ELECTRICITY ACT 1989
TOWN AND COUNTRY PLANNING (SCOTLAND) ACT 1997
DPEA CODE OF PRACTICE FOR ELECTRICITY ACT INQUIRIES

TEALING TO KINTORE UPGRADE PROJECT (TKUP) TRL-120-1

TECHNOLOGICAL ALTERNATIVES for NOTKUP

Public Inquiry Written Submission by BRIAN WADE

Technological Alternatives

We argue that in this case, the developer, an established *public utility* has failed to adequately explore modern, cost-effective, and less intrusive technological alternatives to traditional onshore pylons and substations, thereby failing to meet key planning and regulatory requirements.

1.0 Failure to Meet Regulatory Policy

We highlight several instances where SSEN's proposal appears to conflict with established policies:

* NPF Policy 5: Development on prime agricultural land is only supported if there is a "specific locational need" and "no other suitable site." We contend that since viable preferable alternatives exist (such as offshore or undergrounding), this need has not been proven

* NPF4 Policy 11: This policy mandates consideration for underground connections for grid infrastructure. SSEN is accused of misrepresenting the feasibility of undergrounding

* Treasury Green Book: SSEN has failed to produce a costed options appraisal, which is required for projects involving public expenditure

Proposed Technological Alternatives

We advocate for a transition away from "1920s technology" (overhead AC lines) toward modern solutions used extensively by European neighbours like Germany, France and Denmark:

In brief, these are

a) Grid Enhancing Technology (GETs): Upgrading existing infrastructure through Reconductoring—using lightweight, high-strength conductors—can double or triple power capacity for less capital outlay. Other methods include Flexible AC Transmission Systems (FACTS), Topology Control, and Dynamic Line Rating, which uses real-time weather data to optimize thermal limits.

b) High Voltage Direct Current (HVDC):

* Onshore Undergrounding: HVDC cables require less space, reduce transmission losses, and cause significantly less community disruption than AC alternatives.

* Offshore Integration: We strongly promote an integrated offshore grid over the current "point-to-point" radial approach. This would connect wind farms to "energy islands," potentially saving 14% on CAPEX and 19% on OPEX while protecting the onshore landscape.

Economic and Environmental Impacts

The core argument is that while pylons may be cheaper for the developer upfront, they are costlier for consumers and communities in the long term. Modern technologies offer lower lifetime costs due to reduced line losses and maintenance, as well as greater climate resilience. We suggest that SSEN's resistance to these alternatives is driven by short-term financial gain and rigid politically imposed project timelines rather than the "greatest net benefit" to Scotland or the public. Our reasons are

1.1 SSEN have only ever proposed one solution for the TKUP project, a combination of onshore pylons and substations in NE Scotland. NESO and Ofgem have insisted that they have not specified or prescribed the type of technology used and that such decisions are the choice of the transmission operator.

1.2 NPF Policy 5 says:

b) '*Development proposals on prime agricultural land, or land of lesser quality that is culturally or locally important for primary use, as identified by the Local Development Plan, will only be supported where it is for:*

i. Essential infrastructure and there is a specific locational need and no other suitable site'.

1.3 In the context of NPF Policy 5, SSEN have maintained that their technological solution is much cheaper. However, it is cheaper for the developer and not for the consumer, and it is most certainly not cheaper for the communities impacted. This is a planning consideration because alternatives exist with lower environmental and community impacts, and so there is no specific locational need to build pylons along the proposed route. This issue is also included in Aberdeenshire Council LDP PR1.1.[1]

1.4 There are now viable and cost-effective alternatives to the near hundred-year-old technology of pylons carrying High Voltage Alternating Current (HVAC) cables for long distance power transmission. These alternative solutions have lower environmental and community impacts and also lower long-term costs to the consumer. National Policy

[1] https://online.aberdeenshire.gov.uk/ldpmedia/LDP2021/AberdeenshireLocalDevelopmentPlan2023IntroductionAndPolicies.pdf

Statements should now favour the options of upgrading the existing grid using Grid Enhancing Technology, High Voltage Direct Current (HVDC), HVDC undergrounding and offshore integration ahead of yet more overhead lines (i.e. removing the strong starting presumption in favour of pylons).

1.5 SSEN have failed to identify these alternatives and thus have failed to give planning authorities the ability to judge if there is a 'specific locational need'. Treasury Green Book requirements include the need for a costed options appraisal for all projects involving public expenditure. SSEN have failed to produce any such analysis.

1.6 NPF4 Policy 11 says: '*in the case of proposals for grid infrastructure, consideration should be given to underground connections where possible*'. SSEN have not complied with this policy.

In Germany pylons are seen as a last resort, and high voltage direct current undergrounding is preferred.[2] Our North Sea neighbours, Germany and Denmark, are creating an integrated offshore HVDC grid[3] instead of the damaging and expensive point-to-point approach of the UK using 1920s technology.

1.7 **Onshore High Voltage Direct Current Overhead Lines**

1.7.1 Reconductoring alone offers huge benefits. New technologies enable two to three times more power to be carried over existing infrastructure. It has been found to be a particularly promising, viable and 'cost-effective, implementation-ready solution that is deployable to scale'.[4] For example, in the United States a private developer in California is proposing to convert an existing 500 kV line to HVDC instead of building a new 180-mile line as originally proposed by the System Operator.[5] This alternative proposal re-used existing towers, conductors and insulators and increased the capacity from 1.3GW to 3.5GW. As a result, costs, and environmental and planning barriers are all materially reduced.

1.7.2 The choice of such a solution allows building additional capacity into an existing system to 'unlock otherwise stranded clean energy, especially sources available near existing grid infrastructure, helping meet electricity demand and contributing to grid decarbonization'.[6]

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[2] https://www.cleanenergywire.org/news/rules-underground-cables-push-renewables-paying
[3] https://www.cleanenergywire.org/news/denmark-germany-sign-agreement-joint-offshore-wind-project-bornholm-energy-island
[4] GridLab_2035-Reconductoring-Technical-Report.pdf (2035report.com) and https://www.smart-energy.com/industry-sectors/energy-grid-management/how-advanced-conductors-solve-four-key-grid-challenges/
[5] https://www.caiso.com/documents/reviseddraft-2023-2024-transmissionplan.pdf
[6] GridLab 2035 Reconductoring Technical Report 1: https://www.2035report.com/wp-content/uploads/2024/04/GridLab_2035-Reconductoring-Technical-Report.pdf

It is possible to more than double capacity, for less capital outlay and harm, by maximizing our existing grid.[7] There are lightweight, high strength conductors available which have three times the capacity of standard conductors and 50% reduced line losses.[8]

1.7.3 High voltage DC conductors, of the kind that we propose to be used offshore and underground, can also be strung between existing pylons to increase capacity and reduce losses. This approach is already being used in Germany.[9] TKUP was granted ASTI status on the basis it would be an upgrade, not a whole new line.

1.8 **Onshore Underground High Voltage Direct Current**

1.8.1 Unlike in the UK, in Germany preference is given by law (in the Federal Requirements Plan) to underground cables.[10] Germany favours underground cables to mitigate public opposition, protect natural landscapes, and address concerns about the visual, health and environmental impact of overhead lines. Underground cables are also less susceptible to weather impacts, the whole premise of the grid upgrade is a response to climate change, it therefore makes sense to construct a system that is future proof.

1.8.2 High-voltage direct current (HVDC) transmission lines are often the chosen technology. HVDC benefits include reduced transmission losses, greater stability and control, lower strength EMF, fewer cables, and cost effectiveness over long distances. HVDC cables require far less space and narrower trenches than High Voltage Alternating Current (HVAC) and cause considerably less disruption to residents during installation.

1.8.3 The German approach has been essential in gaining public support for large-scale infrastructure projects. Prysmian Group,[11] for example, uses powerful ±525 kV HVDC underground cable technology. Cable-ploughing is an effective way to reduce costs and physical damage and speed up undergrounding.

1.8.4 In the UK, two reports published in 2024 demonstrate that underground HVDC is a very cost-effective solution: compared to overhead lines. The first was the East Anglia Network Study[12] for the National Energy System Operator.[13] It found a £600m saving in an option using underground HVDC instead of overhead lines if a completion date of 2034 was

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[7] https://theprogressplaybook.com/2024/10/15/how-these-countries-are-unlocking-hidden-grid-capacity-to-speed-up-the-energy-transition/
[8] https://www.2035report.com/wp-content/uploads/2024/05/5.3-Reconductoring-policy-report.pdf
[9] https://www.amprion.net/Grid-expansion/Our-Projects/Ultranet/
[10] Amprion-Innovation-Report.pdf
[11] German HVDC cable projects - Prysmian Group: https://www.prysmian.com/en/product-centre/generation-transmission-and-distribution?page=1&ul_brand=Prysmian&content_type=all
[12] https//www.nationalgrideso.com/document/304496/download East Anglia Study 2024
[13] National Energy System Operator (NESO) | National Energy System Operator

selected instead of 2030. Given that an independent report[14] for the county councils of Essex, Suffolk and Norfolk established that the regional grid has sufficient capacity until 2034, it surely makes sense to select the most cost-effective and more popular option instead of the reviled and damaging overhead line proposal.

1.8.5 The second report was a National Grid document[15] for Eastern Green Link. It found that overhead line technology was 'not considered to meet the identified need for additional transmission system capacity'. Reasons given included:

- power flows on AC transmission system circuits cannot be controlled to the same extent as can be achieved using HVDC connections;
- the required capacity HVDC links over the proposed distance have comparable capital costs, but much lower lifetime costs than the alternative onshore AC option in this case;
- delivery of an onshore solution with a long route length, carries much higher delivery risk than the HVDC reinforcement proposals;
- the use of overhead lines is not considered to be feasible because they cannot be delivered by 2030.

1.8.6 One of the criticisms of HVDC is that it is best for long distance point-to-point connections without mid-way connection points. Amprion has overcome this in Germany and is constructing the world's first hybrid, multi-terminal HVDC link, between Lower Saxony and Baden-Württemberg. In their application, SSEN claim that HVDC lines are limited to 2GW per circuit and three different HVDC circuits would be required to produce the same capacity as the proposed TKUP overhead line, this is not true. Hitachi can provide systems capable of 3GW per circuit.[16]just

1.8.7 It is often claimed by developers that undergrounding is five to ten times more expensive than pylons. However, this assumption mostly emerges from the contents of a very old report published in 2012, which was itself based on historical data[17]. This assumption relates to High Voltage Alternating Current (HVAC) undergrounding, as was preferred by National Grid. Not only is AC undergrounding expensive, but it is also extraordinarily destructive, requiring a construction swathe 120 metres wide[18] and sometimes up to 220 metres wide.

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[14] n2t-the-hiorns-report (suffolk.gov.uk)
[15] Paragraph 5.02. https://www.nationalgrid.com/document/151426/download
[16]https://www.hitachienergy.com/products-and-solutions/hvdc/hvdc-light
[17] https://www.theiet.org/media/9376/electricity-transmission-costing-study.pdf
[18] Layout1 (nationalgrid.com) https://www.nationalgrid.com/electricity-transmission/document/154556/download

1.8.8 SSEN have deliberately tried to cause confusion about undergrounding, producing a brochure that describes all the supposed failings and difficulties of running 400kV AC (alternating current) underground. However, the optimum technology for transmitting high voltage electricity over long distances is High Voltage *Direct* Current or HVDC. Hitachi provide examples of how the benefits of HVDC are demonstrated using Life Cycle Assessment (LCA).[19] Protections for the environment, heritage and communities are needed but undergrounding could be significantly faster than overhead lines.

1.9 **Offshore High Voltage Direct Current**

1.9.1 Study after study has highlighted the benefits of an integrated offshore grid. The UK Government even refers to one of these studies in National Policy Statement EN-5, stating, 'The coordinated approach is likely to provide the highest degree of consumer, environmental and community benefits'. Yet despite this, our UK offshore model still runs on a point-to-point or radial approach. Every offshore wind farm or interconnector operates in isolation. This is bad for consumers, the environment, and communities and bad for the operation of the grid.

1.9.2 An integrated offshore grid would connect offshore wind power in the North Sea, keeping it offshore as long as possible. Wind farms would be linked to energy islands and interconnectors. Landing points should be at brownfield sites close to where power is consumed.

1.9.3 According to a National Grid ESO 2020 report,[20] compared to a counterfactual of radial offshore connections of the type proposed for the Hurlie and Emmock substations and the associated pylons, a fully integrated offshore network could save 14% on CAPEX and 19% on OPEX. Integration savings were previously set out in the 2015 Integrated Offshore Transmission Project East.[21]

1.9.4 Building HVDC has a higher build cost, but much lower operating costs as it has better efficiency. That means the long-term cost for the consumer can be lower than using pylons. SSEN should have considered the solutions which have the lowest total cost to the consumer and at the same time have lower environmental and community impacts.

1.9.5 Here in the UK, there is plenty of research that indicates that an offshore grid would help to reduce challenges of building transmission lines on land and reduce costs. This

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[19] https://publisher.hitachienergy.com/preview?DocumentID=HVDC0028&LanguageCode=en&DocumentPartId=PDF&Action=Launch

[20] Cost-Benefit Analysis of Offshore Transmission Network Designs, National Grid ESO, Report No.: 20-1573, Rev., 1, Date: 26-11-2020 https://www.neso.energy/document/182936/download

[21] Integrated Offshore Transmission Project (East), Final Report, Conclusions and Recommendations, August 2015 https://www.neso.energy/document/125331/download

includes the Atlantic Offshore Wind Transmission Study,[22] which found that offshore coordination results in:

- reduced curtailment, reduced usage of higher-cost generators, and contributions to reliability;
- greater grid reliability (by enabling resource adequacy and helping manage the unexpected loss of grid components (contingencies));
- benefits outweighing the costs, often by a ratio of 2-to-1 or more. Offshore networks with interregional interlinks provide the highest value.

1.9.6 A study by Brattle[23] found that, '*starting proactive planning for these long-term offshore wind generation needs now likely will save U.S. consumers at least $20 billion and reduce environmental and community impacts by 50%. Doing so will also support the timely achievement of policy goals, increase reliability, lower development, and investment risks, increase energy independence, and improve climate resilience',* Moreover, it notes that an '*urgent case for proactively and holistically planning transmission solutions for the nation's increasingly ambitious offshore wind goals'*.

1.9.7 In Germany, work is already progressing with the job of planning for coordination offshore. There are a huge number of benefits of integration and grid operators can respond to the congestion situation flexibly when integrating the power from offshore wind farms. If the offshore grid integration systems are not fully utilised, additional transmission capacity can be provided thanks to the offshore interconnectivity. This lets onshore grid congestion be defused or remedied effectively.

1.9.8 Given that the UK now has around 15 GW of offshore wind, but apparently needs to achieve 50 GW to meet targets, there is simply no option but to coordinate offshore. Every point-to-point project that is connected simply brings more environmental and socio-economic damage, and greater cost to consumers. There is no excuse for not to ensure that all necessary steps are taken for early coordination of more wind farms into offshore platforms and/or interconnectors (as with the offshore hybrid assets programme). Currently two offshore wind projects which were originally planned to have offshore grid connections are now planned to have radial direct connections to proposed substations on the TKUP line. This means more congestion on the B6a boundary, not less, and appears to be an attempt to artificially create a justification for building the project.

[22] Atlantic Offshore Wind Transmission Study | Wind Research | NREL
[23] The Benefit and Urgency of Planned Offshore Transmission: (brattle.com)

1.10 **Grid Enhancing Technology**

There are several hardware and systems methods which can enhance the capacity of existing infrastructure. It is a requirement in the USA that the existing grid be upgraded before new infrastructure is built. Examples of such technology are:

1.10.1 **Flexible AC Transmission System (FACTS)**

FACTS technology intends to provide more efficient and reliable dispatch of electricity by providing tighter control over power flows in the transmission network FACTS devices can be deployed to enhance transient stability, voltage regulation, and mitigate system oscillations. FACTS devices can provide power flow control capabilities through line impedance adjustments, thus increasing the loading capability of the transmission system and alleviating congestion.

1.10.2 **Topology Control**

Transmission switching, also known as topology control, is an effective solution to enhance transfer capability. It is shown that reconfiguring the network by switching out specific lines under certain operational conditions will increase transfer capability. Switching out lightly loaded lines can alleviate voltage issues and enhance grid security.

1.10.3 **Voltage Phase Control**

Voltage phase control over the transmission line allows active power flow rerouting throughout the AC transmission grid and can enhance the transfer capability.

1.10.4 **Dynamic Line Rating**

Transmission line ratings were initially defined as reliability measures. Line ratings are often based on the thermal limits of conductors to prevent line overheating. It is now possible to set thermal limits using real-time weather data rather than the conservative ratings, the system operators use. This would allow more effective use of the current network capacity and enhance the transfer capacity of the grid.

In determining this application, the decisionmaking authorities should be confident that it represents the option with the greatest net benefit to the population, landscape and ecology of Scotland, not just the most financially advantageous for a private, profit focused, organisation. Alternative, modern technologies, as used elsewhere, offer solutions which have lower environmental and socio-economic impacts but they have not been favoured by SSEN because of their focus on short term financial gain.

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for NOTKUP
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