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Respondents

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Response

Note: *We have provided answers to several, but not all questions in which the Committee has expressed an interest, with particular emphasis on the question of small modular reactors*

Whether Wylfa Newydd will be built on schedule

In answering this, we examine issues related to both previous international experience of the ABWR reactor design, as well as matters related to the UK regulatory system, and current and recent new build experience. Horizon nuclear power, acquired by GE-Hitachi in 2012, has plans to construct a new Advanced Boiled Water Reactor (ABWR) at the Wylfa site on Anglesey, currently the location of a Magnox nuclear power station whose final reactor ceased operation in December 2015. The ABWR is the only Generation III reactor to be operating anywhere in the world, with four reactors operating in Japan (Kashiwazaki-Kariwa units 6 & 7, Hamaoka 5, and Shika 2). 2 more ABWRs were under construction in Taiwan (Lungmen 1 and 2), but these construction projects have been suspended (1). In addition to Japan and Taiwan, the USA has also completed the licensing process for the ABWR design. Experience with the four completed ABWRs is that they have had relatively short construction times when compared to the other relevant Gen III reactor design (the European Pressurized Reactor). All reactors in Japan have been completed in a 5-6 year period (3).

The only other ABWR reactors under construction in the world are at the now-suspended Lungmen plant in Taiwan where construction started in 1999. It was expected to be completed in 2004 however construction was still occurring in 2015 when the plant was 90% complete when the construction process was suspended due to public protests. But before this, the construction of the two reactors at Lungmen had been repeatedly delayed, although the reasons for this are complex, entailing a range of regulatory, political and environmental factors.

In terms of new build projects in the UK, the other Generation III reactor project at Hinkley Point (an EPR) is facing significant difficulties, where construction has not started and no final investment decision has been made by EDF. Where construction of EPRs has begun (in France and Finland), the projects are significantly behind schedule (9 years, in the case of Finland). The PWRs planned for Hinkley Point, and those in Finland and France, are of course a different type of reactor than the ABWR. The recent past experience that can be drawn on shows that it took 7 years to construct after a very lengthy pre-construction period (2) and Torness 1 and 2 took 8 and 9 years respectively (ibid).

The proposed schedule for the ABWR at Wylfa outlined by Horizon is for construction to start in 2019 and for completion in 'the first half' of the 2020s (3). This timetable seems optimistic given various stages that the Wylfa project will still need to go through. For one, there is the Generic

Design Assessment (GDA) of the ABWR design as it is not yet licenced in the UK. Good progress has been made, with the timetable being adhered to, and 'step 3' of the GDA now being concluded. However, the Office for Nuclear Regulation (ONR) states that in terms of 'step 4', there is a "vast amount of work to be delivered through step 4", that "first time quality will be critical" and that "Hitachi-GE will have to increase pace" in terms of the identification and resolution of issues (4 p.6). If the schedule of the GDA is kept to, then a 2019 construction start date is possible, but there still needs to be negotiation around the 'strike price' which took much longer than expected in the case of Hinkley C. Other potential issues are concerns over labour supply. If Hinkley C is being constructed at the same time as Wylfa, then there could be labour shortage issues. The Nuclear Skills Alliance identifies several 'pinch points' which suggest that by 2020 there could be significant labour shortages which could make simultaneous nuclear new build challenging in the UK (5).

<u>What the cost of Wylfa Newydd will be and whether it represents value for money</u>

Very little information has been released about the anticipated costs of constructing Wylfa. More detailed costs will be provided by Horizon if or when the stage of making a Development Consent Order is reached. The independent consulting group Miller were commissioned by the Welsh Government to study nuclear industrial prospects for Wales over the coming decades. They calculated that the cost for planning and constructing Wylfa, for construction start in 2019 and completion in 2025, allowing for inflation, might be £14 billion (6). But as the authors point out, this uses the medium point estimates of the Parsons Brinckerhoff model which looks at generic costs of PWR reactors. These generic costs of reactor types do not take in 'site specific' factors, and thus as Parsons Brinckerhoff note, "it should be noted that nuclear costs are considered, as for other technologies, on a generic rather than a site-specific basis. They may therefore differ from the cost of particular planned projects in the UK" (7 p. 24). The second issue is that the cost projections are for a Pressurized Water Reactor (PWR) rather than an ABWR, for which there is limited construction experience.

In terms of the construction experience of ABWRs, the four reactors constructed in Japan were all constructed in a 5-6 year period which is a good track record in terms of timing. However As Thomas reports, total construction costs of the first two units were $3,236 per kilowatt for the first unit and $2,800 per kilowatt for the second, being well above the forecast range as originally reported (8 p.9) (9). The reactors in Taiwan, now mothballed, experienced continual cost escalations (10). By 2008, Lungmen 1&2 were five years behind schedule and costs had risen from $3.7 billion to between $7-9 billion. In the USA, where the ABWR was originally licenced in 1997, no reactor order has been placed. In 2006 plans were announced by NRG Energy to build two ABWRs at the South Texas Nuclear Generating Station site. However in 2011 NRG abandoned an agreement with Toshiba, the main contractor. This was due to continual cost-escalations since 2006 exacerbated by the Fukushima disaster in 2011 (11,12).

Another problematic factor in assessing the costs of Wylfa given limited ABWR construction experience relates to the repeated historic trend of initial cost projections of new nuclear build underestimating final total costs - for a variety of reasons and often by very large margins (13–19). For example, Sovacool et al (20) in a recent international assessment of over 401 energy infrastructure projects found that nuclear power was most likely out of all energy technologies to experience a cost overrun, and such an overrun was most likely (on average) to double their cost. Another factor is that projections of future nuclear costs are not 'site specific' yet much of the total cost of constructing nuclear power depends on siting. On-site engineering may account for over 60%

of the total construction cost, while other non-site-specific items such as the steam generators and the pressure vessel may account for a smaller proportion of total cost (21). Considering the absence of experience in building any kind of BWR in the UK, and potential labour and bottleneck issues that could be caused by simultaneous projects such as Hinkley C, 'on site' cost escalations are a significant possibility.

The Nuclear Energy Agency (22) point out that an increase in the load factor (availability) of a nuclear reactor can lead to a substantial decrease in costs. Looking at the ABWR reactors in Japan and load factors, the reactors have had several unplanned outages, some years achieving less than a 40% load factor (2). These ABWRs have been beset with various technical difficulties, leading to zero output in 2008. For a pre-Fukushima Japan with considerable nuclear capacity, this may not be such an issue, but in the context of the UK with associated energy security issues being a leading justification for the new nuclear development at Wylfa, these difficulties suggest that ABWRs may not yet be fully reliable.

This discussion can be simply summarised: no-one can yet have a clear idea of the construction cost of Wylfa Newydd, and this situation will not change for several years i.e. until we have UK construction experience. Whether it will offer value for money as a whole is an even harder question and depends on 'internal' factors such as its operational reliability and 'external' factors, especially the cost of alternative sources of generation.

What the strike price (the guaranteed price per kilowatt hour for electricity for the owners of Wylfa Newydd) from Wylfa Newydd is likely to be and what impact it will have on energy prices in Wales

It is impossible to know what the strike price for Wylfa Newydd will be. Although the UK Government favours the idea of using auctions to determine strike prices, and has successfully done so for some renewables, this is impossible where there are no competitive pressures and instead a sequence of large one-off projects. The strike price for Wylfa Newydd will therefore almost certainly be the result of a non-transparent bargaining process between Government and Horizon, much as the strike price for Hinkley Point was determined. Given Horizon's confidence in the economics of ABWRs, and the political difficulties in announcing a higher strike price than for Hinkley Point, the signs are that a strike price at Wylfa will be somewhere below the £92.5/MWh agreed for Hinkley Point, but beyond that, very little can be said.

The impact of the strike price on Welsh electricity prices will be negligible. Even if the strike price were to be high, this would make a very limited difference to electricity prices in Wales, because the market from which prices emerge is for GB as a whole, not Wales.

How the decommissioning of Wylfa and Trawsfynydd is being carried out

Decommissioning at all Magnox sites comes under the responsibility of the Nuclear Decommissioning Authority and is implemented by Magnox Limited, the Site Licence Company responsible for all GB Magnox sites. Decommissioning at Trawsfynydd is further advanced than at Wylfa because it ceased generation well before Wylfa. Trawsfynydd is one of two sites, along with Bradwell, that has been marked out for learning from early experience in preparing the site for entry to ‘Care and Maintenance’. This state of ‘Care and Maintenance’ involves what the NDA describes as ‘quiescence’, (23 p. 26) meaning that the site can be rendered safe, and can be effectively abandoned for several decades prior to final site clearance. At present the expectation is that Trawsfynydd will enter Care and Maintenance in 2027-28, with final clearance between 2074 and 2083, while the equivalent dates for Wylfa are 2025-2026 and 2096-2015. (23) While preparations for quiescence are ongoing, both sites will continue to generate employment, but after this state has been achieved there would be – all else equal – virtually no activity at either site for many decades.

However, the NDA’s draft Strategy (23) argues strongly for a fundamental review of Magnox decommissioning strategy, involving examination of the case for a continuous process of decommissioning at some sites, rather than the current idea of long periods of inactivity across all sites (ibid, pp. 26-27.) This could in principle impact on medium term employment opportunities at Trawsfynydd and the Committee might wish to pursue this further with the NDA.

What potential there is for small modular reactors to be built at Trawsfynydd and how that will impact decommissioning and future planning

Increasingly the UK government has been looking favourably towards Small Modular Reactors (SMRs), defined as having a capacity of 300MW or less, to be deployed in the UK in the relatively near future. Trawsfynydd has specifically been identified as a potentially favourable site where SMRs could be deployed (24). £250 million worth of funds for R&D into nuclear for the next five years was announced by the Chancellor in the November 2015 spending review with SMRs identified as a priority, and a recent ‘enabler project’ into SMRs was announced in February 2016. The National Nuclear Laboratory (25) in a review of SMRs – termed, not entirely convincingly, a ‘feasibility study’ - argued that SMRs could be deployed “within a ten year timeframe” and that there could be between 7GW and 21GW of SMRs in operation in the UK by 2035. Even the lower end of this range is ambitious, and the upper end, for reasons argued below, seems well out of reach. This is partly due to the international context of SMRs, as well as UK-specific barriers to deployment. The issue of deployment at Trawsfynydd is also discussed below.

A major difficulty in assessing the viability of developing SMRs in the UK is that there are no commercially operable SMRs anywhere in the world (26). And despite the USA being the most credible place from which the UK would acquire SMRs (because significant public and private R&D resources have already led to a wide range of design ideas), no SMR has even begun the US safety licensing process (27). The licensing procedure in the USA, as well as in the UK, will not necessarily be straightforward given the ‘first of a kind’ features that SMRs may possess (28). Certainly the idea that SMR licensing might be ‘fast tracked’ relative to the process for larger reactors lacks credibility: Dr Hall of the ONR explained to the Energy and Climate Change Select Committee (29 p. 15) that SMR safety licensing, including site-specific issues, would take around six years, the same time as for large reactors. There are also potential regulatory capacity issues in the UK: the ONR is currently licensing the ABWR, the AP100 and could potentially be also licensing the Chinese Hualong design given the UK/France/China deal on the finance of the Hinkley project. Additional licensing of novel SMRs could place extra strain on the resources of the ONR and could contribute to delay.

Given the absence of commercial experience with SMRs anywhere, their economic status is even more uncertain than for larger reactors – where, as outlined elsewhere in this evidence, there is always substantial uncertainty (generally optimism) even for well-established designs. SMR economic viability depends on reversing the traditional, persistent and largely credible argument of the nuclear industry that there are economies of scale in making reactors bigger. SMRs could only overturn this argument if two conditions are powerfully present. The first is that factory production would minimise the kinds of 'on site' cost escalations that have been problematic for conventional nuclear reactors. The second is that if there are orders for a large number of SMR units, then economies of scale in manufacturing multiple units would kick in. Lack of any real-world experience makes these arguments hard to test. The need for such a factory in advance of construction is another factor that puts the NNL timescale of 'within ten years', and at scale by 2035, in serious doubt.

A more recent study by Mott MacDonald for the Energy Technologies Institute (30) is more plausible and rigorous. It argues that for relatively 'conventional' SMRs – essentially cut-down and modernised versions of the PWR technology widely used for larger reactors – the timescale to first deployment would be of the order of 17 years, assuming no full-scale demonstrator plant would be needed, and for more radical designs, this would stretch to 26 years (ibid. p.6). While the report argues that some SMRs may already be 'some way along this timeline' of 17 years, it seems unlikely, given the absence of any UK history in these small reactors that any deployment could occur before the early 2030s at best. Scepticism about deployment any sooner than the early 2030s is reinforced by DECC's espousal of the idea that there should first be a competition to determine the best SMR design for the UK (31). If experience with competitions for Carbon Capture and Storage projects is any kind of guide, this suggests that additional years might be added to the pre-deployment timescale. It is also probable that such 'conventional' SMR designs, while possessing advantages in terms of regulatory processes and potential performance, are precisely those where the diseconomies of small scale are difficult to avoid - given their generic similarities to larger PWRs that have been expected by the industry over several decades to achieve substantial scale economies.

The Mott MacDonald report also argues convincingly that the lowest costs likely for SMRs depend on the commercial use of the (otherwise wasted) heat produced by the nuclear reaction in addition to electricity (30 p 25-6). This would involve connecting SMRs to district heating schemes. This in turn means that the location of SMRs would need to be close to substantial heat loads, either industrial or domestic. This is a serious handicap to the idea that Trawsfynydd would be a good SMR site as it is in a relatively isolated location, some distance from large heat loads. If Trawsfynydd were therefore a location for SMRs, there would be a significant financial penalty compared to other potential sites (including several current nuclear reactor sites) that are much closer to heat loads. Potential developers of SMRs at Trawsfynydd would be unlikely to get any significant financial benefit from selling heat and would therefore need specific financial inducements to locate in Snowdonia rather than an economically more favourable site.

Whether the Welsh Government and UK Government are co-ordinating their policy in this area

In relation to decommissioning, NDA manages public sector sites across all three GB countries, and there is no public indication that either NDA or the UK Government are doing anything, in relation to England and Wales, that is other than co-ordinated. In relation to new build, both the Welsh and UK Governments have made strong positive statements about the need for nuclear new-build, including at all potentially active sites. The two governments clearly have a common purpose in this area, whether or not they actively 'co-ordinate policy' - about which there is little public evidence.

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