Westinghouse, the Japanese/US vendor that offered the AP1000 for Moorside were both effectively bankrupted by losses incurred building EPRs and AP1000s elsewhere. Hitachi, which offered the ABWRs planned for Wylfa and Oldbury, is unwilling to risk any of its own resources. The Chinese vendor, CGN, which plans to build two reactors of its own design (Hualong One) at Bradwell has no experience outside China and the Bradwell project is much less advanced than those of the other three consortia. Its design is some years from receiving approval from the UK safety regulator and dealing with them raises concerns about UK national security.

The record of the designs offered is abysmal. The four EPRs and the six AP1000s that have started construction worldwide are 5-12 years late and many times overbudget and two more AP1000s had to be abandoned after four years of construction due to high and still escalating costs. Two of the remaining six AP1000s may also be abandoned. The first of the four EPRs and the first four of the six AP1000s (all of these in China) only entered service in late 2018, so their reliability is unknown. There are four operating ABWRs but these are all of a version of the design that pre-dates Chernobyl so of limited relevance. Their reliability has been very poor and they have not operated since the 2011 Fukushima disaster. No Hualong One reactor has been completed yet.

Little is going to improve with these four issues in the next decade so there is no prospect that carrying out a nuclear project is going to be any less problematic. The non-nuclear options available to ensure low carbon, secure and affordable electricity are not without their own difficulties however experience in overcoming them is so consistently better as to make the Government's insistence that it can succeed in overcoming those of proceeding with further nuclear appear perverse.

Furthermore, as the UK National Infrastructure Commission has pointed out, the electricity industry is undergoing a digital revolution as the combination of sophisticated sensors, massively increased data analytics capacity and increasingly intelligent software is transforming business models and permitting far more efficient use of generating capacity. These developments focus policy attention more on system design choice than simply technology choice and place a premium on flexible management of generating resources. Large electricity generators of any kind are a barrier to flexibility and require disproportionate investment in security of supply.

4. Small Modular Reactors (SMRs)

There has been a great deal of PR about the promise offered by Small Modular Reactors (SMRs) despite the fact these exist only in the minds of designers. Worldwide, no SMR design has completed evaluation by an open, experienced safety regulator, much less are there operating prototype or demonstration plants or firm orders. While SMRs are spoken of as a class of reactors, they comprise a very diverse range of designs ranging in size from 3-500MW.

SMRs can be split into two classes: Scaled down reactors of the same type, light water reactors (LWRs) (as proposed for the UK's large reactor programme), and radical new designs of a configuration not in commercial operation anywhere. The premise for the LWRs is that scaling them down will reduce costs. This seems implausible given that for the previous 50 years, whenever existing designs appeared uneconomic, the nuclear industry scaled them up to gain scale economies. Unless major safety features can be left off by scaling LWRs down, it seems inevitable that costs will be higher not lower.

The radical designs are generally concepts that have been talked about for many decades and in the case of fast reactors and high temperature reactors have been built at prototype and demonstration scale with uniformly poor results. It is hard to see, after a record of failure over many decades and in many countries, why there should now be success in developing these concepts to commercially viable designs especially at small scale.

It is difficult to see how SMRs can play any part in helping the Scottish Government meet its Climate Act targets. Even if a safe and affordable design were to emerge from the current research projects, the whole concept relies on there being a sufficient guaranteed pipeline of orders for the construction and ramping up to scale of a large and expensive production facility. Without such a pipeline, itself requiring an unlikely level of long-term policy consistency, it is difficult to see the private sector being willing to finance such a facility.

5. So What's to be Done ?

The record of the large reactors is so poor in terms of cost and lead-time, it is hard to understand why this option would be pursued in any form. SMR technology is profoundly uncertain, and no public money should be gambled on these designs, and they should not be included in any plans.

Fortunately, as discussed in the main body of the RSE Report, there are several attractive options. At the top of the list must be energy efficiency. In the past decade, UK electricity demand has declined significantly despite the lack of a strong energy efficiency programme – the introduction of LED lamps appears to have been a significant factor. For the future, a priority must be improving the housing stock – the UK housing stock is amongst the least efficient in Europe - especially for low-income households. This will have the double benefit of reducing consumer bills and hence fuel poverty as well as reducing greenhouse gas emissions. If gas is to be replaced as the primary space heating fuel by electricity, it is essential if this is to be affordable that the heating load is minimised. Recent work by the UK Energy Research Centre (UKERC)[6] has shown that currently cost-effective investments in energy efficiency could save around a quarter of the energy now being used. This is equivalent to more than the output from the whole of the UK Government's originally

---

[6] http://www.ukerc.ac.uk/network/network-news/ukerc-energy-efficiency-briefing-published.html

planned 16GW of new nuclear - and could be more rapidly and reliably delivered on time and to budget. Using the Treasury's own policy appraisal guidance, this would have a net present value of £7.5 billion not counting any co-benefits such as improved health, which might raise the benefits to £47 billion.

Prices of renewables have fallen sharply in the past few years. For example, the cost of offshore wind fell from about £140/MWh to £57.5/MWh in only four years with every prospect that prices will fall further. Incentives for onshore wind and solar panels can easily be re-introduced with a rapid impact on new capacity. There is an increasing recognition even among utility executives that an all-renewable electricity system could soon be feasible[7]. It will be essential for government to give assurances about the long-term nature of these incentives if a local capability is to be built up. In the past, UK capabilities in, for example, energy efficiency and solar power, have had the ground cut from beneath them by the arbitrary withdrawal of central government support.

The encouraging reality is, as much of the RSE Report points out, there are no lack of attractive options to pursue. Energy efficiency, onshore and offshore wind and solar could more than meet any feasible Scottish electricity demands at lower cost and with more certainty than nuclear - and could be in place much, much sooner.

In the journey to manage the decline of fossil fuels, nuclear power (a quintessentially 20th century technology) fails to compete with the technological, economic and security advances and advantages of the coming renewable evolution. In bidding a long goodbye to fossil fuels, we are also bidding adieu to nuclear - and given the associated ramping cost and risk issues that cling to nuclear power, not before time.

---

[7] https://unearthed.greenpeace.org/2019/03/27/interview-scottishpower-ceo-offshore-wind-energy-uk/