NFLA New Nuclear Monitor Policy Briefing

Edition Number 55, 21st December 2018

NFLA All Ireland Forum model submission to Irish Councils to respond to a transboundary environmental consultation of the potential impacts of the proposed Wylfa B development

i. Overview of Policy Briefing

This edition of the NFLA's New Nuclear Monitor provides a NFLA All Ireland Forum model submission for Irish Councils and interested groups to respond to the UK Government's transboundary consultation of the potential impacts on Ireland of the Wylfa B nuclear development.

The transboundary submission comes after the UK Government was instructed by the UN Espoo Convention Secretariat to hold such consultations for neighbouring European states, groups and individuals to make their representation on transboundary issues of concern, should the Wylfa B site in Anglesey be considered for development. At present the National Planning Inspectorate are holding an inquiry around approving a development control order to Horizon Nuclear to start developing the site. The NFLA All Ireland Forum is pleased that the Irish Government has initiated this consultation so quickly, given it was much slower to do so for the Hinkley Point development.

The Irish Government is initiating this consultation through Irish Councils and agreed responses that will be sent to the UK Government via the Councils. The closing date for responses is the **25th January 2018.**

To respond to the consultation - All Councils are collating responses from individuals and groups that come in via their Planning sections, and contact points for each Council can be found at -
https://www.housing.gov.ie/planning/other/transboundary-environmental-public-consultation-wylfa-newydd-nuclear-power-plant

The NFLA All Ireland Forum also encourages Irish Councils to send their own formal response of submissions or observations, using its model response below. If Councils do so, it would be helpful to give due credit to the NFLA.

1. Core summary of NFLA All Ireland Forum response to the consultation

The core concerns the NFLA has with the transboundary impacts to Ireland of the proposed Wylfa B nuclear reactor include:

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- The type of nuclear reactor being proposed for Wylfa B – the Advance Boiling Water Reactor (ABWRs) - have high gaseous emissions which are far more important than liquid emissions in terms of radiation doses to local people.

- Bearing in mind that Hitachi is proposing to build 2 ABWR reactors at Wylfa, it can be calculated around 6 deaths will occur somewhere in the world for every year the station operates.

- Over 60 years – the expected operating life for an ABWR - the total could be as much as 360 deaths.

- Wylfa B would produce extremely high levels of radioactive spent fuel. In the year 2200 its spent fuel arisings would amount to ***80% of the radioactivity contained in all existing legacy wastes from the UK's nuclear power industry.***

- The requirement for 'Best Available Techniques' (and clean technology) for producing electricity should rule out building new electricity generating stations which produce such highly dangerous wastes. Especially as less expensive, quicker and safer alternatives are available which don't produce such wastes.

- Energy efficient improvements could reduce the energy consumed in UK households each year equivalent to the output of six nuclear power stations the size of Wylfa B.

- Offshore wind and solar are now both able to generate electricity more cheaply than nuclear power. If the UK had continued renewable expansion at the same rate as between 2010 and 2015 it could have achieved an all-renewable UK electricity supply by 2025.

- In addition, a report from ESRI suggests, in the worst-case scenario, ***the economic cost of a nuclear accident impacting on Ireland could be as high as €161 billion.***

- An additional recent submission by NFLA / KIMO to the OSPAR Commission outlines that a full proposed UK new nuclear programme will only compound these issues and threatens the OSPAR Treaty regulations of 'close to zero' discharges into the Irish Sea by 2020 and beyond.

- Sea level rises exacerbate by climate change put at risk in the medium to longer term the Wylfa B coastal site.

2. Introduction

After significant pressure from Irish environmental groups including the NFLA All Ireland Forum, and a judgement from the Espoo and Aarhus Convention Committees, the UK Government has offered the opportunity to non-UK residents, governments and groups in Europe to make submissions and review the environmental impact report and the accompanying documents for possible cross-border environmental impacts. The NFLA All Ireland Forum welcomes this procedure being undertaken by the Irish Government through the Planning Sections of Irish Councils so as to allow Irish views on the transboundary impacts of a nuclear reactor development the other side of the Irish Sea to it.

This submission provides information that the NFLA has submitted to previous UK Government environmental consultation on Wylfa B, to the current National Planning Inspectorate inquiry into a Development Control Order for the proposed Wylfa B site, and to a joint response submitted by NFLA and KIMO International to the OSPAR Radiation Substances Committee.

3. Gaseous Discharges from an ABWR built at Wylfa

According to the UK Environment Agency's ABWR Assessment Report on gaseous radioactive waste disposal and limits published in 2017 (1) it is expected that each year the proposed ABWR-type reactors would emit to air 2700 gigabecquerels1 (GBq) of tritium; 910GBq of carbon-14; and 9180GBq of radioactive noble gases. These are large amounts of radioactivity when compared with the French EPR proposed for Hinkley Point C. The table below compares gaseous emissions from ABWR with the AP1000 (which was originally proposed for Moorside near Sellafield) and EPR reactor types.

Radionuclide	**EPR** (2)	**AP1000** (3)	**ABWRs** (4)	**Range for 1000 MWe station** (5)
Tritium	500GBq	1800GBq	2700GBq	100 – 3600GBq
Carbon-14	800GBq	606GBq	910GBq	40 – 530GBq
Radioactive Noble Gases	350GBq	8047GBq	1980GBq	100 – 10,000GBq

Table 1: Predicted gases discharges for a single reactor of each type.

The UK Committee on Medical Aspects of Radiation in the Environment (COMARE) recommended that as: "…*part of a new generation of plants, it might be expected that discharges would be lower than existing facilities, rather than 'within the range of historic discharges' which seems to be the criterion being applied by EA*." (6)

This begs the question: if EPRs can reduce tritium emissions to the atmosphere to 500GBq per reactor why can't ABWRs being planned for the Wylfa site?

4. Radiation Risks

In the assessment of radiation risks to local people, aerial emissions from nuclear reactors are more important than liquid discharges for two reasons. First, the key parameter in estimating radiation doses to local people from radioactive isotopes is their concentration in environmental materials. Contrary to popular perceptions, air emissions result in much higher environmental concentrations than sea discharges, because water is much more effective than air at diluting contaminants. This is not to accept that dilution is the solution to pollution: it isn't. It merely reflects the fact of current (ill-advised) methods of disposing nuclear wastes. (7)

Second, individual and collective doses from aerial emissions are much larger than from sea discharges. People living near Nuclear Power Plants (NPPs) receive doses from eating contaminated food, drinking contaminated water, breathing contaminated air, and skin absorption (especially of tritiated water vapour).

For example, the contamination of local foods occurs by air emissions - particularly tritium and carbon-14 emissions. The only exception is contaminated sea foods. But these concentrations are very low. People who elect to live near discharge sites can largely avoid eating contaminated sea foods but, they cannot avoid breathing contaminated air from aerial emissions. It is for these reasons that NPP operators go to considerable lengths to divert radioactive releases away from aerial emissions towards sea discharges. The tritium discharges to sea for example from the AP1000 type of reactor are almost 20 times larger than tritium air emissions. With the ABWR this situation is revered with tritium emissions to the atmosphere thirteen times larger than tritium emissions to the sea.

It is also worth noting that COMARE has highlighted the recent report of the Advisory Group on Ionising Radiation (AGIR) (November 2007) which suggests that current dose estimates for tritiated water are ***too low***. (8)

5. Tritium

The largest aerial emissions are of tritium in the form of tritiated water vapour, i.e. radioactive water. In recent years, many official reports have discussed the hazards of tritium - the radioactive form of hydrogen. In the past, this isotope had been regarded as being only “weakly” radiotoxic: this view is now changing among governments and international agencies concerned with radiation exposures. For example, recent reports have been published by radiation safety agencies in the UK, Canada and France. (9) These reports draw attention to the hazardous properties of tritium including its extremely rapid distribution in the environment, its heterogeneous distribution within tissues, its ability to bind with organic molecules resulting in higher doses, and its high biological effectiveness compared with gamma radiation.

Over 60 epidemiological studies world-wide have examined cancer incidences in children near nuclear power plants (NPPs): ***most of them indicate leukemia increases***. These include the 2008 KiKK study commissioned by the German Government which found relative risks (RR) of 1.6 in total cancers and 2.2 in leukemias among infants living within 5 km of all German NPPs. The KiKK study has retriggered the debate as to the cause(s) of these increased cancers.

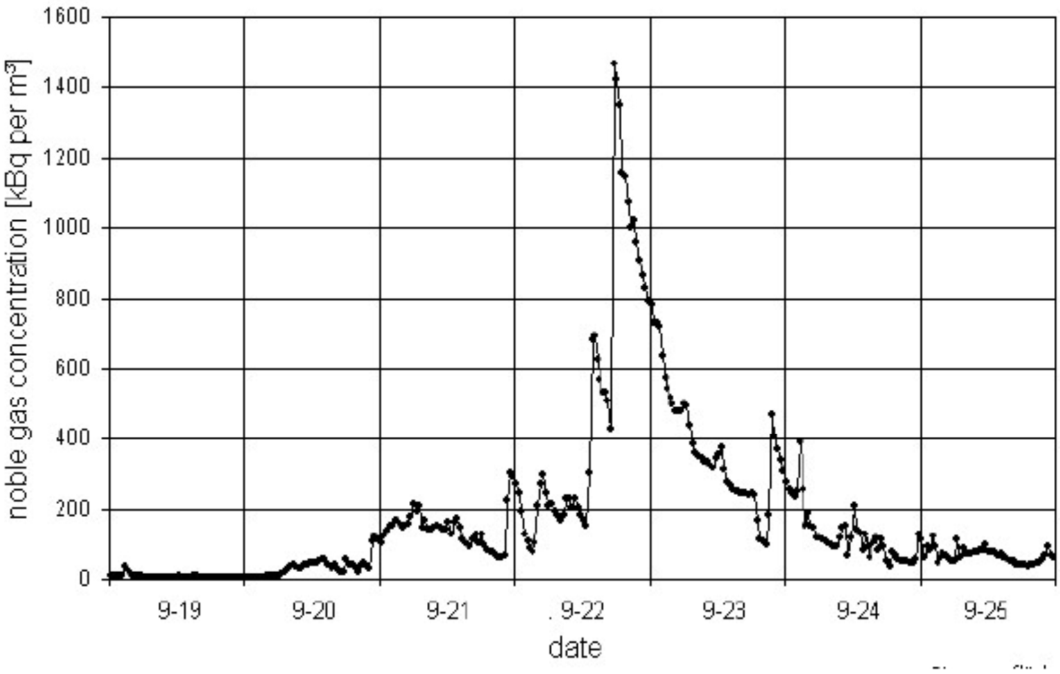
Although several studies in the late 1980s and early 1990s revealed increased incidences of childhood leukemia near UK nuclear facilities, official estimated doses from released nuclides suggest these would have been too low by 2 to 3 orders of magnitude to explain the increased leukemias.

A suggested hypothesis is that the increased cancers arise from radiation exposures to pregnant women near NPPs. However any theory has to account for the >10,000 fold discrepancy between official dose estimates from NPP emissions and observed increased risks. An explanation may be that doses from spikes in NPP radionuclide emissions are significantly larger than those estimated by official models which are diluted through the use of annual averages. In addition, risks to embryos/fetuses are greater than those to adults, and haematopoietic tissues (stem cells that create other blood cells) appear more radiosensitive in embryos/fetuses than in newborn babies. The product of possible increased doses and possible increased risks per dose may provide an explanation. (10)

The evidence for radionuclide spikes during refuelling was revealed for the first time in November 2011. Published data from the Gundremmingen NPP in Southern Germany showed that very large spikes of radioactive noble gases were released during refuelling than were emitted during normal power operation throughout the rest of the year. (See graph below). According to the International Physicians for the Prevention of Nuclear War (IPPNW) in Germany, the normal emission concentration during the rest of the year is about 3kBq/m3 but during inspection/refuelling episodes this concentration increased to ~700kBq/m3 with a peak of 1,470kBq/m3. Nuclide emissions during the period of refuelling were about 65% of total annual releases. Noble gas concentrations can be used as a proxy for other gaseous emissions, including tritium, C-14 and iodine releases. (11)

The table below provides this information:

Graph 1. Noble gas concentrations from Gundremmingen C. 1/2 hourly values. Sept 19 to 25



In order to refuel, the pressure vessels of all nuclear reactors are opened up about once a year. This releases large volumes of radioactive gases and vapours, including noble gases, tritium, carbon-14 and iodine-131, to the environment. Until now, these nuclide releases had been published only as annual data throughout the world. After repeated requests by the SPD-Green Party Government in Bavaria, half-hourly data were made available for scientific evaluation for the first time. Brief exposures to high concentrations are more hazardous to residents near NPPs than chronic exposures to low concentrations. Exposures to high concentrations result in higher internal doses, so these nuclide spikes during re-fuelling could go a long way to explaining the increased incidences of child leukaemias near NPPs shown by the KiKK findings.

6. Liquid Discharges

Radionuclide	EPR (12)	AP1000 (13)	ABWRs (14)	Range for 1000 MWe station
Tritium	52,000GBq	33,400GBq	200GBq	2,000 – 30,000Gbq
Carbon-14	23GBq	3.3GBq		3-45GBq
Iodine radionuclides	7MBq	15MBq	0.035MBq	10-30MBq
Other radionuclides	0.6GBq	2.7GBq	2.3MBq*	<1-15GBq

Table Two: Predicted liquid discharges for a single reactor of each type.

*This is Fe-55. According to the Environment Agency the aqueous discharge activity is dominated by tritium (H-3), which is not abated and constitutes over 99.99% of the activity in the aqueous discharges. The second largest contributor of activity to the discharges is iron-55 (Fe-55), which only constitutes 0.0012% of the activity discharged.

With regard to the UK's proposed new reactor programme concern has been expressed about the UK's lack of compliance with its obligations under the OSPAR Convention on the Protection of the Marine Environment of the North East Atlantic. (15)

Under the treaty the UK Government is committed to:
"...*progressive and substantial reductions of discharges, emissions and losses of radioactive substances, with the ultimate aim of [achieving] concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances*." [by 2020].

The application of "*best available techniques and best environmental practice, including, where appropriate, clean technology*" is one of the Guiding Principles of the OSPAR Strategy with regard to radioactive substances. (16)

"Clean Technology" should not, in the view of many environmental commentators, involve end-of-pipe filters to remove pollution from discharges to the environment – it should be a technique which produces no pollution to begin with. The requirement for 'Best Available Techniques' (and clean technology) for producing electricity should rule out the possibility of building new electricity generating stations which produce highly dangerous wastes when alternative ways of generating electricity are available which don't produce such wastes.

The EA's Final Assessment Report on Aqueous Waste, published in 2017, makes no mention of the OSPAR requirement for progressive and substantial reductions in discharges of radioactive substances and achieving close to zero concentrations in the environment for artificial radioactive substances by 2020.

7. Critical Group Doses

The NFLA notes that the UK environmental regulators the Environment Agency (EA) and Natural Resources Wales (NRW) have assessed that the total impact of radioactive discharges (including gaseous discharges) from a single ABRW reactor to the most exposed person to be around 14 - 24μSv y^{-1}. The contribution from aqueous discharges is less than 1 μSv y^{-1} illustrating the point made earlier that aerial emissions are more important than liquid discharges. The critical group dose from aerial emissions is dominated by carbon-14.

These numbers compare with the radiological dose limits to members of the public of 1,000μSv y^{-1} with dose from any single new source not to exceed 300μSv y^{-1}. The former Health Protection Agency (now Public Health England) had advised the UK Government to select a constraint value of less than 150 μSv (0.15mSv) per year for members of the public for new nuclear power stations. (17)

The UK Strategy for Radioactive Discharges 2001-2020 included an aim to progressively reduce human exposure to ionising radiation arising from radioactive discharges, so that a representative member of a critical group of the general public will be exposed to an estimated mean dose of no more than 20μSv y^{-1} from liquid radioactive discharges to the marine environment made from 2020 onwards. (18) The 20μSv y^{-1} figure was subsequently dropped from the 2009 updated strategy without explanation, but it still aims for "*progressive reductions in human exposures to ionising radiation resulting from radioactive discharges*." (19)

Given that the Wylfa B proposal is to build two ABWR reactors, each potentially giving a critical group dose of 24μSv y^{-1}, the 20 μSv y-1 figure could be breached albeit from a combination of liquid and gaseous discharges.

8. Collective Doses

In 1991, the International Commission on Radiological Protection (ICRP) adopted a linear, no-threshold model for radiation's effects. Thus no dose of radiation, no matter how small is without some added level of risk. Collective dose is an important measure of the total exposure of a population over time from a given release of radionuclides and it is an indicator of total detriment to health. The collective dose is, to a first approximation, the average individual dose in an exposed population multiplied by the size of the population. Collective dose represents an attempt to quantify the radiological impact of radioactive discharges to populations larger than the critical group. Collective doses are measured in person-sieverts (person Sv).

Collective doses are sometimes calculated for UK or European populations, but for radionuclides which have long half-lives and become globally dispersed, including tritium, carbon-14, krypton-85 and iodine-129, it is internationally accepted practice to calculate their global collective doses. Calculating the global collective dose can also be seen as morally important when one considers the fact that no-one outside the UK is receiving a countervailing benefit from discharges.

As with critical group doses, estimates of the risks associated with a particular collective dose are fraught with uncertainties and unknowns. The behaviour of radionuclides in the global environment must be predicted over long time-scales and the computer models used to do so are unlikely to be validated by comparison with sufficient data. Future human behaviour and the behaviour of each radionuclide in the human body must also be predicted and estimation of the dose-risk factor in itself involves a large number of assumptions and several models all with uncertainties attached which have to be multiplied together.

Such risks from collective doses are underestimates as they do not include detrimental human health effects other than fatal cancers (e.g. skin cancers) and genetic effects.

Of course the above dose/risk estimates in this report neglect detriment to ecosystems, organisms and species.

It is sometimes argued that collective doses should be truncated to 500 years, because after that the uncertainty becomes too great. However, just because there is uncertainty does not seem to be a good enough reason to assign a zero risk.

To convert from collective doses to fatal cancers, the ICRP's absolute fatal cancer risk of 10% per Sv can be used, although some analysts apply a dose and dose rate reduction factor (DDREF) which reduces the number of estimated fatal cancers in Europe by a factor of 2, and in the US by 1.5. However, as pointed out by Beyea (2012) many epidemiology studies offer little support for the use of such a factor, certainly for solid cancers (Little et al, 2008). Also, the recent WHO (2013) report on risks from Fukushima recommends that a DDREF should not be used for longer term exposures. (20)

The EA and NRW report that its independent assessment calculated collective doses to be 30 person Sv per year of discharge for the world (truncated to 500 years). (21)

The radiation protection community is usually reluctant to translate collective dose into numbers of deaths. This seems to stem from the Greenpeace campaign during the THORP public consultation in 1993-4 when it was argued that THORP would cause 600 deaths (calculated using a 5% risk factor). But Sumner and Fairlie have stated that radiation protection should be about protecting people, not the industry from criticism. (22) Bearing in mind that Hitachi is proposing to build 2 ABWR reactors at Wylfa B, the total collective dose would be in the region of 60 person Sv per year of discharge. By applying the risk factor of 10% per sievert it can be calculated that this means there will be around 6 deaths somewhere in the world for every year the station operates. Over 60 years, the total could be 360 deaths.

9. Uncertainties

There are many uncertainties in current estimates of radiation doses and risks and larger uncertainties exist with internal radiation. These arise mainly from the many steps used to derive doses, and partly from lack of statistical precision in deriving risks from epidemiology studies. The size of these uncertainties has been estimated by a number of expert dosimetrists: for some nuclides these are very large. A report by the Committee Examining Radiation Risks of Internal Emitters (CERRIE) recommended that uncertainties should be acknowledged and dealt with by the government. Its parent committee, the Committee on Medical Aspects of Radiation in the Environment COMARE, backed these findings. (23)

A 2001 Consultation Paper from the UK Department for Environment Food and Rural Affairs summed up the view which prevailed at the time:

"*The unnecessary introduction of radioactivity into the environment is undesirable, even at levels where the doses to both humans and non-human species are low, and on the basis of current knowledge are unlikely to cause harm*" (24)

10. Radioactive Waste Volume

The nuclear industry and the government repeatedly claim that the volume of nuclear waste produced by new reactors will be small, approximately 10% of the volume of existing wastes; implying this additional amount will not make a significant difference to finding an underground dump for the wastes the UK's nuclear industry has already created. The use of volume as a measure of the impact of radioactive waste is, however, highly misleading. (25)

Volume is not the correct measure to use to assess the likely impact of wastes and spent fuel from a new reactor programme, in terms of its management and disposal. The 'high burn-up fuel' which Wylfa Newydd is expected to use will be much more radioactive than the spent fuel produced by existing reactors like Heysham 1 and 2. So rather than using volume as a yardstick, the Bq amounts of radioactivity in the waste, (which in turn affects how much space will be required in a GDF), is a much more appropriate way of measuring the impact of nuclear waste from new reactors.

According to Radioactive Waste Management (RWM) Ltd, the radioactivity from existing waste (i.e. not including new reactors) is expected to be 4,770,000 terabecquerels (TBq) in the year 2200.

For the NFLA, it would be interesting to see how much the mooted Wylfa B reactors would add to this pile. This can be estimated from the Radioactive Waste Management Ltd Derived Inventory 2013. This calculated that the waste inventory in 2200 after a 16GW programme of new reactors would be around 27,300,000 TBq – an extra 22,530,000TBq or 1,408,125TBq for every GW of new nuclear capacity. If we multiply this by Wylfa Bs proposed 2.7GW of capacity we get 3,801,938TBq. ***This is about 80% of the radioactivity in existing nuclear wastes.*** (26)

The UK Government expects spent fuel from the proposed new generation of reactors to be stored not reprocessed. In fact the Thermal Oxide Reprocessing Plant (THORP) at Sellafield which reprocesses the spent fuel from Heysham closed in November 2018, and there are no plans to replace it. Instead spent fuel is expected to be emplaced between 200 and 1000 metres underground in a Geological Disposal Facility (GDF) –(27) a site for which has still to be found. A GDF is not expected to be ready to receive such wastes until around 2045. The UK and Welsh Governments have initiated a process to seek 'volunteer' communities to consider hosting such a facility – this is the seventh attempt by UK authorities over the past 40 years to do this, and great uncertainty still exists as to whether the eight attempt will be successful.

Waste from new reactors like Wylfa B is not expected to be emplaced in the GDF until after all the government's existing waste has been emplaced which is expected to take around 90 years – around 2130. This means that spent fuel could remain on the site for at least the next 100 years. The other factor which needs to be taken into account is that Wylfa Newydd s expected to use high-burn up fuel which could require up to 100 years of cooling before it will be cool enough to be emplaced in a GDF. So assuming Wylfa Newydd comes on stream around 2030, although spent fuel might start to be emplaced in 2130, as the reactors are expected to have a life of 60 years, there may be some spent fuel still stored on Anglesey up until about 2190.

11. Safer, sustainable renewable energy alternatives to Wylfa B

Clearly there are cleaner ways to generate electricity available which do not discharge radioactive wastes into our atmosphere and seas. These should be used in preference to building Wylfa B. The evidence is stacking up to show that, in the words of Professor Keith Barnham, author of '*The Burning Answer: A user's guide to the solar revolution*' the UK "…*doesn't need a new generation of expensive nuclear reactors or a dash for shale gas to keep the lights on. An all-renewable electricity supply can provide energy security*." (28)

The Environmental Impact Assessment for Wylfa B should compare the potential impact of building two new ABWR reactors in Anglesey, Wales, with improving energy efficiency or supplying energy from alternative sources such as renewable energy. Horizon Nuclear's Environment Statement does not do that.

NFLA notes that, according to the UK Energy Research Centre (UKERC), energy efficient improvements to home heating, insulation, lighting and appliances could reduce the energy consumed in UK households each year the equivalent to the output of six nuclear power stations the size of Hinkley Point C saving consumers £270 off the average household energy bill of £1,100. (29) In fact, when the UK government first endorsed Hinkley Point C, (HPC) it was projecting an increase in electricity consumption of 15% by now, whereas in practice the UK is consuming 15% less than a decade ago. In other words Government projections were out by 30%, and the need for new nuclear therefore lessens. (30)

The price of £57.50 per megawatt hour unveiled recently for two giant wind projects, off the coast of the UK is almost half the level expected to be paid for HPC - £92.50/MWh at 2012 prices (which by now will be around £100/MWh). What is more the offshore wind payments only continue for 15 years compared with nuclear payments which continue for 35 years.

NFLA also note that, according to the *Daily Telegraph,* Britain could theoretically produce up to 595GW from offshore wind at competitive cost, an order of magnitude more than Britain's entire power needs, even at peak times in the dead of winter (53GW). Some excess power could be sold to Europe through interconnectors, and some could be turned into hydrogen through electrolysis and used to replace fossil gas. (31)

Solar power, once so costly it only made economic sense in spaceships, is becoming so cheap that it will push coal and even natural-gas plants out of business faster than previously forecast according to the Bloomberg New Energy Finance (BNEF) outlook. (32) According to the 100% renewable utility, Good Energy, the wholesale price of electricity in the UK is falling, mainly due to the rise in solar photovoltaics (PV) and wind power. (33) Emeritus Professor Keith Barnham says if renewable expansion had continued at the same rate it did between 2010 and 2015 we could have achieved an all-renewable UK electricity supply by 2025.Why cull such popular and successful industries, apart from the political imperative to develop new nuclear?

The UK has more than 32GW of renewable power, 10 times the power the Hinkley Point C nuclear plant may achieve in 2030. Hinkley's power is not only almost irrelevant; its inflexible nature will make it redundant. Once operating, a nuclear reactor should run with constant output, 24/7, month to month, but power that complements wind and PV has to vary in less than one hour. What the UK needs (like Ireland) is flexible, not continuous baseload power generation to back up wind and PV power. (34)

Clearly, the electricity which HPC is expected to generate could be replaced by energy efficiency measures and renewable energy systems more cheaply, more quickly and without radioactive discharges to the environment or the generation of radioactive waste. The risk that the UK, Irish and European public will be subjected to by the construction of HPC can, therefore, no longer be justified.

12. Additional observations

NFLA would like to note a number of additional observations, which add relevant concerns.

ESRI report – The Potential Economic Impact of a Nuclear Accident: an Irish Case Study

This 2016 report was commissioned by ESRI for the Irish Environmental Protection Agency to consider what the economic impacts could be from a UK or French based nuclear accident sending a radiation cloud over parts of the island of Ireland. (35) The report looked at a range of scenarios from one where no radioactive contamination occurs, to others with minor, significant or high on-land contamination. NFLA encourages the UK Government to study this report and respond directly to its totality as part of this consultation process.

'Headline' issues noted from the report include:

- In the worst-case scenario, a nuclear disaster in North West Europe (originating from the UK or France in particular) could create total economic damage to the Irish economy of **€161 billion.**
- Irish agricultural production would grind to a halt, with the tourism industry and exports also incurring substantial damage.
- Even the most benign scenario considered by ESRI, where no radioactive contamination occurs, could still see a total loss estimated at €4 billion, due to the reputational damage this could have on Ireland.
- By comparison, the total value of corporation tax collected in the first nine months of 2016 (when the report was published) was €4.16 billion.
- ESRI also acknowledge that their analysis ***underestimates*** the true extent of such an incident to its cost to the economy.
- For example, in addition, health risks from high levels of radioactive contamination, could put a significant strain on the health service, requiring additional resources to be found.
- The total cost of a low-level radioactive contamination scenario, which requires the imposition of food controls to reassure the public and restrictions food imports to Ireland, would be €18 billion.
- The impact on tourism would also be significant, with long-term reputational damage resulting in an economic cost of €80 billion.
- In the absolute worst-case scenario in the ESRI study, not only would exports be decimated but the need to import much of the country's food would lead to far higher domestic costs. There could also be significant emigration.

NFLA / KIMO submission to the OSPAR Radiation Substances Committee -

In early 2018, NFLA was commissioned by KIMO International, to consider the potential impacts of the entire proposed UK new nuclear programme, which at that time included Hinkley Point, Wylfa, Sellafield Moorside, Sizewell, Bradwell, Oldbury, Heysham and Hartlepool. (36)

This table summarises the levels of planning electricity such a programme could generate:

Proposed Nuclear Station	Technology Proposed	Developer	Construction start expected	Commercial operation forecast
Hinkley Point C (Somerset)	2 x 1600MW EPRs	EDF 66.5% CGN 33.5%	First concrete 2019	End of 2025 with risk of 15 month delay (11)
Wylfa Newydd (Anglesey)	2 x 1350MW ABWRs	Horizon Nuclear Power - wholly owned subsidiary of Hitachi, Ltd.	2020	First electricity mid-2020s - 2025-2028 (12)
Moorside (Cumbria)	3 x 1150MW AP1000s (but could be replaced by 2 x 1400MW APR1400)	NuGen (currently owned by Toshiba – but hoping to sell to KEPCO) (13)	No date – but a 4-5year Generic design Assessment process required for APR1400, so ~2023-4	Not by 2025 – no new date
Sizewell C (Suffolk)	2 x 1600MW EPRs	EDF 80% CGN 20% (14)	2021	2031 (15)
Oldbury B (Gloucestershire)	2 x 1350MW ABWRs	Horizon Nuclear Power - wholly owned subsidiary of Hitachi, Ltd.	Late 2020s at the earliest. (16)	Mid to late 2030s?
Bradwell B (Essex)	2 x 1000MW UK HPR1000	CGN 66.5% EDF 33.5% (17)	No defined timeline; began GDA process in Jan 2017	

The NFLA / KIMO submission also considered the potential levels of gaseous and aqueous discharges from such a programme.

Given that there are four EPRs proposed, three AP1000s and four ABWRs from Table 1 above we can derive the total gaseous discharges from the proposed new nuclear programme noted in Table 3.

Table 3: Predicted gaseous discharges from notional UK new reactor programme

Radionuclide	4 x EPRs	3 x AP1000s	4 x ABWRs	Total
Tritium	2,000GBq	5,400GBq	10,800GBq	18,200GBq
Carbon-14	3,200GBq	1,818GBq	3,640GBq	8,658GBq
Radioactive Noble Gases	1,400GBq	24,141GBq	7,920GBq	33,461GBq
Radio-iodines	200MBq	630MBq		830MBq

Similarly from Table 2 we can derive the following liquid discharges shown in table 4.

Table 4: Predicted liquid discharges from notional UK new reactor programme

Radionuclide	4 x EPRs	3 x AP1000	4 x ABWRs	Total
Tritium	208,000GBq	100,200GBq	800GBq	309,000GBq
Carbon-14	92GBq	9.9GBq		101.9GBq
Iodine radionuclide	28MBq	45MBq	0.14MBq	73.14MBq
Other radionuclides	2.4GBq	8.1GBq	9.2MBq	10.5GBq

The report goes into detail about these issues and it concludes:

- Gaseous and liquid emissions from the UK's proposed new reactor programme could mean up to 23 theoretical deaths somewhere in the world for every year all of the reactors operate. Since they are each expected to operate for 60 years the total number of theoretical deaths could be 1380.
- The new reactors would produce extremely high levels of radioactive spent fuel. In the year 2200 spent fuel arisings would amount to almost five times the radioactivity contained in all existing legacy wastes from the UK's nuclear power industry.
- The requirement for 'Best Available Techniques' (and clean technology) for producing electricity should rule out building new electricity generating stations which produce such highly dangerous wastes. Especially as less expensive, quicker and safer alternatives are available which don't produce such wastes.

These two additional reports adds much to the concerns of the NFLA All Ireland Forum that the transboundary impacts of Hinkley Point C and the wider UK new nuclear programme could be significant and severe.

13. Sea Level Rise

In 2007, a report for Greenpeace by the Middlesex Flood Hazard Research Centre took as the basis for its worse-case scenario the collapse of the West Antarctic Ice Sheet (WAIS), which would trigger an abrupt and extreme rise in sea level, estimated at 5-6m. The report pointed out that there are widely divergent opinions on the likelihood of this extreme sea-level rise but one view is that WAIS collapse could begin in the 21st century. (37)

In 2012 an assessment, carried out by the Department of Environment, Food and Rural Affairs, of the risk of flooding and storm surges for the UK's nuclear sites did not show a high risk of flooding and erosion by 2080 at Wylfa. (38) Nevertheless, it might be expected that Horizon Nuclear would at least mention that it has looked into the risks to the site of sea level rise, when there is little evidence that it has.

The 2012 assessment was before the increasing volume of melting of the Greenland ice cap was properly understood and when most experts thought there was no net melting in the Antarctic. Now estimates of sea level rise in the next 50 years have gone up from less than 30cm to more than a metre, well within the operating lifespan of Wylfa B – let alone the period before final decommissioning of the reactors, and the period when spent nuclear fuel is likely to be stored on site.

Some researchers say sea levels could rise by six metres or more even if the 2 degree target of the Paris accord is met. Sustained warming of one to two degrees in the past has been accompanied by substantial reductions of the Greenland and Antarctic ice sheets and sea level rises of at least six metres – several metres higher than what current climate models predict could occur by 2100. (39)

NFLA note that one group of researchers believe we could soon cross a threshold leading to boiling hot temperatures and towering seas in the centuries to come. Even if countries succeed in meeting their CO_2 targets, we could still lurch on to this "irreversible pathway". The climate might stabilise with 4-5 degrees C of warming above the pre-industrial age. Thanks to the melting of ice sheets, the seas could be 10-60 metres higher than now. (40)

Such issues are of real and great concern for a coastal site like the proposed Wylfa project.

14. Conclusions

ABWRs have high gaseous emissions which are far more important than liquid emissions in terms of radiation doses to local people. Bearing in mind that Hitachi is proposing to build 2

ABWR reactors at Wylfa we can calculate around 6 deaths will occur somewhere in the world for every year the station operates. Over 60 years the total would be 360 deaths.

Wylfa Newydd would produce extremely high levels of radioactive spent fuel. In the year 2200 its spent fuel arisings would amount to 80% of the radioactivity contained in all existing legacy wastes from the UK's nuclear power industry.

The requirement for 'Best Available Techniques' (and clean technology) for producing electricity should rule out building new electricity generating stations which produce such highly dangerous wastes. Especially as less expensive, quicker and safer alternatives are available which don't produce such wastes.

Other concerns, like the economic damage to Ireland of a nuclear accident, and the real concern over sea level rises also suggest this proposed development should not go ahead.

There are cheaper, waste free sustainable renewable energy alternatives, which coupled with energy efficiency and energy storage schemes, are much more quicker to develop with none of the environmental externalities that new nuclear facilities would inevitable create.

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