Net Zero, Energy and Transport Committee Consultation: "Scotland's electricity infrastructure: inhibitor or enabler of our energy ambitions?"

NUCLEAR INDUSTRY ASSOCIATION RESPONSE – 17 APRIL 2023

The NIA welcomes the opportunity to submit evidence to this inquiry. We have endeavoured to confine our answers to those areas relevant to nuclear energy in Scotland and within our expertise. The NIA is also willing to provide oral evidence to the committee if so desired.

The NIA is the trade association and representative body for the civil nuclear industry in the UK. We represent more than 250 companies operating across all aspects of the nuclear fuel cycle and in all parts of Britain.

Electricity network readiness

1. Do the current business plans from Scottish and Southern Energy Networks (SSEN) and ScottishPower Energy Networks (in relation both to transmission and distribution) allow for sufficient investment in networks to realise the Energy Strategy's ambitions?

- n/a

2. To what extent are SPEN and SSEN able to alter investment plans in response to a fast-moving policy environment?

- n/a

System resilience

3. What role will dispatchable* electricity sources - pumped hydro, battery technologies, thermal generation (hydrogen power, gas with CCS) - play in ensuring security of supply and system resilience? Should any other technology play a role in supporting Scotland's electricity system?

- Scotland also needs nuclear power to ensure security of supply and system resilience.

- Nuclear power is the only clean, non-weather dependent, dispatchable technology proven and deployed at scale.

    - The UN Economic Commission for Europe recently concluded that the whole nuclear lifecycle has the lowest carbon emissions, lowest land demand, lowest impact on ecosystems and low mining and material use compared to all other electricity-generating technologies.[1]

[1] Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources: https://unece.org/sites/default/files/2022-08/LCA_0708_correction.pdf

        - Current estimates put gas + CCS lifecycle emissions at 130 grams of CO_2 per kWh of electricity, 25 times higher than nuclear at 5.1g., according to the UN's Economic Commission for Europe.[2]

- Nuclear power can be used either to provide constant, baseload electricity, as it has done in Scotland for 65 years, or more flexible, dispatchable power, as it has in France for more than 40 years. Again, it is the only clean technology that has these capabilities.

    - Scotland has a proud history in nuclear deployment and generates and consumes more nuclear power proportionally than any other nation of the United Kingdom. 30% of Scottish electricity came from nuclear in 2021. [3]

    - Nuclear power has saved Scotland more emissions than any other energy source. Hunterston B and Torness power stations have been the most valuable and productive green energy assets in Scottish history, generating enough electricity to power every home in Scotland for 60 years while saving over 400 million tonnes in carbon emissions, equivalent to 9 years of Scotland's entire carbon output.[4]

    - Nuclear energy is Scotland's most efficient energy source in terms of land use: Torness Nuclear Power Station takes up just 0.11 square miles of land, from which it produces 15-20% of Scotland's electricity.

    - The energy density of nuclear cannot be overstated: the whole UK nuclear fleet uses just 0.57 square miles of land, containing nearly 6GW of clean capacity, from which it generates 15% of the country's electricity, enough for 10-11 million homes. No other energy source comes close to this.

        - For perspective, just one nuclear fuel pellet, the size of a fingertip, can generate the same amount of electricity required to power an electric vehicle for 20,000 miles.

        - A kilogram of uranium can release about 3 million times the energy of a kilogram of coal.

- Since Scotland will have a non-negligible minimum grid demand in a net zero world, it should look to preserve the historic 25-30% nuclear baseload contribution alongside the significant expansion of renewable technologies. This will ensure grid stability, security of supply, and affordable decarbonisation.

- Scotland's own experience shows that a mix of clean technologies is more effective than excluding nuclear. The South Scotland region, as defined by National Grid (taking in Glasgow, Edinburgh, and up to Stirling and St Andrews), is home to Torness Nuclear Power Station as well as substantial renewable energy assets. In contrast, North Scotland has no nuclear stations to stabilise the grid.

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[2] *Ibid.*

[3] Electricity generation and supply in Scotland, Wales, Northern Ireland, and England, 2017 to 2021: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1126111/Regional_electricity_generation_and_supply_2017-21.pdf

[4] NIA calculations based on IAEA PRIS database reactor output figures.

    - South Scotland, despite having many times more people and power demand, has 35% cleaner power than North Scotland. In 2022, South Scotland had an average carbon intensity of 55gCO_2eq/kWh, and North Scotland being 86gCO_2eq/kWh.[5]

- International experience bears out the need for proven nuclear technology in the mix. With nuclear, hydro and wind, Sweden has the cleanest power in the EU. Germany, which has phased out nuclear while building up renewables, burns more coal than anybody else in the EU.

- It should also be noted that pumped hydro, battery storage and hydrogen power are not primary energy sources but stored primary energy via an energy vector and initially require primary energy from another source to be generated. Many of these technologies are indeed necessary for short-term balancing of the grid and peaking power. Still, we should not try to use them to substitute for proven, clean baseload electricity from nuclear.

    - Using multiple-technology solutions is inherently more inefficient than single-technology solutions and would involve significant capital costs for technologies that do not produce primary energy.

        - This year, Bloomberg reported that 4-hour grid-scale battery storage costs will remain incredibly high throughout this decade.[6]

        - The largest battery storage system in operation is California's Moss Land Energy Storage Facility. It can discharge 400 MW of power for 4 hours (1,600 MWh) in total.[7] That is equivalent to 1/3 of the output of Torness Nuclear Power Station (1200 MW) for an afternoon. However, it is not a substitute for baseload power.

- The initial focus for the use of these technologies should be to examine their viability for peaking power at short notice at times of very high demand. This service is currently provided by pumped hydro facilities and by unabated gas generation.

    - Again, these emerging technologies should not be used to replace the very large, predictable and stable output of nuclear power stations.

- We should also consider how the deployed dispatchable technologies support the economic prosperity of the country and communities as a whole. The nuclear sector across the UK has a gross value added per worker of nearly £100,000 twice the national average, which is reflected in wages at nuclear facilities.

    - In Scotland, the sector employs more than 3,500 people: 24% of direct employment in the sector in Scotland occurs in the most deprived 10% of local authorities. That number rises to 48% in the most deprived 25% of local

[5] NIA calculations based on daily National Grid ESO grid mix data.
[6] https://www.bloomberg.com/news/articles/2023-01-12/even-high-battery-prices-can-t-chill-the-hot-energy-storage-sector
[7] The Top 5: Largest Battery Energy Storage Systems Worldwide: https://www.saurenergy.com/solar-energy-news/the-top-5-largest-battery-energy-storage-systems-worldwide.

authorities. It is crucial that energy infrastructure development supports the communities that need it with high-quality jobs and investments like this.

4. What are the key barriers to deploying these technologies and how should they be addressed?

- Carbon capture from fossil gas plants is unproven at scale, and ultimately uncompliant with net zero, as there are still significant residual carbon emissions, plus emissions from initially obtaining the fuel.

  - Continued demand for fossil gas as the primary input will still expose consumers to global gas market volatility. Therefore, the cost of CCS plants will be set by international gas prices, with the added cost of carbon capture and storage.

  - Current estimates put gas + CCS lifecycle emissions at 130 grams of CO_2 per kWh of electricity produced. According to the UN's Economic Commission for Europe, this is compared to 37g for solar, 14g for wind, and 5.1g for nuclear.[8]

  - The initial focus of carbon capture technologies should be on the decarbonisation of industry, which will require temperatures that only fossil fuel burning can currently produce, and on potential viability for peaking power. It should not be to meet stable, predictable power demands best met by clean baseload from nuclear.

- Using hydrogen as thermal, grid-scale generation is highly inefficient. This involves powering electrolysers with excess electricity, storing it, then burning it to drive a turbine to make electricity again, with each stage involving significant yield loss.

  - These challenges mean that it is likely to be most suited in the electricity system to provide peaking power for short periods at times of high demand, and not to replace the stable, predictable baseload power output of nuclear power stations.

  - Hydrogen storage and transport are also complex and expensive processes, with leakage remaining an unresolved problem. Recent reports for the UK Government show that H_2 gas, especially leakage, has Global Warming Potential that should be considered.[9]

- Nuclear power, by contrast, is proven at a market, commercial and technological level. In addition, after the retirement of Scotland's only operating station at the end of this decade, there will be 3GW of unused Grid connections at Hunterston and Torness, strengthening the case for those to be used as nuclear new build sites. The availability of this infrastructure removes a key difficulty facing projects elsewhere.

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[8] Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources: https://unece.org/sites/default/files/2022-08/LCA_0708_correction.pdf
[9] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1067144/atmospheric-implications-of-increased-hydrogen-use.pdf

5. Do proposed UK Government reforms to the electricity capacity market align with the Draft Energy Strategy?

- n/a

Wind energy
6. What are the key barriers to achieving the Scottish Government's ambition for onshore and offshore wind contained in the Draft Strategy; could the readiness of the electricity network to accommodate new projects affect the business case for the proposals?

- The NIA cannot comment on the specific effects on business cases but is at pains to stress that we support network investment to accommodate increased renewable power generation.

- We do think that in addition to this, the Scottish Government should make use of the approximately 3 GW of existing grid connections at Hunterston and Torness that will be unused by the end of this decade to support investment in new nuclear power stations. Scotland should exploit as far as possible existing infrastructure assets to speed up decarbonisation and cut costs.

7.Given the generation potential, and market ambition, is there a risk of oversupply if options for use of surplus electricity (e.g. green hydrogen production) do not become reality?

- There is already oversupply at times of high renewable output and lower demand, with constraint payments in Scotland running in the hundreds of millions of pounds per year to address the issue and balance the grid.[10] Already insufficient Grid infrastructure forms a major part of this problem.

- As variable generation increases and baseload decreases, there is a strong risk that the grid will be oversupplied more and more frequently. If options to use excess power do not become reality, that risk will become quite intense. Scotland should account for this risk when considering the available avenues and methods of diverting excess power, such as hydrogen, making ammonia fuels for shipping, sustainable aviation fuels, and molten salt storage and robustly model an energy system that identifies the maximum economical extent of electrification.

Hydrogen and the electricity system
8. How much of the Scottish Government ambitions for 5 GW of hydrogen production capacity by 2030, and 25 GW by 2045 should come from green hydrogen?

- Green hydrogen should be the default option for hydrogen production as soon as possible.

- Investing in facilities which rely on any fossil fuel use, including blue hydrogen, effectively locks in a pathway which is subject to global fossil fuel markets and compromises net zero.

- Priority should be given to technologies which produce zero carbon, such as electrolysers powered by clean energy from renewables and nuclear, but also

[10] See National Grid ESO's *Monthly Balancing Services Summary*: https://data. nationalgrideso.com/balancing/mbss.

maintain optionality for high-temperature thermochemical hydrogen production from the advanced reactors of the future.

- A feasibility study was conducted in 2019 called *Hydrogen to Heysham,*[11] which modelled hydrogen production from a nuclear power plant, concluding Heysham was capable of producing hydrogen at the cost of £6.73 – £8.60/kg, with a carbon emission of 24gCO_2/kWh of H_2.

- As noted above, using a greater number of technologies together to solve a problem introduces extra steps, costs, and inefficiencies. Given this, Scotland should carefully study how the carbon cost of direct use of gas with CCS compares to the use of gas with CCS to produce hydrogen to then burn the hydrogen. Both processes, of course, must still be proven commercially.

- The focus of these technologies should be on the decarbonisation of industry, where gas or hydrogen burning could produce the high temperatures many sectors need, and perhaps the narrow use of peaking power. But, again, these technologies cannot and should not be seen as a "synthetic baseload" replacement for nuclear power.

9. What are the key infrastructure barriers to building a hydrogen economy in Scotland and how should they be addressed?

- The hydrogen economy is inexorably linked to the final use of said hydrogen, be it for using in a blast furnace to decarbonise steel or ceramics production or as an ingredient in another previously mentioned net zero solution, such as aviation or shipping fuels.
    - This dictates the market for which the hydrogen is being created, thus the economics and location of production.
    - By knowing where hydrogen demand will be, it enables strategic co-generation planning and facilitates system efficiencies.
        - Ideally, hydrogen will be generated as close as possible to the point of end use, this will reduce storage and transportation costs.
    - In doing such assessments, it will become clear that using hydrogen for synthetic baseload is not an inefficient way of running a system.

Ofgem
10. Ofgem are "working with government, industry and consumer groups to deliver a net-zero economy". What changes have recently been made to support the delivery of net-zero? What more could be done to support a regulatory regime that delivers decarbonised energy supplies affordably?
Find out more about Ofgem

11
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/866374/Phase_1_-_EDF_-_Hydrogen_to_Heysham.pdf

- The Nuclear Industry Association, in conjunction with Energy UK, Renewable UK, Solar Energy UK and the Renewable Energy Association, has called for all relevant regulators, including Ofgem, to be given a Net Zero Mandate/Duty.

11. What are the most important issues for the UK Government's Review of Electricity Market Arrangements to address? What are the benefits of the current system, and the potential pitfalls of moving away from it? What are the implications for the Draft Energy Strategy of the Review?

Find out more about the Review of Electricity Market Arrangements - UK Government

- It is imperative that the future energy market encourages investment and preserves the business cases of long-term, nationally critical assets. Imposing volatile pricing models actively discourages investment from long-term investors such as pension funds, which will be vital in building net zero-compliant infrastructure.

Community energy
12. Are community and locally owned projects inhibited by the current electricity network?
n/a

13. What are the key infrastructure barriers to Scottish Government community energy ambitions and how should they be addressed? Is it enough to "encourage" shared ownership models, or should a more formal mechanism be implemented?
n/a

Further Information

For any further information or any clarifications on the above, please contact Lincoln Hill, Director of Policy and External Affairs

The NIA is also more than happy to provide oral evidence to the committee if so desired.