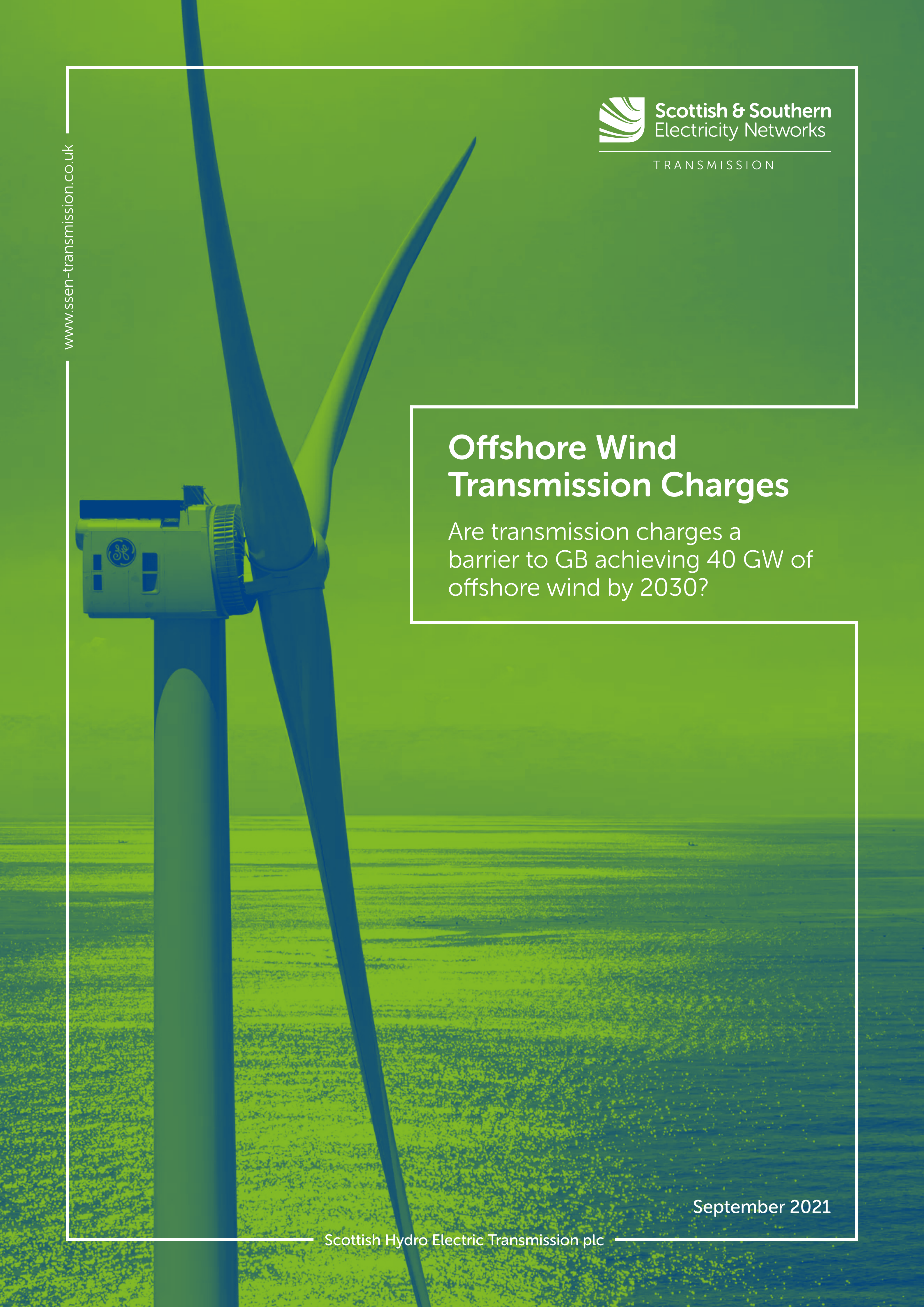

Scottish & Southern Electricity Networks
TRANSMISSION

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Offshore Wind Transmission Charges

Are transmission charges a barrier to GB achieving 40 GW of offshore wind by 2030?

September 2021

Scottish Hydro Electric Transmission plc

About us

Scottish Hydro Electric Transmission, operating under the name of Scottish and Southern Electricity Networks (SSEN), is responsible for the electricity transmission network in the north of Scotland **(Figure 1)**.

As the Transmission Owner (TO) we maintain and invest in the high voltage 132kV, 220kV, 275kV and 400kV network of underground cables, overhead lines on wooden poles and steel towers, and electricity substations, extending over a quarter of the UK's land mass crossing some of its most challenging terrain. We take electricity from generators and transport it at high voltages over long distances through our transmission network for distribution to homes and businesses in villages and towns.

The north of Scotland is powered by wind and water[1]. Over 80% of the connected generation capacity is renewable energy. This energy powers all of the homes and businesses in the north of Scotland, and around two-thirds is exported onwards to the rest of GB. An important part of our role as the TO is to provide timely and cost-effective connections for renewable generators. Renewable power from the north of Scotland is critical to the national decarbonisation effort to achieve net zero greenhouse gas (GHG) emissions.

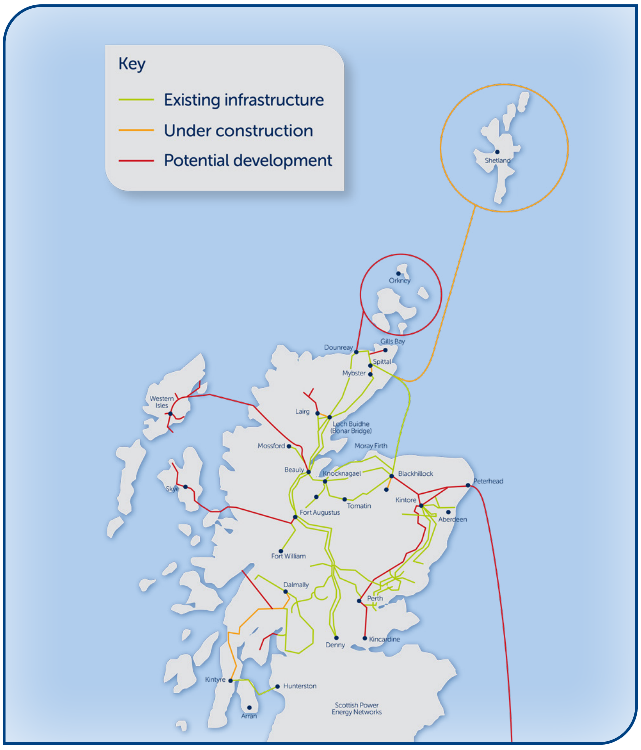


Figure 1 SSEN Transmission network

About transmission charges

In February 2021, we published a paper Transmission Charges: An overview of charges for the GB transmission system.

This paper was prompted by the concerns of existing and future generation developers in the north of Scotland. Generators tell us that one of their greatest challenges is the current approach to charging for use of the transmission system – and highlight the relatively high cost of these charges (compared to similar generators elsewhere in the UK), the year-on-year volatility of charges and the difficulties in being able to accurately forecast charges even a single year ahead.

We undertook detailed analysis of Transmission Network Use of System (TNUoS) charges. Our analysis also showed that the volatility and unpredictability of charges for use of the transmission system is felt across the whole of GB and are in stark contrast to the stability and predictability of the underlying costs of the transmission system (TO revenues). Based on this analysis, we concluded that there is a strong case for review and reform of the transmission charging framework.

The response to our analysis has been overwhelming. Many generators and wider stakeholders have backed our case for reform and shared their own experiences of the detrimental impacts of the transmission charging regime. The impacts are being felt by all generators, big and small, of all technology types and across GB. Many have stated that transmission charging is one the greatest barriers to achieving national net zero GHG emissions targets.

We published a full report on stakeholders' feedback in May 2021.

[1]See North of Scotland Energy Trends, July 2020

Offshore Wind and Transmission Charges

Offshore wind targets
The UK Government has an ambitious target of 40 GW of offshore wind by 2030.

Currently around 27GW[2] of offshore wind is operational or have consents to build. To achieve the 2030 target will also require significant deployment of the:

- Six 'Round 4' projects awarded leases in England and Wales waters in February 2021, representing just under 8 GW; and
- 'ScotWind' options in Scottish waters where leasing is underway and up to 10 GW is the target.

Growth in offshore wind generating capacity is acknowledged to be a critical component of achieving the UK's net zero GHG targets. Offshore wind investment is also viewed by many commentators as central to a 'green recovery' from the covid-19 pandemic. The December 2020 Energy White Paper estimated that up to 60,000 direct and indirect jobs could be supported by the offshore wind sector by 2030.

Offshore Transmission Network Review (OTNR)
In July 2020, the UK Government announced a review into the offshore transmission regime to address the barriers it presents to further significant deployment of offshore wind, with a view to achieving net zero ambitions.

The call for evidence for the review prompted 48 responses from a wide range of stakeholders. While the responses have not been published, the BEIS and Ofgem joint response highlighted transmission charging as a cause for concern. Through our engagement we have identified some common concerns of offshore wind developers in addition to those highlighted in our February 2021 paper:

- The impact of unpredictability and volatility on Contract for Difference (CfD) bidding
- The impact of unpredictability and volatility on securing project financing
- The methodology for the local circuit charge and impact on anticipatory investment
- The methodology for the wider tariff and onshore generator zones

Together, developers argue the transmission charging regime is increasing the cost and delaying the deployment of essential offshore wind generation.

Going forward, the workstreams of the OTNR explicitly include transmission charging. Changes within the existing legislative framework are envisaged for the period up to 2030, with the potential for more fundamental change to take effect after 2030.

More information on the OTNR can be found here.

Our analysis
In our February 2021 paper we assessed the impact of transmission charges on offshore wind generators. This analysis showed that transmission charges are higher in Scotland than the rest of GB **(Figure 2)**, and charges everywhere are volatile and unpredictable. These findings are the same for offshore wind, onshore wind and gas generators.

Offshore wind developers welcomed our findings, but have argued that the impact of transmission charging is more acute for offshore wind than other technologies. In response to this feedback, we have undertaken further analysis of transmission charging for offshore wind and present our findings in this paper.

Offshore Wind

The declared capacity and load factor for the three wind farms are:

Beatrice 588 MW 49%;
Greater Gabbard 500 MW 44%;
London Array 630 MW 56%

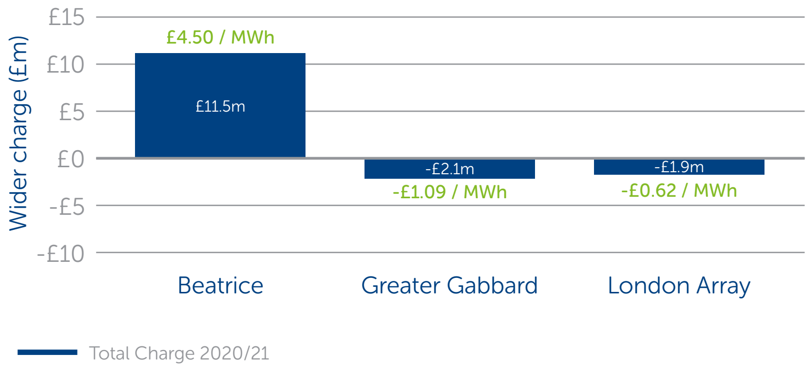


Figure 2 Comparison of the wider TNUoS charge in 2020/21 for three offshore wind generators[3]

[2]Renewable Energy Planning Database (REPD): June 2021
[3]From Figure 6 of our February 2021 paper

Offshore Transmission Owners

Offshore transmission

Offshore transmission has its own definition in the Electricity Act 1989: high voltage electrical equipment that is located in GB offshore waters and used to convey electricity generated offshore **(Figure 4)**. Generators are prohibited by law from owning operational offshore transmission assets.

This definition was enacted in 2008 to allow for competitive tenders for offshore transmission licences. Ofgem is responsible for the running of these tenders and appointment of the offshore transmission licensee (OFTO). To date, Ofgem has run 21 tenders with eight in-flight.

The prevailing regime for offshore transmission is that the offshore wind developer designs, consents and constructs the offshore transmission connection from its windfarm to the shore. Prior to energisation, Ofgem runs a tender to appoint an OFTO that adopts the assets and is responsible for operation for the duration of the licence.

OFTO Allowed Revenue

Ofgem sets the maximum amount that OFTOs are allowed to charge each year as part of the tender process.

The OFTO tender determines a Transfer Value for the offshore infrastructure. This is paid to the offshore wind developer when the offshore transmission assets transfer to the newly appointed OFTO.

Bids made in the tender process are for a long term revenue stream (20 or 25 years) based on the Transfer Value. The successful OFTO has the allowed revenue set out in its licence, adjusted each year for inflation and asset availability. Unlike onshore transmission licensees, there is no subsequent price control review of the annual revenue. OFTO revenues are paid by the ESO. The ESO recovers the majority of this cost through local TNUoS tariffs paid by offshore generators, however some of the OFTO allowed revenue is socialised across other areas of TNUoS **(Figure 3)**.

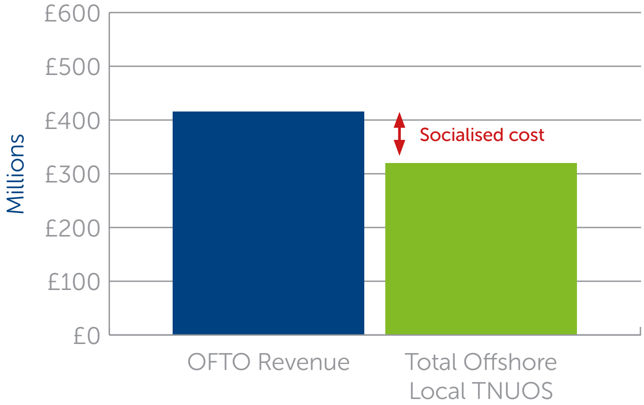


Figure 3 OFTO allowed revenue (excluding forecasted asset Transfer Values) and local offshore transmission charges, 2021/22

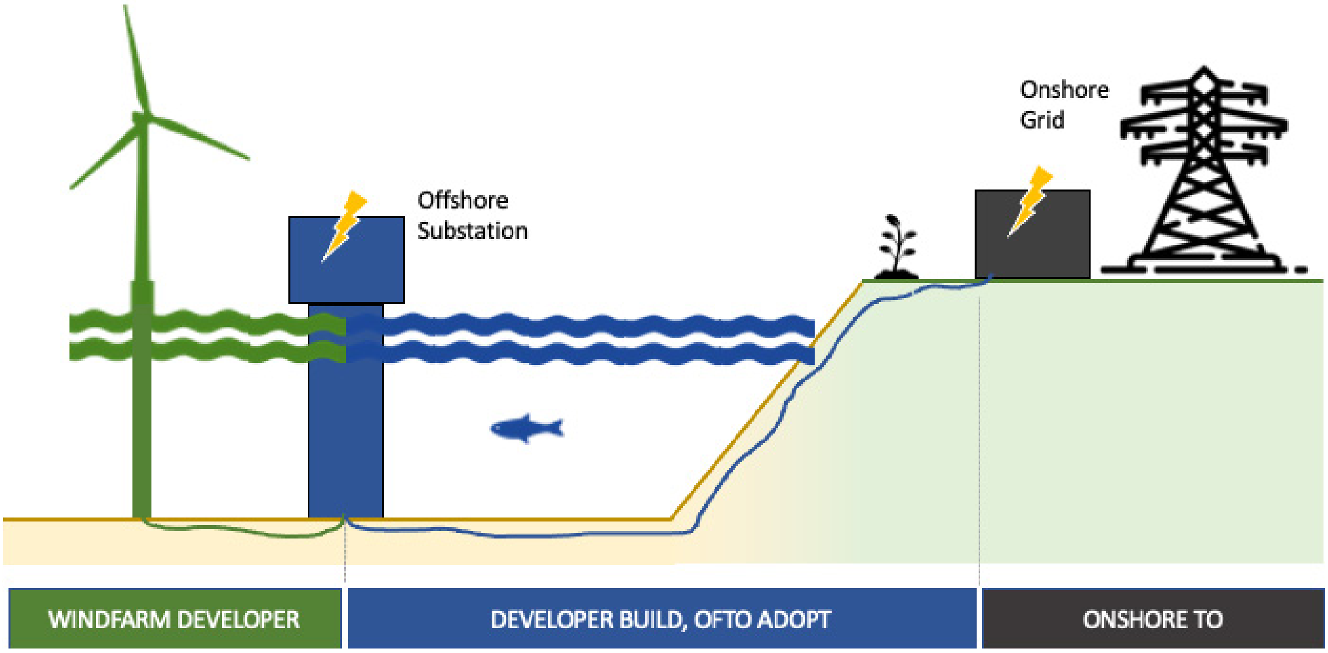
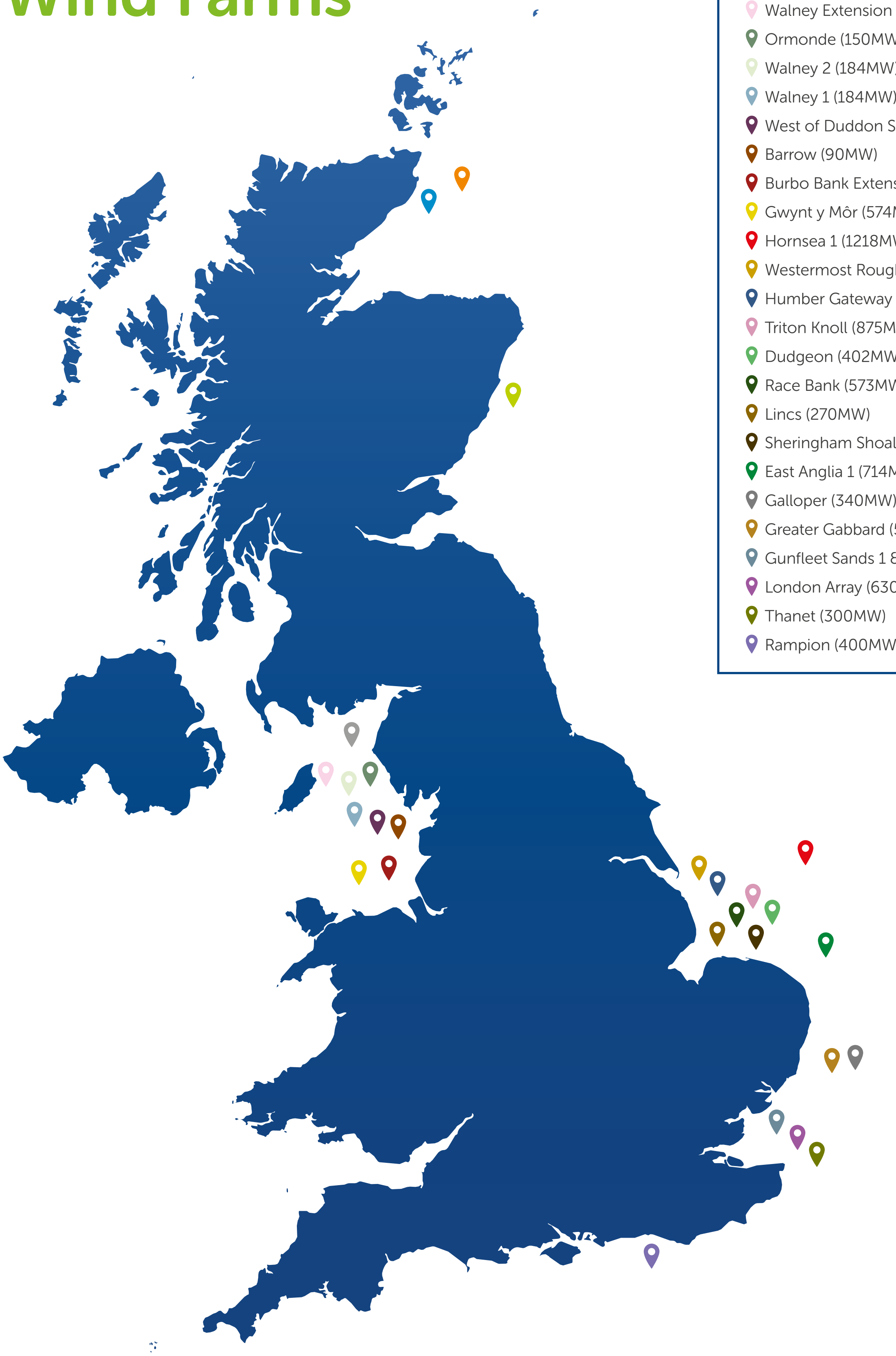


Figure 4 Offshore transmission assets

GB Offshore Wind Farms

- Moray East (900MW)
- Beatrice (588MW)
- Aberdeen Bay (95MW)
- Robin Rigg East & West (180MW)
- Walney Extension (600MW)
- Ormonde (150MW)
- Walney 2 (184MW)
- Walney 1 (184MW)
- West of Duddon Sands (388MW)
- Barrow (90MW)
- Burbo Bank Extension (258MW)
- Gwynt y Môr (574MW)
- Hornsea 1 (1218MW)
- Westermost Rough (205MW)
- Humber Gateway (220MW)
- Triton Knoll (875MW)
- Dudgeon (402MW)
- Race Bank (573MW)
- Lincs (270MW)
- Sheringham Shoal (315MW)
- East Anglia 1 (714MW)
- Galloper (340MW)
- Greater Gabbard (500MW)
- Gunfleet Sands 1 & 2 (173MW)
- London Array (630MW)
- Thanet (300MW)
- Rampion (400MW)



Operational transmission connected offshore wind farms in GB as per the TEC register 10 Sept 2021

Greater Gabbard Offshore Wind Farm TNUoS Charge

Greater Gabbard Offshore Wind Farm is located some 20km from the Suffolk coast in England. It comprises 140 wind turbines, with a total installed capacity of 500 MW. It produced its first energy in 2011. The windfarm has a load factor of around 45%, equivalent to powering up to 400,000 homes.

Local Offshore Tariffs

Offshore windfarm generators pay specific tariffs for the offshore transmission infrastructure that connects their windfarm to the onshore transmission system.

These local offshore tariffs are calculated using the Transfer Value determined by Ofgem as part of the OFTO tender process, along with the allowed OFTO revenue.
The Transfer Value for Greater Gabbard OFTO was £317 million when made in November 2013.

The offshore local substation charge is based on the Transfer Value of transformers, switchgear and offshore platform(s). The tariff is derived from the rating of the installed equipment.

The offshore local circuit charge is based on the Transfer Value of the cable, harmonic filtering and reactive compensation equipment. The tariff is derived from the rating of the cable, adjusted for redundancy where there is more than one cable.

Offshore local substation charge 2021/22

Tariff (£/kW)	16.473633
2021/22 Charge (£)	8,236,817

Offshore local circuit charge 2021/22

Tariff (£/kW)	38.093075
2020/21 Charge (£)	19,046,538

The total local offshore charge is £27.3 million.
In 2021/22 the allowed revenue for Greater Gabbard OFTO is £32.1 million.

The difference between the local offshore charge and the OFTO revenue is recovered through other areas of TNUoS.

Wider Tariff

Wider tariffs are intended to signal to generators the impact to the transmission system of connecting at different locations. As such, wider tariffs vary by geographic location of the point of connection with 27 charging zones across GB.

Greater Gabbard Offshore Wind Farm is connected in generation zone 18.

There are two wider tariffs for intermittent generators in zone 18: the shared year round tariff and the not shared year round tariff. For this year, only the shared year round tariff applies to Greater Gabbard Offshore Wind Farm. The shared year round tariff is pro-rated by the load factor.

Shared Year Round Tariff (£/kW)	1.788458
Load Factor (%)	45.6592
Not Shared Year Round Tariff (£/kW)	0
2021/22 Charge (£)	408,298

Adjustment Factor

The adjustment factor is a 'balancing item' and is set to ensure the required revenue is recovered without exceeding the legal upper limit of €2.50/MWh for the average TNUoS charge for generators. All generators pay the same adjustment factor.

Tariff (£/kW)	-0.432600
2021/22 Charge (£)	-216,300

Total TNUoS Charge

The total TNUoS charge for the 500 MW Greater Gabbard Offshore Wind Farm in 2021/22 is **£27.5 million**.

Local Offshore Substation Charge (£)	8,236,817
Local Offshore Circuit Charge (£)	19,046,538
Wider Charge (£)	408,298
Adjustment Factor (£)	-216,300
TOTAL (£)	27,475,353

Differences in the TNUoS methodology for onshore and offshore generators

The complex methodology used to calculate TNUoS tariffs considers many different parameters, however for onshore and offshore intermittent generators the resultant tariffs applied are very similar.

The main differences relate to the derivation of the Local Circuit and Substation tariffs:

1. For onshore generators, local tariffs are derived from a 'basket' of unit cost data provided by onshore TOs. In contrast, for offshore generators, local tariffs are derived from the specific Transfer Value of the assets and aligned with OFTO revenue.
2. Offshore generators do not pay a Local Substation tariff at the point of connection to the Main Interconnected Transmission System.
3. Offshore generators have a small discount on Offshore Local Circuit and Substation tariffs, known as a civils discount. This discount accounts for the cost savings associated with no groundwork being required to construct the offshore assets.
4. The local security factor for onshore wind is calculated using circuit redundancy. If one circuit is out of service and a remaining circuit can take the full capacity to the Main Integrated Transmission System (MITS) then a 1.8 security factor is applied. Otherwise the local security factor is set at 1. For offshore wind, the local security factor equals the circuit capacity divided by the generator capacity.
5. An offshore interlink is a circuit which connects two offshore substations to a single common substation. The cost associated with this is divided between the offshore generators that use the interlink. Nothing similar exists onshore.

Our Analysis

Offshore wind and transmission charging

Response to our February 2021 paper
Two of the key findings from our paper were:

- Higher TNUoS charges are intended to send a 'signal' to potential future generators not to connect in remote locations – penalising existing renewable generators and acting as a barrier to net zero targets; and
- We have not been able to identify any ascribed consumer benefit that would offset the additional risks to generators arising from volatility and unpredictability in future TNUoS charges – we expect these risks feed through to increase the cost of energy to end consumers.

These findings were highlighted as significant barriers to offshore wind development.

Locational signal
For renewable energy generators, it is questionable whether the locational incentive intended by the wider TNUoS tariff has ever been effective. Investment decisions have largely been driven by the availability of the energy resource (wind, water or sun) and the potential to gain necessary planning consents.

This is even more the case for offshore wind where location is determined by the allocation of sea bed that is leased via auction for offshore wind development. Neither Crown Estate nor Crown Estate Scotland, who make these locational decisions, take account of the transmission system or local TNUoS tariffs.

This counters the inherent assumption in the transmission charging methodology that developers have an unconstrained choice in power station location.

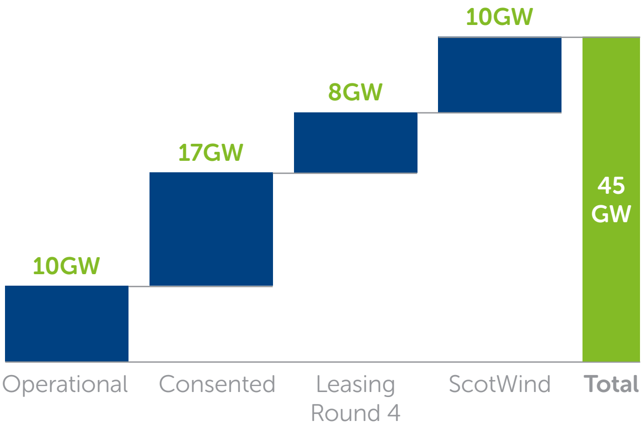


Figure 5 40 GW of offshore wind by 2030[4]

Where location is prescribed by other factors, as is the case for renewable energy generation, the assumption must be that only some of the possible locations will be need to be used.

Again, this is a questionable assumption in the case of offshore wind. For the UK Government's target of 40 GW by 2030, all known locations must be developed **(Figure 5)**.

It could be argued that, even with all known locations being developed, the locational differences in the wider TNUoS tariff encourage offshore developers to connect to the onshore transmission system at an economically optimal point. However, the choice of that point of connection does not sit with the generator, but rather with the transmission licensees. Thorough system modelling is undertaken to identify that point of connection. This modelling results in better decision-making than through the blunt tool of the TNUoS tariff.

Looking forward, the OTNR is considering options for co-ordination and a strategic approach to transmission system planning. The benefits of this would be to enable long lead time grid investments and so reduce risks for offshore wind development. If the future transmission system is to be strategically planned then the case for charging to incentivise location becomes weaker still.

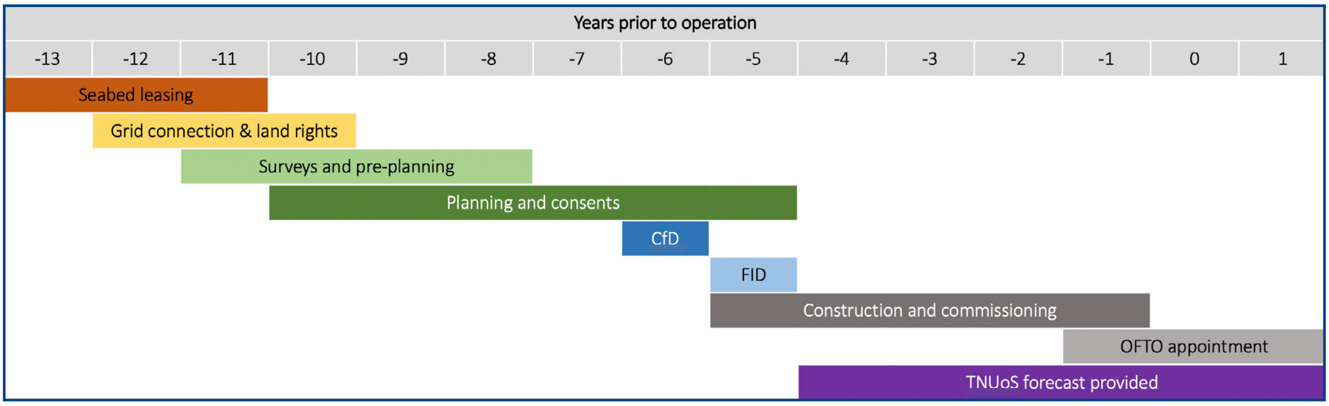
Overall, it is not possible to see any rationale for the locational signal in the wider TNUoS tariff.

Consumer impact of uncertainty
The lead time for the development and construction of an offshore windfarm is over ten years **(Figure 6)**. Final investment decision (FID) will be made around five years before first energy.

As we illustrated in our February 2021 paper, TNUoS tariffs are highly unpredictable. The ESO publishes TNUoS tariffs with a five-year look ahead. Our analysis showed that these forecasts are highly inaccurate.

Given this, the final investment decision for offshore windfarms is made with significant uncertainty about transmission costs. Depending on location, TNUoS charges can be up to 30% of the operating costs of an offshore windfarm[5].

[4]Renewable Energy Planning Database (REPD): June 2021
[5]Derived from: Electricity Generation Costs 2020, BEIS, August 2020



From OTNR presentation, December 2020

Figure 6 Lead time for the development and construction of an offshore windfarm

Likewise, offshore wind developers participating in the Contracts for Difference (CfD) auction, do so with significant uncertainty about transmission costs.

Developers tell us that there are two material impacts from this uncertainty about transmission costs that increase the costs of offshore wind deployment and, ultimately, increase the cost of electricity for end consumers:

First there is impact on financing costs for the multi-billion pound offshore wind farm investment. Uncertainty and volatility from unpredictable transmission charges increase risk in future cashflows. This, in turn, will decrease developers' credit ratings and hence increase cost of capital throughout the lifetime of operation.

The second impact relates to the CfD auction. At the time of placing a bid in the auction – some six years prior to energisation – developers need to forecast transmission charges over the 15 year lifetime of the CfD award. This has two perverse effects **(Figure 7)**:

- As the CfD auction is price-based, those generators that under-forecast future transmission charges are more likely to be successful – a "winners curse" – which, in the extreme, could cause some developments not to proceed; and
- The highest successful CfD bid sets the strike price for all others. Thus, all other factors being equal, there is the potential for windfall gains to generators located in zones with relatively low TNUoS tariffs if the strike price is set by generators located in regions of high transmission charges.

Analysis undertaken by NERA Economic Consultants for Ocean Winds[6] has sought to quantify these two impacts of cashflow volatility and CfD bid mispricing. NERA presents the case that these two factors alone materially increase the financing costs of offshore windfarms.

NERA estimates that uplifts to the rate of return arising from the risks in TNUoS charges could result in a total cost to consumers of between £122 and £391 million per year by 2030. We estimate that this would equate to an additional £4-14 per GB household in 2030.

Overall, there is strong evidence that the unpredictability and volatility of transmission charges is increasing the risk and cost to offshore windfarm developers and, in turn, to energy consumers.

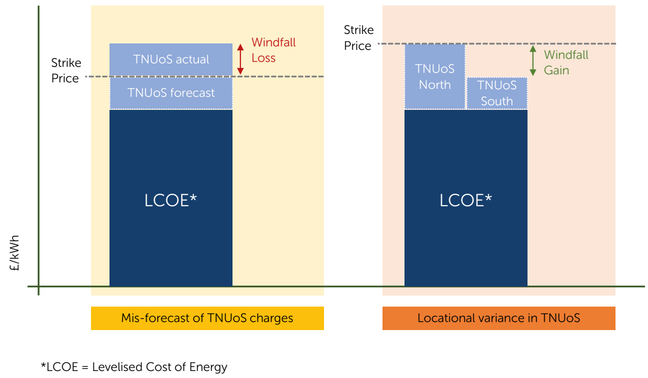


Figure 7 Schematic illustration of potential impact of TNUoS on CfD bidding (not to scale)

[6]Quantifying the risk of TNUoS charge volatility for wind developers, NERA Economic Consulting, 8 March 2021

Impact of offshore wind farm growth on transmission charges for onshore generation

As we described in our February 2021 paper, the wider TNUoS tariff is forward looking – generators pay not for their actual use of the transmission system, but based on the notional cost of network investment to connect future generation in the vicinity. This means the tariff varies as the connected and forecast generation changes.

The complexity of the model used to determine TNUoS tariffs makes this impact difficult to accurately assess. However, we have undertaken some high-level modelling to explore the effect (if any) of connecting an additional 1 GW of offshore wind generation into East Aberdeenshire (zone 2). Our analysis indicates that there is a meaningful impact on the year round wider TNUoS tariffs from the new 1GW offshore wind. The wider TNUoS tariff would rise in seven of the eight zones in the north of Scotland. This increase could be up to £3/kW.

Summary of our findings

- Our review supports our stakeholders' view that there is no apparent value in the locational 'signal' to offshore wind farm developers
- The leadtime for offshore wind farm development is such that investment decisions and CfD bidding are made without confidence in future transmission use of system charges
- There are demonstrable impacts of transmission charge unpredictability and volatility on offshore wind farm costs and, hence, the cost to energy consumers
- Analysis undertaken by independent consultants NERA shows that the current transmission charging regime could increase energy costs for the average GB household between £4 and £14 by 2030

Our further examination of the impact of transmission charging on offshore wind development strengthens our previous conclusion that there is a strong case to review and reform the transmission charging regime.

It is evident from the evidence described herein that transmission charging is a barrier to both the achievement of national decarbonisation objectives and is increasing the cost of energy for end consumers.

We welcome the recent 'minded to' position of Ofgem that potential issues with TNUoS charges might warrant a holistic review. We would urge a decision to be made, and review be commenced, as a matter of urgency.

Next steps

This is the second of our papers assessing the GB transmission charging framework.

Our first paper published in February 2021 supported generators' concerns over the relatively high cost of TNUoS charges (compared to similar generators elsewhere in the UK), the year-on-year volatility of charges and the difficulties in being able to accurately forecast charges even a single year ahead.

Our analysis also showed that the volatility and unpredictability of charges for use of the transmission system are in stark contrast to the stability and predictability of the underlying costs of the transmission system (TO revenues).

We reached the conclusion in our February paper that, nearly 30 years after it was established, there is a strong case to urgently review the transmission charging regime.

In this paper we have explored the specific impacts of transmission charging on offshore wind farm development. Our analysis strongly indicates that there is an increased cost to energy consumers arising from the transmission charging methodology. We agree with our stakeholders that this presents a significant barrier to achieving the national target of 40 GW of offshore wind generation by 2030.

Going forward, we intend to continue our analysis and explore options for reform of transmission use of system charges. We will summarise this work, and stakeholders' views, in a future paper to be delivered in autumn 2021. If you would like to get involved in this conversation, then please get in touch.

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Resources

The analysis of transmission charges presented in this paper has been undertaken using public data issued by the ESO.

Key data sources are listed in the list below.

Our analysis has been subject to independent assurance by Baringa Partners LLP to ensure consistent and correct application of the TNUoS methodology and accuracy in data sourcing.

2021 National Grid ESO TEC Register

Final TNUoS Tariffs 2012/22

SSEN Transmission Charges Paper February 2021

North of Scotland Energy Trends, July 2020

BEIS Electricity Generation Costs 2020

Quantifying the risk of TNUoS charge volatility for wind developers, NERA Economic Consulting, 8 March 2021

Ofgem State of the Energy Market 2019

Scottish Government Climate Change Plan Update 2021

OTNR December presentation

Baringa has assured the TNUoS calculations that have been included in this paper. This assurance covers:

- Validation of tariff values, calculation methodology and correct application; and
- Confirmation that values used within the final paper are correct

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