Evidence to House of Lords EAC inquiry on the economics of UK energy policy

About the author: this evidence is written by myself as an independent energy consultant who is also the representative for the campaigning group PAWB (Pobol Atal Wylfa B) on the (former) DECC-NGO nuclear Forum. I have been an active member of the nuclear Forum, writing and presenting various papers, focussing on non-nuclear UK energy scenarios to 2050 and beyond.

My work on the Forum on the subject of 'Reasons For A Nuclear Review' culminated in a meeting with the DECC Chief Scientific Advisor Prof John Loughhead in February.

I have a degree in Electrical Engineering from Liverpool University in 1977. Between 1994 and 2010 I was a staff member of Friends of the Earth (FOE) Cymru, specialising in energy and transport issues. I became FOE's anti-nuclear spokesperson in 2004 and subsequently served on the BERR stakeholder group during the public consultations on a new-build nuclear programme around 2007. I was a speaker at several major conferences on nuclear power and many other smaller conferences and public meetings up and down England and Wales and occasionally in Europe.

My work included promoting the concept of tidal lagoons in the UK from 2002. I was also a member of the Advisory Committee on Carbon Abatement Technologies (ACCATS) between 2007 and 2009. After leaving FOE I became a full-time campaigner and UK representative for the Bellona Foundation for a six months period in 2010 promoting renewables and CSS (focusing on bio-energy with CCS or 'carbon negative' BECCS) and opposing new-build nuclear power. I was also a consultant to a company associated with alkaline fuel cell development AFC Energy in 2011.

The views expressed below are my own and I receive no funding from anyone for my campaigning work.

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The evidence below puts a case that new nuclear power programmes (be they conventional Generation III+ designs or Generation IV small modular / molten salt / fast breeder-burner reactors and associated activities) are a major dis-benefit to the economics of UK energy policy because :

i) current and emerging nuclear energy technologies present inherent dangers to energy security, national defence and public safety and are NOT necessary for UK or global climate protection or energy security

Earth including the UK has sufficient renewable energy resources, be it solar schemes in deserts, to wind energy in cold climes, to marine currents and underground heat, to meet any future foreseeable demands.

Globally nuclear energy supplies just 2.3 % of global (final) energy demand and even optimistic nuclear industry forecasts (of 1,000+ GW) would see only around 5 % by 2050, see author's article in the Ecologist :
http://www.theecologist.org/campaigning/2884401/lies_damned_lies_and_energy_statistics_why_nuclear_is_so_much_less_than_it_claims_to_be.html

Yet ministers and senior politicians from all the major English political parties have variously and routinely stated that nuclear power is 'crucial', 'key', or 'absolute'. Surely any policy with major economic and security implications which is based on a major false premise is fundamentally flawed.

A UK industrial strategy which seeks to globally showcase foreign largely unproven versions of conventional nuclear reactors (EPR, AP1000, ABWR) and which intends to develop and showcase (UK or foreign) unproven new reactor designs (SMRs, molten salt, fast breeder/burners) is both a high risk and potentially a self-defeating economic strategy.

Any policy aimed at promoting the spread of (foreign or UK) nuclear technology, expertise and materials around the world including UK nuclear exports is reckless on non-proliferation grounds and risks probably irreversible security threats to tens of billions of people globally across many future generations (ie more genie out of the bottle or like gun control in the USA).

ii) a UK industrial strategy which is increasingly focussing on new nuclear technologies would, and already is, undermining the deployment, funding and focus on renewable energy systems (RES) and CCS/BECCS technologies in which the UK has considerable academic and industrial leads

The UK has globally significant resource advantages in its offshore wind resource (1,500+ TWh/y ie greater than future UK energy demand), and its North Sea geological capacity for carbon dioxide storage (billions of tonnes in depleted gas and oil fields and extensive favourable natural geology).

The planned 18 GW nuclear programme would generate 140 TWh/y of electricity by 2030 and so would marginalise if not cripple RE and CCS deployment and development. Electricity demand in 2030 has been variously estimated around 350 TWh/y. The UK may achieve 110 TWh/y from renewables by 2020 as part of its EU commitment and the CCC sector emissions recommendations may allow 10-50 TWh/y of unabated gas-fired generation (assume 20 TWh/y) in 2030. Sizewell B would also still be operating at nearly 10 TWh/y.

So, assuming that 20 TWh/y of new generation in the 2020s comes from lagoons, new hydro and new onshore wind schemes, then offshore wind, PV, bio and gas CCS/BECCS deployment in the 2020s would be reduced from schemes generating **190 TWh/y to just 50 TWh/y** :

350 = 110 RE to 2020 + 0 new nuclear + 20 unabated gas + 10 Sizewell + 210 other built in 2020s
350 = 110 RE to 2020 + 140 new nuclear + 20 unabated gas + 10 Sizewell + 70 other built in 2020s

50 TWh/y is half of the probable renewables build from a standing start in 2010 to 2020 and so would represent a stagnation if not decline in offshore wind and PV deployment in the 2020s. Offshore wind was estimated to reach 35-40 TWh/y by 2020 and PV 10-15 TWh/y by 2020 (ie 50 TWh/y combined).

A ‘regional' CCS pipeline of 2 feet diameter (eg West Yorkshire to North Sea) could transport a massive 17+ million tonnes of CO_2 per year from ‘gas’ fired (natural Gas or bio-SNG) schemes and industrial plants. That one pipeline could abate up to 40 TWh/y of Natural Gas fired generation (17 / 0.4). **So one CCS regional pipeline in a nuclear-inclusive Grid could then cripple the UK offshore wind and PV industries.**

If no nuclear schemes went ahead in the 2020s then the 190 TWh/y by 2030 could be generated from say 50 TWh/y from PV (5.5 GW installed per year) and 105 TWh/y from offshore wind (3 GW installed per year). **Such high but achievable installation rates in the 2020s would see offshore wind and PV industries boom and see 35 TWh/y from a significant gas-CCS or BECCS-bio-SNG deployment.**

iii) the export of any commercially-viable future 'British' nuclear technologies would be highly compromised by weapons proliferation concerns

Concerns include thorium-cycle technologies which open routes to improvised U233 bomb devices eg via the transmutation of thorium fuel using emerging small-scale particle accelerators : http://thebulletin.org/thorium-wonder-fuel-wasnt7156 and http://phys.org/news/2014-05-path-powerful-tabletop.html.

Nuclear reactors and associated facilities are hardly a set of safe and peaceful technologies, for a 'mother' country which aims to project 'soft power' on the global stage, to promote. Even one improvised device could ultimately undermine the UK's national security.

If a stated national policy is for multi-lateral nuclear weapons disarmament (as claimed by UK political parties and HMG ? despite opposing such talks recently) then there surely must be a value in not promoting a renaissance and spread of nuclear technology, expertise and materials around the world.

These western democratic values cannot be valued at £ 0 / MWh. A nuclear-inclusive energy system should surely should have to have significantly lower £ /MWh costs (as was originally claimed during the public debate on nuclear power between 2005-2011) to be chosen over a non-nuclear energy system.

iv) national defence implications of nuclear and non-nuclear energy infrastructure

New centralised nuclear infrastructure (ie six very large power stations with toxic contents on coastal sites at the end of long transmission lines) would present major avoidable critical infrastructure vulnerabilities and so major risks to UK national defence (a top duty of Government). **Each sites' Interim Store would accumulate nearly half the peak radioactivity of spent fuel and other wastes stored at Sellafield.**

In contrast, widely geographically dispersed RE schemes (eg wind farms, PV panels) and decentralised multi-source 'gas' back-up and other back-up (eg on brown-field sites, basements in urban areas) would significantly strengthen Grid resilience (local Grids) and future heat provision to consumers.

Indeed, fast flexible back-up for RE is a major security benefit not a costly CO2-belching drain as routinely portrayed for the last 20 years. The national defence vulnerabilities for nuclear-inclusive and non-nuclear critical infrastructure pathways could hardly be greater and this has various economic implications for UK plc eg additional military defence requirements, wider security spending and regulation.

When considering system and wider costs, the national security value and non-proliferation value between a nuclear-inclusive and non-nuclear Grid / energy system cannot be = £ 0 / MWh and £ 0 / MWh. For example if a parent is trying to entertain a bored child and the cost of a live grenade is the same as a tennis ball - would it be a 50-50 choice on which one the parent would give to the child... it is that stark a security choice in the author's view.

v) the cost to consumers (domestic and business) of electricity and heat generated by a mix of renewable energy technologies is likely to be equal or lower than that from a nuclear-inclusive system from 2025 to 2050 and beyond

The Hinkley C scheme is now projected to start generating by end of 2025 (at £ 95 /MWh in 2016 prices for 35 years to 2060). Yet the contract costs (for just 15 years) for an equivalent mix of onshore wind, large-scale solar and offshore wind are forecast to be lower than Hinkley C before 2025 even when including the NET wider system costs for balancing and back-up (including hot back-up for one or two 1.6 GW reactors).

In the last few weeks of 2016 Danish offshore wind farms have been awarded contracts of 60 Euros MWh and 49.9 Euros / MWh plus connection charges of not more than 30 Euros / MWh (80 Euros / MWh = £ 70 / MWh currently). A 2015 ETi report forecast floating offshore wind levelised costs possibly falling to below £ 60 / MWh including HVAC transmission cables by 2050.

The cost to consumers of the scenarios needs to be worked out over the 35 year nuclear CfD contract lifetime at least ie 2060 from 2025 to fairly include two full 15 year contract periods for renewables. The 2040 and 2055 renewables technology and hence CfD costs are likely to have fallen significantly. The balancing and back-up (B&B) costs then need to be added (for nuclear and renewables). For example :

Hinkley C may generate 890 TWh (25.5 x 35) over its CfD period which would cost = 25.5 m x £ 95 (in 2016 prices) x 35 = **£ 85 billion over 35 years**. If an equivalent 2025-2060 non-nuclear (mainly additional offshore wind + PV) scenario CfD costs averaged £ 90 / MWh for 15 years to 2040 then £ 80 / MWh for next 15 years to 2055 then £ 70 x 5 years the total cost of electricity = **£ 74 billion over 35 years** (25.5 x [90 x 15 + 80 x 15 + 70 x 5) which is **£ 11 billion less than a Hinkley CfD.**

Apparently BEIS has estimated the balancing and back-up costs for a significant renewables deployment of £ 10-15 / MWh in addition to the CfD contract (technology/scheme) cost. This estimate seems very high and the assumptions on which it is based need to be scrutinised. Such B&B costs for renewables would amount between £ 8.9-13.4 billion (25.5 TWh/y x 35 y x £ 10 to 15 / MWh) or **about £ 11 billion !**

The author estimated a 25.5 TWh / 3.2 GW renewables scenario B&B cost of **£ 5 to 7 billion over 35 years** partly depending on if much of the capacity is CHP configured and the heat is usefully used in industrial or district-heating. That equates to £ 5.6 to 8 / MWh which is about half the BEIS estimate. These examples (which would also change for an 18 GW nuclear programme) show how crucial it is for access and scrutiny of the BEIS model scenarios and cost assumptions - see Supplementary Recommendations below.

vi) the cost forecasts for commercially-unproven, if not technically unproven, SMR technologies generating electricity at £ 80 / MWh (in current prices and presumably baseload) deployable in the 2030s are still higher than RE cost forecasts in the 2030s.

Cost forecasts for floating offshore wind technologies between 2030-2050, and 2030's PV and PV-Thermal technology costs (and roof-integrated) are likely to be highly competitive. SMRs built on industrial sites could also provide low-cost high-temperature process heat but that specialised heat demand is relatively small (currently ~ 30 TWh/y) and could be provided by non-toxic molten salt stores directly heated by low value 'excess' electricity (eg wind and PV peaks), or solid-oxide fuel cells (SOFCs).

Lower temperature heat demands supplied by nuclear-CHP schemes to industrial sites and urban district heat networks could similarly be supplied by inter-seasonally borehole stored low-value excess solar heat for PV-Thermal (PVT) arrays and or geothermal heat schemes.

vii) future consumers in the UK and globally may well have an increasing preference for devices and local networks that give 'power to the people'

Domestic or community-scale PVT systems (plus diurnal battery and inter-seasonal heat storage) and wind devices which can achieve a high degree of electricity and heat self-sufficiency could well be far more attractive to future consumers than dependence on large utilities with too-big-to-fail nuclear power and heat projects backed by elitist government, business and establishment circles (with revolving door senior staff positions, insider lobbying, non-transparent costs, smart lifestyle monitoring, heavily guarded power stations, and potentially fuel transports and toxic interim stores within a couple of miles).

viii) demand for (British made) steel would probably be two to three times greater in the building of non-nuclear energy infrastructure

The author estimated that a 35 GW offshore wind deployment between 2018-2030 would generate the equivalent 125 TWh/y output as the previously planned 16 GW (five x 3+ GW projects) new-build nuclear programme built in the same timescale with a steel requirement of about 1.2 million tonnes. Such a 35 GW offshore windfarm deployment (or some onshore too), would have a steel requirement of **4.5 million tonnes.** This offshore wind farm steel demand would be equivalent to :

* over 3 x the planned 16 GW new-build nuclear power programme (4.5 million / 1.2 million = 3.3)
* over 6 HS2 projects (4.5 million / 733,000 t = 6.2)
* over 280 Trident successor submarines (4.5 million / 16,000 t)

The following two decades to 2050 and beyond would require similar multi mega-tonne steel demands for offshore wind turbines and other renewables. Has BEIS carried out a steel demand assessment ?

Consequently, there is an opportunity to build a specialist British steel-making industry on sites around the UK, eg Port Talbot, Scunthorpe, Teeside. The UK could now take a lead and invest in the world's widest rolling mills (eg 6+ metres) to produce the type and size of steel required for the marine wind giants (10+ MW offshore wind turbines) of tomorrow.

Even a more likely mix of offshore wind and PV built to 2030, plus the steel required for the additional 15+ GW of gas-fired back-up plants, would probably still require more than double the steel demand of the equivalent nuclear programme.

ix) the planned new-build nuclear programme is difficult to plan or even deliver in comparison to RE deployments

There are probably just as many jobs, possibly more, created in direct and associated industries (eg civil engineering, construction, concrete, steel-making, welding, electrical works, back-up schemes, access roads etc) in a non nuclear-inclusive energy policy as in the current nuclear-inclusive (essentially nuclear-centric) policy. Job creation in renewable technologies are and would be much steadier over time and geographically widespread compared to the localised high employment surges that very large-scale nuclear projects would create.

For example, thousands of RE jobs have this year been curtailed by the current Government (in solar PV, onshore wind and offshore wind amounting to around 3-4 TWh/y additional output each year) to reduce 'subsidy' payments from the Levy Control Framework (LCF). Yet by December 2017 the LCF would have had to fund a Hinkley C output of 25 TWh/y had it been delivered as promised in 2011 (to cook the 2017 Xmas turkeys) instead of being 8 years late (if built and operating by Xmas 2025). Those nuclear jobs simply did not materialise between 2012 and 2017.

There is also no guarantee that Hinkley C or any other of the six planned multi-billion pound 3 GW projects would be started or delivered on time, if at all, which could be a significant cause of skills bottlenecks and planning problems with potentially serious economic and or energy policy consequences, emission-reduction and EU renewables commitments. It is only due to the major political parties rose-tinted view of new nuclear power that the economic and wider downsides of recent energy policy has been overlooked, down-played or dismissed.

In promoting nuclear power as a solution to climate change it was often argued that 'we need all the low-carbon technologies that we can get'. Yet the LCF and finite funding pot clearly limits some low carbon technologies at the expense of others. What would be a valid argument is 'that we need the best low-carbon technologies we can get'.

Recommendations

In view of the points above, which all have significant economic implications, HMG should cancel its planned nuclear programmes and aim to exit the expensive, embarrassing Hinkley C deal (+Bradwell) which is still vulnerable to unresolved technical, legal and possibly financing issues. The UK should focus energy policy (RD&D) on safe, secure and scaleable renewable energy and BECCS / bio-SNG technologies and industries, with potentially high British content, which the planned first-tranche 18 GW nuclear programme is already significantly marginalising and could cripple in the 2020s.

As regards UK industrial strategy the nuclear-centric focus of the major political parties, several engineering and other establishment circles is a high risk strategy and reckless in terms of non-proliferation. The promise of jobs in commercially-viable SMR technologies manufactured by British companies (eg Rolls Royce) or UK-based foreign SMR vendors, based on overcoming various technical issues and then achieving large-volume sales including exports, is a high risk promise. It may well not materialise.

Yet what is guaranteed to happen is a further and sustained negative impact of RE and CCS funding, British innovation, and deployment learning from 2016 and across the 2020s.

The following renewable energy technologies and energy systems are what the UK could be focussing on and investing in (not just at the margin) :

* floating offshore wind turbines (opening a massive UKCS resource)
* PVT systems (including district heating and inter-seasonal borehole heat stores at tens of GWh scale)
* large-scale lagoon schemes with integrated coastal defence (eg Somerset Levels)
* floating PVT technologies for export to arid zone countries for fresh water evaporation reduction and strategic-scale seawater desalination (eg for regional irrigation projects);
* bio-gasification of dryland biomass to Synthetic Natural Gas (eg agave and opuntia cacti with projects demonstrated in Commonwealth countries or bi-lateral co-operation eg cacti imports from Mexico),
* dumb Grids, insensitive to cyber attack (eg RE back-up schemes on local Grids) as distinct to nationwide smart technology (with smart disaster potential)

possibly also :

* pumped storage lagoons for electricity storage/Grid balancing
* novel low-disruption district-heating network installation techniques

continued :

Supplementary Recommendations

Public scrutiny of government department computer modeling : It would be useful if the 'black-box' computer models (MARKAL, etc) used by government departments to inform, advise and justify ministerial decision-making, especially for multi-tens of billion pound projects, have absolutely clear, transparent and realistic methodology and input assumptions set out on departmental websites eg including as a summary on two sides of A4, for public understanding and scrutiny.

The methodology must be subject to possible revision following informed and fair reasoning between departmental staff and non-government stakeholders. Otherwise the public (who pay the wages of the departmental staff and ministers) do not have access to proper scrutiny of the basis for decisions taken on their behalf.

Any impediment to scrutiny is virtually guaranteed to be abused at some point be it due to team group-think, bias in self-selecting staff and ministerial appointees, lack of devil's advocates (including public observers), ministerial pressure and or internal agendas. The model software may also contain an error or errors.

As regards the current energy policy advice it would be useful to know what assumptions were used for the cost of fast, flexible gas-fired back-up plant installed per GW, at what annual average fuel efficiency by year, what wind data was used, and what future offshore wind CfD costs were used. Also what non-nuclear scenarios were tested - including if biomass were combusted in post 2030 power stations or converted to bio-SNG for use in winter gas-fired RE back-up (eg via storage in the 30 TWh Rough gas caverns).

In the author's meeting with the CSA in February the CSA stated that they may not have time to model the non-nuclear scenarios I had presented because his team was busy. What confidence does such a statement inspire in due-diligence by a ministerial appointee, however objective, regarding one of the most expensive critical infrastructure projects on Earth with strategic UK security implications extending into the next century.

Smart Meter (SM) policy review : The £ 11 billion, repeat £ 11 billion, rollout of domestic electricity and gas Smart Meters should be reviewed in terms of objectives and outcomes and comparative spend. Gas SMs could well be dispensed with as any efficiency savings due to consumption awareness may well be transitory. Electricity SMs are also supposed to facilitate a reduction or shift in consumer demand at times of low supply from intermittent RE sources (wind, PV, tidal) eg a 2 GW ? shift by a few hours (washing machines switching on at 3 am rather than 8pm, etc).

Yet a £ 11 billion spend on gas-fired back-up (eg fast, flexible aero-derivative gas turbines at £ 450 million per GW installed, gas-engines or post 2025 fuel cells) could buy over 20 GW of back-up, repeat over 20 GW, which could match supply to demand for months not a few hours. It would be far cheaper to supply demand peaks rather than try to shift or suppress them.

About half of electricity demand has been on half-hour meters for years anyway (in industry and commercial sectors which are more appropriate for demand-side management). Domestic SMs would mainly benefit the Bix Six in billing costs and gathering data on consumer habits with major privacy implications (eg when showers and cookers are being used, when no-one is home, etc). Also, minister Ed Davey stated that consumers had a choice to have a costly SM installed or not but it now appears that some utilities are offering free installation and so are presumably spreading the cost across all their consumers.

A review could reassess the objectives and likely outcomes of an SM rollout and its value for money compared to an equivalent spend on other ways to meet useful outcomes.

Neil Crumpton 17 th November 2016