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11th October 2022

Updated January 2023

Sir Bernard Jenkin,
Chair Offshore Electricity Grid Task Force,

Dear Sir Bernard,

National Grid Electricity Transmission (NGET) response to questions raised by Offshore Electricity Grid Task Force (OffSET) meeting of Monday 18 July 2022
East Anglia Green Energy Enablement Project (East Anglia GREEN)

Thank you for taking the time to organise the meeting with OffSET on the 18th July. We found this meeting helpful in understanding the questions that OffSET have raised and we are pleased to provide a written response as requested. This response provides further information on the fully offshore high voltage direct current (HVDC) option to deliver our East Anglia GREEN proposal. Also included are responses to other questions asked by OffSET in the meeting.

We appreciate that this is a lot of information, and the project team would be happy to have a round table meeting with you to talk through the technical detail if this would be helpful.

We do understand that people have strong opinions about our proposals, and it is of utmost importance to us that we build a strong relationship with the communities where we need to develop new connections and understand their concerns/thoughts on our proposals. Integral to this is a good working relationship with you, other elected representatives and all stakeholders including the public.

We take our responsibilities in supporting delivery of the Government's targets for enhancing energy security, reducing cost to consumers and achieving zero carbon goals very seriously and are committed to delivering the network reinforcements required to achieve this transition to a new energy system to a high standard and in a timely manner. We recognise the need for cleaner greener energy to be transported to our homes and businesses so that we can secure low cost, sustainable secure energy in the medium term.

Under the terms of its licence, NGET is required to provide an efficient, economic, and co-ordinated transmission system in England and Wales. The transmission infrastructure needs to transport electricity safely and securely from and to customers. As customer requirements change, we must ensure that the transmission system remains capable of accommodating the changing needs of society. NGET welcomes the ongoing public and policy debate, championed by OffSET, about how we can best meet the future energy needs of the country and ensure the provision of a sustainable transmission system for the future in accordance with the requirements of our licence.

It is important to note that in cases such as this where there is a potential for NGET to require a Development Consent Order (DCO) to deliver nationally important infrastructure, Parliament has provided a framework for consultation and engagement. There is also national guidance on consultation with which NGET (unless there is proper reason) will comply. NGET is happy to assist Offset in its understanding of the need for the project and how that need can potentially be met in a way which is consistent with NGET's important statutory duties. Any such explanation is not and is not meant to be part of or to replace these requirements and/or guidance.

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It is also important to note that at this stage of the potential project, the processes of consideration and preliminary determination are always evolving and iterating as the knowledge about the project, and the potential areas in which it will be sited, grows and or alters. In addition, previous preliminary assumptions and/or decisions are the subject of constant checking and backchecking as part of the consideration and engagement process. Any description of the assessment and rationale for non-final decisions (particularly at non-statutory stages of a potential project) must be understood in that context. There can be no settled view at this stage of the process. The duty on NGET to consider how a pressing need for more transmission capacity, which is in the national interest, is best provided requires a process a part of which potential alternatives are judged to be less likely to meet the statutory requirements and are for now not progressed through the development of a solution. This need to narrow options, subject to ongoing back-check and reconsideration, is an inevitable part of any method of meeting the identified need for more capacity.

There is, in this case, a twin imperative for additional transmission capacity. First, the need to ensure that there is the capacity to secure continuity of service consistent with the main duty of NGET and the relevant technical capacity documentation. Second, the need to ensure that the UK meets its ambitious carbon neutral targets by having the ability to bring ashore, electricity generated offshore. The existing transmission infrastructure is simply not sufficient to meet these needs.

The way in which transmission capacity is selected and provided engages the statutory duties referred to above. There is a duty in considering transmission options to have regard to providing transmission in an economic way and to have regard to the impact of transmission equipment on the environment, including visual and landscape impact.

Transmission costs are also clearly relevant to the overall price of electricity to the consumer and thus to the economic supply of electricity. There is also interest in the broad consistency of decision making and policy approach from project to project. The Government seeks to provide this consistency of broad approach by issuing specific nationally applicable guidance to the electricity infrastructure companies in the form of the EN-5 National Policy Statement.

EN-5 provides that Government does not believe that development of overhead lines is generally incompatible in principle with developers' statutory duty under section 9 of the Electricity Act, to have regard to amenity and to mitigate impacts. It states that in practice, new above ground electricity lines, whether supported by lattice steel towers/pylons or wooden poles, can give rise to adverse landscape and visual impacts, dependent upon their scale, siting, degree of screening and the nature of the landscape and local environment through which they are routed. It also advises that for the most part these impacts can be mitigated, however at particularly sensitive locations the potential adverse landscape and visual impacts of an overhead line proposal may make it unacceptable in planning terms, taking account of the specific local environment and context.

The extant new draft EN-5 deals specifically with bringing offshore generation onshore. It provides that: the scale of offshore transmission infrastructure required to support the Government's offshore wind development targets means that a substantial amount of new onshore network infrastructure will be required, including network reinforcements, to enable transmission of the domestic and international offshore power flows coming onshore. It repeats the advice that Government does not believe that development of overhead lines is incompatible with duties in relation to amenity and impact and states that it is the Government's position that overhead lines should be the strong starting presumption for electricity networks development in general, this presumption is reversed only when proposed

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developments will cross part of a nationally designated landscape (i.e., National Park, Broads, or Area of Outstanding Natural Beauty).

NGET is required to have regard to this advice as part of its consideration when it develops proposals to meet transmission needs. Clearly, the draft advice is not yet perfected but insofar as it is consistent with other published national guidance it is a material consideration of some weight. Compliance with the relevant statutory duties, including the requirement related to economic provision, is ultimately regulated and overseen by Ofgem.

As part of and following on from NGET's recent consultation on East Anglia GREEN, we have provided (as an annex) information on the potentially feasible offshore strategic option to deliver the additional transmission capacity required, having regard to the duties and advice set out above and to other relevant matters. This information is not final and does not form part of any statutory process. It is provided voluntarily on that understanding and in the spirit of co-operation as a way of answering the questions posed by OffSET.

In summary, the capital costs of the options considered are as follows:

- AC onshore option (Norwich/Bramford/Tilbury) at 6.9GW £793.50m
- HVDC offshore (Norwich/Tilbury) at 4GW £2,028.20m
- HVDC offshore (Norwich/Tilbury) at 6GW £3,104.90m
- HVDC offshore (Norwich/Bramford/Tilbury) at 6GW £4,168.40m

With lifetime costs as follows:

- AC onshore option (Norwich/Bramford/Tilbury) at 6.9GW £1,136.00m
- HVDC offshore (Norwich/Tilbury) at 4GW ~~£3,769.00m~~ £2,475.00m
- HVDC offshore (Norwich/Tilbury) at 6GW ~~£5,654.00m~~ £3,713.00m
- HVDC offshore (Norwich/Bramford/Tilbury) at 6GW £~~7,332.10m~~ £5,099.83m

The annex document explains why, at this early pre-statutory stage of consultation, the offshore strategic option is not being progressed for now. As no final decision has been made, and as the matter will be reconsidered and backchecked throughout the process, having regard to consultation responses and other relevant information, none of the conclusions should be seen as final.

Factors which have been considered in deciding options to be taken forward for now, include but are not limited to, the advice contained in the adopted policy that overhead lines are not inconsistent with NGET's statutory duty. This is on the potential for mitigation of on-shore options including undergrounding - where justified and feasible, based on costs and economics, with the offshore option being several billion pounds more expensive than reasonable onshore options.

We strongly encourage local communities to continue to engage with us. Consultation feedback and local knowledge will help us to develop the best project possible, while supporting the ambition of the country to achieve targets for clean power, efficiently, economically, and quickly. The next phase of consultation will include detailed information showing how we have developed the scheme in response to the feedback received, as well as providing greater detail on the route of the onshore corridor presently selected to be taken forward, and how we will be mitigating impacts on local communities living in close proximity.

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We fully commit to doing what we can to mitigate impacts where we can, and where our regulatory framework allows.

We recognise the complexity of these issues and would welcome further round table discussion to ensure mutual understanding,

Yours sincerely,

Liam Walker
Project Director
East Anglia GREEN

This letter was updated and republished in January 2023 with updated lifetime cost figures

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Annex:

NGET answers to questions raised by OffSET

Q. East Anglia GREEN comparison of preferred onshore and offshore options considered.

The Corridor Preliminary Routeing and Siting Study (CPRSS) published in April 2022 to support the recent non-statutory consultation sets out in section 1 details of the need case for the project and technologies considered to make the connection.

All strategic options identified as part of the CPRSS (April 2022) were reviewed and checked. This work is subject to ongoing back-check and review and will continue to be reviewed.

Within the CPRSS, together with its technical appendices and referenced documents, there is a large amount of detail, analysis and explanation that fed into the summary documents and summary chapters within the CPRSS itself along with additional consultation material. It is important to note that those documents and indeed any others that are produced are all part of an ongoing iterative process to narrow down the huge list of potentially feasible options. That process is ongoing and will rightly remain ongoing as is required of us under the regime laid down by Parliament in the form of the Planning Act. Any report can only speak to the knowledge gained at that point in time. With new information (especially new information that comes to light as part of the various consultation stages) new analysis will be undertaken as part of a back-check to see if the previous analysis and resulting preliminary decisions are still valid. If we need to change a previous decision then we will and the reasons for doing so will be made transparent in whatever report we need to publish at that point in time, and all in accordance with the requirements that Government have placed upon us.

The CPRSS explains why, at the early pre-statutory stage of consultation, the offshore strategic options were not being progressed for now. As no final decision has been made and as the matter will be reconsidered and backchecked throughout the process having regard to consultation responses and other relevant information, none of the conclusions should be seen as final.

An early part of the process to evaluate potential strategic options is to identify and understand the need for the connection/reinforcement. The electricity industry in Great Britain is undergoing unprecedented change. Closure of fossil fuel burning generation and end of life nuclear power stations means significant additional investment in new generating and interconnection capacity will be needed to ensure existing minimum standards of security of supply are maintained.

Growth in offshore wind generation and interconnectors to Europe have seen a significant number of connections planned in the East Anglia and south-east coastal areas of England. The Government's commitment to Net Zero by 2050 has strengthened the likelihood of the majority of these connections progressing to delivery.

The existing transmission network infrastructure in the East-Anglia and South-East areas was not originally designed to accommodate such large volumes of generation capacity and transmission circuits to provide both connections for those new customers and to ensure that

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power can be transferred securely to the onshore demand centres to meet the needs of GB electricity customers.

To resolve the need to increase capacity of the National Electricity Transmission System (NETS) to remain compliant with Section 9 of the Electricity Act "the Act" and Standard Condition D3 (Transmission system security standard and quality of service) of National Grid Electricity Transmission (NGET "The Company") Transmission licence, the company undertook a series of assessments to establish an option which both satisfies the National Policy statements EN-1 and EN-5 and requirements of Section 9 of the Act and Standard condition D3.

Factors which have been taken into account in deciding which options are to be taken forward for now include, but are not limited to, the advice contained in the adopted policy EN5 (overhead lines are not inconsistent with NGETs statutory duty on the potential for mitigation of onshore options, including undergrounding where justified and feasible), and on the basis of costs and economics with the offshore option being several billion pounds more expensive than reasonable onshore options.

The options were evaluated against the following topics:

a. Technical
b. Cost/Lifetime cost
c. Environmental and Socio Economic (Landscape and Visual, Historic Environment, Biological Environment, Physical Environment, Marine Environment (where appropriate), Settlement and Population, Tourism and Recreation, Land Use, Infrastructure and Shipping/Navigation (where appropriate)).

NGET considered that all options were treated equally in achieving delivery in the same timescales to meet the need.

The preliminary conclusions from our early strategic optioneering work identified that any likely feasible offshore strategic option would involve new offshore transmission connections between the existing substation at Norwich Main and the existing Tilbury substation (approximately 220 km).

<u>Additional infrastructure required for the offshore option includes:</u>

- Extensions at existing substations at Norwich Main and Tilbury
- HVDC options require a convertor station at each end similar in size to a large DIY warehouse. For 4GW, 2 convertor stations are required at each end and for 6GW, 3 convertor stations are required at each end
- It was anticipated that convertor stations would be sited in the locality of the existing substations depending on suitable site availability
- Connections would be required from the substations to the convertor stations and then on to the coast (routes/landfall would need to take account of environmental considerations)

HVDC offshore options would be limited by the largest technology available for submarine DC cables currently being developed at 2000MW (2GW). Each convertor would require 2 cables to be installed between each convertor with land installation to coastal landing points and

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submarine cabling, crossing many other services and needing to be carefully routed to avoid marine designations. The convertor stations can have a large visual impact on local communities, the circuit itself is not visible and does not have the visual impact that overhead lines have. HVDC links are controllable and use a control system to respond to system conditions which has advantages in controllability, however response to very fast transient faults can lag that of an AC system.

Environmental considerations summary for the offshore option:

- Two nationally designated landscapes (Broads National Park and Suffolk Coasts and Heaths AONB). Impacts both direct and on setting from buried cables (both temporary and permanent) and convertor stations
- Scheduled monuments distributed throughout the study area which includes sites dating from prehistoric period onwards
- European and national designated sites unlikely to be avoidable particularly at landfalls
- Six Country Parks - four through the northern area and two to the south
- Significant amount of infrastructure including numerous existing/proposed subsea cables/pipelines and offshore wind farms with associated substations and cables
- Thames Estuary - large volumes of sediment deposited during glacial times and subsequent movement by sea has created large features (sand banks/sand wave fields) which have direct impact on bathymetry profile of Estuary. Continuing shifting/migration of the sand banks and channels
- Crossing offshore infrastructure may lead to unacceptable reduction in water depth presenting a hazard to vessels in areas of shallow water
- Thames is a key navigation route for both freight and passenger shipping. Over 10,000 ships per year are recorded to be transiting the Thames
- A number of channels are dredged for navigation to maintain an appropriate safe depth of water. Dredging would both pose a risk to cable and safety concern for the dredging works

Onshore vs. Offshore cost summary:

Updated January 2023

Item	Onshore AC	Offshore DC	Offshore DC	Offshore DC
	Norwich to Bramford (AENC) + Bramford to Tilbury via customer substation (ATNC)	Norwich to Tilbury Does not connect customers (add ›£500m approx)	Norwich to Tilbury Does not connect customers (add ›£500m approx)	Norwich to Bramford and Bramford to Tilbury Does not connect customers (add ›£500m approx)
Capacity (GW)	6.9	4.0	6.0	6.0
Length approx . (Km)	180	220	220	270
Capital Cost (£m)	793.50	2,028.20	3,104.90	4,168.40
Lifetime cost (£m)	1,136.00	2,475.00	3,713.00	5,099.83

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Summarised below are a number of important factors that we took into account as part of our evaluation to identify a potential offshore strategic option:

- HVDC meets current need (4GW) for current connections, with capital cost £2,028.20m and lifetime cost of ~~£3,769.00m~~ £2,475.00m. Future connections require the higher HVDC cost with additional 2GW (6GW overall) with capital cost £3,104.9m and lifetime cost of ~~£5,654m~~ £3,713.00m, to match the capacity available on the AC onshore option
- For full like for like with the AC onshore option, the HVDC solution would need to be a multi-terminal design (three additional 2GW convertors located at Bramford and cabling 50km from offshore). Additional capital cost of £1,063.5m (3 x 2GW convertors + 3x50km DC cable pairs) on top of the 6GW solution cost of £3,104.9m, a total capital cost of £4,168.4m and total lifetime cost of ~~£7,332.10m~~ £5,099.83m.
- The additional flexibility provided by the AC solution - at a cost of £10s of millions connecting to Bramford, can be justified by the system benefits gained. However, the Direct Current (DC) alternative could not justify such costs and therefore DC circuits would only be directly connected to Tilbury, with the loss of additional flexibility and benefit of connections at Bramford.
- Offshore HVDC option does not enable connection of North Falls and Five Estuaries Wind Farms (2GW). To make an offshore connection, the link would require the additional cost of HVDC convertor station, AC substation, offshore HVDC platform, Offshore AC platform with an additional capital cost of > £500m
- The onshore option best supports the regulatory, legislative and policy framework within which we are required to operate
- The onshore option for East Anglia GREEN is the most economic solution whilst also supporting the connections for Sizewell, North Falls and Fives Estuaries
- North Falls and Five Estuaries have signed agreements to connect into the new substation near Lawford, Essex. If the connection location for this low carbon generation changes, we will backcheck and review the proposed substation site and route

The option that currently best meets NGET obligations under Section 9 of the Act and aligned with EN-1 and EN-5 is:

- AENC – OHL Norwich Main to Bramford with capital cost £312.3m and lifetime cost of £505m; plus
- ATNC – OHL Bramford via a new substation to Tilbury with a capital cost £481.2m and lifetime cost of £631m;

  Total Capital Cost of £793.5m and lifetime cost of £1,136m

This is compared with the HVDC subsea alternative able to provide the same electrical capacity (but not with the same system benefits as the AC option) as the OHL between Norwich and Tilbury proposal of circa 6GW capacity.

Subsea with capital cost £3,104.9m and lifetime cost of ~~£5,654m~~ £3,713m.

The capital and lifetime costs between the alternatives are substantial and would be further supplemented by additional costs to make connections for Five Estuaries and North Falls. To make an offshore connection into the link would require the additional cost of HVDC convertor

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station, AC substation, offshore HVDC platform, Offshore AC platform with an additional capital cost of > £500m.

For more information about NGET's legal obligations, requirement for development consent, technology options and economic appraisal please refer to the Strategic Options Technical Appendix published on our website.

Q. Will the community have an opportunity to comment on the offshore option?

As we scope our projects, we consider numerous technology solutions. Offshore solutions were considered as part of our strategic proposal to upgrade the network in East Anglia and are part of our preliminary recommended solution. National Grid's appraisals, which were based on our knowledge of the network, understanding of the capacity and costs of developing subsea links as well as evaluation of the environmental and socio–economic implications, reached a preliminary conclusion that, on balance, the right solution was an offshore DC link between the Sizewell area and Kent (Sea Link) in combination with onshore reinforcement between Norwich and Tilbury (East Anglia GREEN). We presented our evaluation work and our preliminary preferred solution at the recent non-statutory consultation, which was an opportunity for members of the public to comment (which they did).

It would have been disingenuous for us to present an offshore option to the public for consultation feedback, knowing this did not comply with the framework requirements.

As noted, before, decisions made will be reconsidered and backchecked throughout the process, having regard to consultation responses and other relevant information (policy and regulation), none of the conclusions should be seen as final. Further opportunities to provide feedback are to come.

We carefully consider comments and will publish a feedback report at our next consultation stage. This will set out information on the feedback received and our responses. We recognise the strength of feeling locally, and that people may feel uncertain about what the project could mean for them.

We continue to be open-minded to all options (on-shore and off-shore) that have the reasonable potential to comply with the obligations set out under our licence and by Ofgem to be economic and efficient.

We strongly encourage local communities to keep engaging with us. It is consultation feedback and local knowledge that will help us to develop the best project possible, while supporting the ambition of the country to achieve targets for clean power, efficiently, economically, and quickly. The next phase of consultation will include detailed information showing not only how we have developed a proposed solution in response to the feedback received, but more importantly will provide greater detail on the route of the proposed onshore corridor presently selected to be taken forward and how we will be mitigating impacts on local communities living in close proximity. We fully commit to doing what we can to mitigate impacts where we can, and our regulatory framework allows.

We are also working closely with statutory consultees, including local authorities, to develop our proposals and will hold a further statutory public consultation which will take place next year taking account of local feedback as we progress through the Nationally Significant

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Infrastructure Project (NSIP) process ahead of submitting a Development Consent Order (DCO) for consideration in 2024.

Q. The proposed Essex windfarm extensions (North Falls and Five Estuaries) have said they are looking to work with both NGET and National Grid Ventures (NGV), to coordinate their projects. It would be helpful to understand, without prejudice, the range of potential outcomes from these discussions, particularly as it appears one outcome may be that the wind farms do not connect in Essex at all, with significant implications for the design and delivery of East Anglia Green.

The department for Business Energy and Industrial Strategy (BEIS) are running an 'early opportunities' process to examine the opportunities to co-ordinate these windfarm connections with interconnection and Sea Link. We do not anticipate this fundamentally changes the need to reinforce the transmission boundary South of Bramford, but of course we will examine our proposals in the light of any change to customer connection arrangements. .

Q: Our understanding is that converter stations to switch from Alternating Current (AC) to Direct Current (DC) and vice versa, cannot be built on offshore platforms because of their size, and can only be built on artificial islands or onshore, is this correct?

Converter stations can be built on offshore platforms. A number of offshore windfarm developers are doing this, and offshore platforms are included as part of Electricity System Operator's (ESO) Holistic Network Design (HND). NGET are already aware of 1 gigawatt (GW) converters located on offshore platforms. For higher capacities of high voltage direct current (HVDC) link (i.e. Sea Link is 2GW) you may require very large platforms or multiple interconnected ones.

Q: What are the principle technical/engineering challenges remaining to the delivery of an offshore network?

The distances involved in developing an offshore network mean that it would need to be predominantly HVDC technology. The principal challenges for HVDC are the capacity of offshore cables which are currently limited to 2GW, meaning multiple links would be required to match the capability of onshore circuits.

Q: To what extent is it essential to be able to build a multi-vendor offshore grid in order to limit consumer costs? To what extent does this need have the potential, to slow the roll out of an offshore network?

It is NGET's understanding that today a multipurpose HVDC network would need to be built by a given supplier. This is due to 'intellectual property' – for instance the control and protection software is developed independently and is bespoke to each supplier. There is indication of attempts to resolve interoperability issues between different suppliers, as there has been for some time, but this may yet take time to resolve. In the meantime, if different companies wish to build an HVDC network they would need to procure their infrastructure from the same supplier.

If the procurement is not undertaken jointly and simultaneously then a given supplier would have a monopoly over any further parties wanting to add a connection to the network. This poses the following problems:

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- A monopoly in which the supplier was able to unfairly charge a higher cost.
- Undertaking joint procurement activities with other organisations, including ones based abroad, in itself proving more challenging.
- The pressure on any one given supplier being tasked with the delivery of an HVDC network causing delays – resource, manufacturing and other logistical constraints may be significantly strained.

Decarbonisation of the energy system along with the urgent need to increase security of energy supply is a significant challenge facing our country and involves a radical change in where our energy comes from. It is important that this transition is cost effective for consumers, particularly given the current pressures on household budgets.

Government has set clear targets for the development of clean power, including up to 50GW of offshore wind by 2030 and National Grid is at the heart of delivering this ambition, which requires us to reinforce our network across the country. East Anglia GREEN is identified as a key project on this journey. . Our current preferred proposal for East Anglia GREEN was shaped after very careful consideration of all our duties and responsibilities, alongside current planning policy, as set by Government.

Q. Has a preliminary cost estimate been undertaken for NOA option SCD2?

A very high-level indicative cost estimate has been calculated to help inform the Network Options Assessment (NOA) of approximately £1.2 billion.

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Q. Additional issues raised by OffSET to be responded to by the Office of Gas and Electricity Markets (Ofgem) and ESO

In addition to the responses provided by NGET above, members of OffSET also raised a number of issues, the answers to which do not fall within NGET's remit.

Q. In previous discussions, Ofgem have referred to concerns regarding market weakness in the procurement of some technologies needed for an offshore grid, would it be possible to elaborate on these issues and the potential or expected impact on consumer costs?

Q. It is notable that SCD2, a second offshore link between Suffolk and Kent, does not appear in the refreshed NOA. Does the proposed NOA option LRN4, between Lincolnshire and Hertfordshire, effectively replace that project?

These two questions are to be answered separately by Ofgem and ESO, respectively, who are the bodies responsible.