

Moray West Offshore Windfarm Connection Engineering Justification Paper



Moray West Offshore Windfarm Connection**1 Executive Summary**

Our paper 'Planning for Net Zero: Scenarios, Certain View and Likely Outturn'¹ sets our methodology for determining the Certain View. The Certain View is every activity and investment that we propose to undertake during the RIIO-T2 period where there is compelling evidence of need. This encompasses capital investment to grow the network and accommodate new renewable generators.

This paper identifies the need to carry out transmission works to accommodate the connection of Moray East Offshore Windfarm which has a Transmission Entry Capacity of 800MW. The primary driver for this scheme is Load.

Following a process of optioneering and detailed analysis under the Connection Infrastructure Options Note (CION) process, the proposed scope of works is:

- Extension of the existing Blackhillock 400kV GIS double busbar and installation of two new 400kV GIS double busbar feeder bays complete with line circuit breakers, line disconnectors and associated busbar selector disconnectors.

This scheme delivers the following outputs and benefits:

- Connect 800MW of renewable offshore wind to the SHE Transmission Network in line with our goal to transport the renewable electricity that, in total, powers 10 million homes
- Provide a network connection tailored to meet our customers' requirements and in line with our goal to deliver every connection on time.

The cost to deliver this scheme is £8.01m and the works are planned to be completed during the RIIO-T2 period.

The Moray West Offshore Windfarm, 800MW connection is also one of the primary drivers for the need and timing of the North East 400kV Upgrade².

The Moray West Offshore Windfarm Connection is not flagged as eligible for early or late competition due it being under Ofgem's £50m and £100m thresholds respectively.

¹ Planning for Net Zero: Scenarios, Certain View and Likely Outturn

² RIIO-T2 Engineering Justification Paper – North East 400kV Upgrade.



Moray West Offshore Windfarm Connection

Name of Scheme/Programme	Moray West Offshore Windfarm
Primary Investment Driver	Growth (Load)
Scheme reference/ mechanism or category	SHT20051
Output references/type	LRT2SH2025
Cost	£8.01m
Delivery Year	2024
Reporting Table	C0.7 Load Master Data
Outputs included in RIIO T1 Business Plan	There are no outputs associated with this scheme included in our RIIO-T1 plans.

Moray West Offshore Windfarm Connection**2 Introduction**

This Engineering Justification Paper sets out our plans to undertake the connection of Moray West Offshore Windfarm (also referred to as Moray West) during the RIIO-T2 period (April 2021 to March 2026). The planned work is at Blackhillock 400kV substation as shown on the map below:

The Engineering Justification Paper is structured as follows:

Section 3: Need

This section provides an explanation of the need for the planned works. It provides evidence of the primary and, where applicable, secondary drivers for undertaking the planned works. Where appropriate it provides background information and/or process outputs that generate or support the need.

Section 4: Optioneering

This section presents all the options considered to address the “need” that is described in Section 3. Each option considered here is either discounted at this Optioneering stage with supporting reasoning provided or is taken forward for Detailed Analysis in Section 5.

Section 5: Detailed Analysis

This section considers in more detail each of the options taken forward from the Optioneering section. Where appropriate the results of Cost Benefit Analysis are discussed and together with supporting objective and engineering judgement contribute toward the identification of a selected option. The section continues by setting out the costs for the selected option.

Section 6: Conclusion

This section provides summary detail of the selected option. It sets out the scope and outputs, costs and timing of investment and where applicable other key supporting information.

Section 7: Price Control Deliverables and Ring Fencing

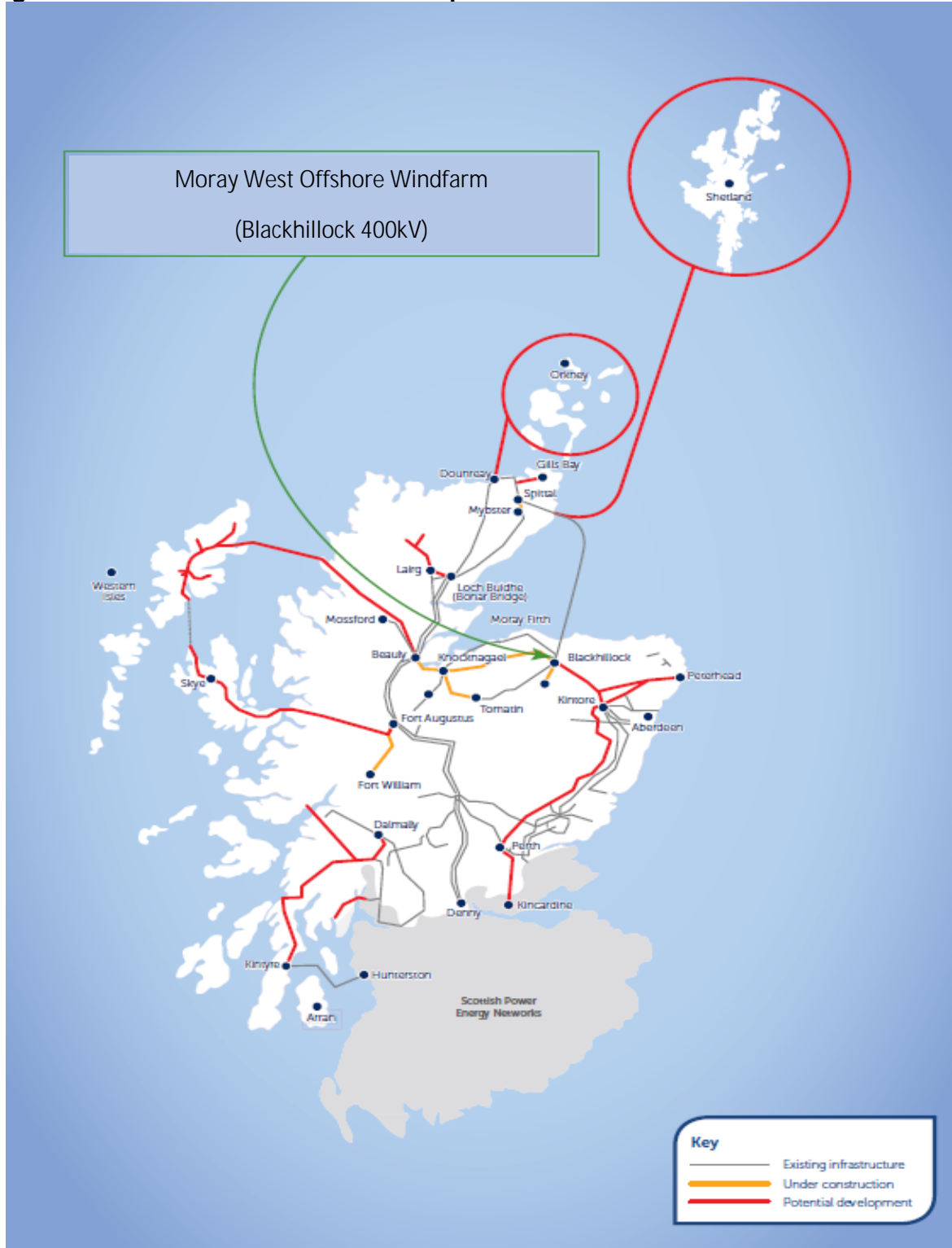
This section provides a view of whether the proposed scheme should be ring-fenced or subject to other funding mechanisms.

Section 8: Outputs included in RIIO-T1 Business Plan

This section identifies if some or all the outputs were included in the RIIO-T1 Business Plan and provides explanation and justification as to why such outputs are planned to be undertaken in the RIIO-T2 period.

Moray West Offshore Windfarm Connection

Figure 1: SHE Transmission Network Map and Location of Works



Moray West Offshore Windfarm Connection**3 Need**

This section provides an explanation of the need for the planned works. It provides evidence of the primary and, where applicable, secondary drivers for undertaking the planned works. Where appropriate it provides background information and/or process outputs that generate or support the need.

3.1 Growth Need

We are required at all times to plan and develop our transmission system in accordance with the National Electricity Transmission System Security and Quality of Supply Standard (SQSS), and, the System Operator Transmission Owner Code (STC). Furthermore, we are obliged to ensure that we can provide adequate transmission capacity to facilitate connections to customers in the north of Scotland who wish to connect to, and use, the transmission system in order to participate in the national wholesale electricity market.

The load driver for this project is an offshore windfarm located in the Moray Firth in the North East of Scotland. This project consists of the connection of the 800MW Moray West development.

The contracted connection is split into two stages (one day apart by request customer³):

- Stage 1 for the connection of 400MW on 31st March 2024; and
- Stage 2 for the connection of an additional 400MW on 1st April 2024.

These stages are one day apart and therefore provision of Transmission Entry Capacity (TEC) does not require the project completion to be phased.

The connection of Moray West was subject to the Connection and Infrastructure Options Note (CION) process³. The CION records the output of the work between the Developers, TOs and NGESO to identify the overall economic, efficient and coordinated connection option. The CION is a document developed and jointly owned by the parties to the CION process. NGESO is responsible for coordinating the development of the CION, however, each party is responsible for the accuracy of any information they provide to the CION as part of the CION process.

The Moray West development falls under the Offshore Transmission Regime. The developer is undertaking an Offshore Transmission Development User Works (OTSDUW) build which will then be transferred to a competitively appointed Offshore Transmission Owner (OFTO). This means the developer will design and build the assets up to the point of interface with the main onshore transmission system, and then the offshore transmission assets will transfer to the OFTO following a competitive tender – see Single Line Diagram (SLD) in Appendix A highlighting these demarcations.

³ [National Grid ESO - Connection Infrastructure Options Note Guidance Note](#)

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In line with the Connect and Manage Guidance 2013⁴ generators can connect ahead of the completion of Wider Works. Under Connect and Manage, derogations from the planning criteria of NETS SQSS are required to allow these generators to connect ahead of the completion of the Wider Works. We submitted a derogation report as part of the associated Moray West offer, this was accepted by NGENSO.

The transmission works required to be complete ahead of the Moray West connection are categorised as 'Sole Use Enabling Works' and 'Shared Use Enabling Works'.

Sole Use Enabling Works - Local system infrastructure which is being developed, designed and built solely for the benefit of the user making the application and requiring this to connect to the existing transmission system.

Shared Use Enabling Works - Local system infrastructure which is being newly developed and built for the benefit of multiple applicants, or which is existing infrastructure being upgraded to accommodate new applicants in addition to existing users, effectively triggering the requirement for an increase in capability on the existing system.

The developer signed a Transmission Owner Construction Agreement (TOCA) in August 2017 which details the Sole Use Enabling Works, Shared Use Enabling Works, Wider Works and Derogated Wider Works.

The Moray West Offshore Windfarm, 800MW connection is one of the primary drivers for the need and timing of the North East 400kV Upgrade.

⁴ [National Grid ES\) - Connect and Manage Guidance, March 2013.](#)

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4 Optioneering

This section presents all the options considered to address the need that is described in Section 3. Each option considered here is either discounted at this Optioneering stage with supporting reasoning provided or is taken forward for Detailed Analysis in Section 5.

A number of transmission reinforcements have been proposed to provide adequate transmission capacity in accordance with the transmission planning standard, the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS).

The five options presented in Table 1 are the Sole Use Enabling Works options to facilitate the connection of Moray West to our network. All are progressed to the cost benefit analysis under the CION process – this is outlined in Section 5 Detailed Analysis.

It should be noted that the CION was completed in 2017. The options costs and earliest in-service dates for each option were accurate at the time of writing and are consistent with our inputs to the CION process. Should a material change to the Moray West connection trigger a review of the CION, the dates, costs and options would need to be reviewed.

Table 1: Table of Options

Option	Option Detail	Cost (£m)
1	Connect to 400kV busbar at existing Blackhillock 400kV substation.	5.4 ⁵
2	Connect to a new 275kV substation at Dunbeath.	419
3	Connect to a new 400kV substation at Cullen.	65
4	Connect to 400kV busbar at existing New Deer 400kV substation.	5.4
5	Connect to 275kV busbar at existing Spittal substation.	388

'Do nothing' option

We are obliged to ensure that we can provide adequate transmission capacity to facilitate connections to customers in the north of Scotland who wish to connect to, and use, the transmission system in order to participate in the national wholesale electricity market therefore there is no 'do nothing' option.

⁵ The costs used in the CBA for Option 1 differ from the updated £8.01m 2018/19 cost estimate. This is due to the CBA been carried out on cost estimates from 2017. This change is not material to the outcome of the CBA since the cost estimates used in the CBA would all change by the same proportion if they were updated.

Moray West Offshore Windfarm Connection**Option 1 (Connect to 400kV busbar at existing Blackhillock 400kV substation)**

The Sole Use Enabling Works comprise an extension of the 400kV busbar and the provision of two fully equipped 400kV circuit breaker bays at the existing Blackhillock 400kV substation in the North East of Scotland.

The Shared Use Enabling Works to facilitate this option include the construction of the Rothienorman Substation and Rothienorman to Kintore Reconductoring (April 2021 completion) and the North East 400kV Upgrade (October 2023 completion).

The earliest in-service date for both Sole and Shared Use enabling works is 31st March 2024, meaning this option could satisfy the Moray West contracted connection date. This is in-line with our RIIO-T2 Business Plan commitment; Every Connection Delivered on Time.

PROGRESSED TO DETAILED ANALYSIS

Option 2 (Connect to a new 275kV substation at Dunbeath)

The construction of a new 275kV substation at Dunbeath located in the Caithness region of Scotland. This would be a major development which has additional requirements in relation to consultation and assessment for consenting.

The Shared Use Enabling works for this option would require a new 275kV OHL between Loch Buidhe and Spittal. This will require a full Environmental Impact Assessment given the number of designated areas, peatlands, historic monument and proximity to settlement. New Wayleaves arrangements will need to be established with the landowners.

The earliest in-service date for the enabling works required for this option is 31st October 2026 which will not satisfy the contracted connection date for Moray West.

PROGRESSED TO DETAILED ANALYSIS

Option 3 (Connect to a new 400kV substation at Cullen)

The construction of a new 400kV substation at Cullen in the North East of Scotland. This would be a major development which has additional requirements in relation to consultation and assessment for consenting.

As Shared Use Enabling works this option would require a new 400kV OHL between Cullen and Blackhillock. This will require a full Environmental Impact Assessment given the number of designated areas, peatlands, historic monument and proximity to settlement. New Wayleaves arrangement will need to be established with the landowners.

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The proposed completion date for the enabling works required for this option are 31st October 2026 which will not satisfy the contracted connection date for Moray West.

PROGRESSED TO DETAILED ANALYSIS

Option 4 (Connect to 400kV busbar at existing New Deer 400kV substation)

Connect in to New Deer substation located in the North East of Scotland. New Deer substation is being constructed as Sole Use Enabling Works for Moray East offshore wind farm, due for completion on 16th September 2020. It is a 400kV build however it will be operated initially at 275kV, with the move to 400kV operation being part of the North East 400kV Upgrade in October 2023.

This option shares the same set of Shared Use Enabling Works as Option 1 – the completion of the North East 400kV Upgrade.

The completion date for all associated enabling works is 31st March 2024, meaning this option could satisfy the Moray West contracted connection date. This is in-line with our RIIO-T2 Business Plan commitment; Every Connection Delivered on Time.

PROGRESSED TO DETAILED ANALYSIS

Option 5 (Connect to 275kV busbar at existing Spittal substation)

An extension of the 275kV busbar and the provision of two fully equipped 275kV circuit breaker bays at the existing Spittal 275kV substation.

As Share Use Enabling Works this option would require a new 275kV OHL between Loch Buidhe and Spittal. This will require a full Environmental Impact Assessment given the number of designated areas, peatlands, historic monument and proximity to settlement. New Wayleaves arrangements will need to be established with the landowners.

The proposed completion date for the enabling works required for this option are 31st October 2026 which will not satisfy the contracted connection date for Moray West.

PROGRESSED TO DETAILED ANALYSIS

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5 Detailed Analysis

This section considers in more detail each of the options taken forward from the Optioneering section. Where appropriate the results of Cost Benefit Analysis are discussed and together with supporting objective and engineering judgement contribute toward the identification of a selected option. The section continues by setting out the costs for the selected option.

5.1 Cost Benefit Analysis

As part of the CION process, a Cost Benefit Analysis (CBA) was carried out by NGENSO on the five options progressed to Detailed Analysis. NGENSO undertakes a lifetime Net Present Value based CBA on the options taking into account the capital cost as well as the associated forecast operational constraint cost and Cross Border Balancing costs attributable to the connection option. Regret analysis is then used to rationalise around the different connection options.

The CBA considered the cost of the onshore transmission system, the cost of the offshore transmission system and the impact on network constraint costs as a result of Moray West connecting at each of the proposed sites. As a result of considering constraints, this CBA captures the widest possible whole system impact as it factors in GB system operation. The CBA used four different generation backgrounds, taken from the NGENSO Future Energy Scenarios (FES) 2016⁶.

The results of the CBA analysis are presented in Table 2 as a table of Net Present Values (NPVs) per option per generation background scenario.

Table 2. CBA NPV results

Onshore Transmission Interface Point	NPV (£m)			
	Consumer Power	Gone Green	No Progression	Slow Progression
Blackhillock 400kV	-2219.27	-2370.58	-2048.42	-2902.67
Dunbeath 275kV	-2528.11	-2678.11	-2347.57	3208.12
Cullen 400kV	-2253.66	-2384.46	-2059.33	-2927.77
New Deer 400kV	-2274.12	-2334.90	-2076.81	-2917.01
Spittal 275kV	-2575.96	-2722.96	-2391.21	-3252.62

⁶ The FES 2016 document is available here: <http://fes.nationalgrid.com/fes-document/fes-archives/>

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A Least Worst Regret Analysis (LWR) was carried out on the results of the CBA to identify the option with the lowest possible regret. The results of this LWR exercise are presented in Table 3.

Table 3. Least Worst Regret analysis

Onshore Transmission Interface Point	Regret (£m)				Maximum Regret (£m)
	Consumer Power	Gone Green	No Progression	Slow Progression	
Blackhillock 400kV	0	35.68	0	0	35.68
Dunbeath 275kV	308.84	343.21	299.15	305.45	343.21
Cullen 400kV	34.39	49.56	10.90	25.09	49.56
New Deer 400kV	54.85	0	28.38	14.34	54.85
Spittal 275kV	356.67	388.04	342.76	349.92	388.04

As identified in Table 3, the option with the lowest overall regret is Blackhillock 400kV. As seen in Table 3, Blackhillock 400kV and New Deer 400kV have the joint lowest CAPEX NPV. Therefore, based on the CBA, Blackhillock 400kV is the most preferable option. It is not anticipated that more recent Future Energy Scenarios would have material impact on CBA results and that Blackhillock remains the optimal connection location for Moray West.

On 20 September 2019, the UK Government announced the provisional results of the third CfD allocation round. In the context of the north of Scotland transmission system, Moray West were among the generators that were not successful in the allocation round. Recent engagement with the developer has confirmed that Moray West intend to progress this connection in line with the current contracted position and do not foresee a material impact to the project on the back of the CfD announcement.

In line with our sustainability strategy commitments, whole life costs, losses, regional gross value add and the carbon impact of each of the options have also been assessed as part of our CBA (See Table 4)

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Table 4: CBA Impact Table

Benefit category	Details	CBA value impact
Carbon impact – embedded carbon	Embedded carbon relates to carbon emissions associated with the manufacturing and production of the materials procured and installed as part of the project.	The discounted value of embedded carbon is estimated at around £0.3m over the lifetime of the assets.
Carbon impact – carbon displacement	Carbon displacement is determined through allocating a value to the displacement of fossil fuels from connecting new renewable generation.	The estimated annual discounted carbon abatement associated with the Transmission Entry Capacity of 800MW is the region of £62m, according to the Scottish Governments Renewable Electricity Output Calculator ⁷ .
Regional Gross Value Add (GVA)	<p>GVA is a measure of the value generated in an economy by any unit engaged in the production of goods and services. SHE Transmission has developed a tool to quantify the estimated regional GVA on the Scottish economy resulting from expenditure associated with the new generation connections enabled, and the work associated with SHE Transmission investments. Total GVA is calculated by measurements at three levels:</p> <ol style="list-style-type: none"> 1. Direct GVA: value generated from direct project expenditure 2. Indirect GVA: value generated from employment of sub-contractors and demand for goods and services from suppliers down the supply-chain 1. 3. Induced GVA: value generated from greater demand and spending on goods and services such as accommodation, food, fuel and retail by employees who are employed as a result of the direct and indirect impact. 	<p>The total direct regional GVA to the Scottish economy associated with the connection of the windfarm is estimated at £57m (discounted over estimated asset life). Indirect and induced GVA totals £48m (discounted).</p> <p>The direct GVA associated with the SHE Transmission expenditure is estimated at £1m (discounted), indirect and direct GVA totals £1m).</p>

⁷ <https://www2.gov.scot/Topics/Statistics/Browse/Business/Energy/onlinetools/ElecCalc>

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5.2 Project Sensitivity

As outlined in our core RIIO-T2 business plan document, “A Network for Net Zero”, we believe we have a critical role to play in delivering Net Zero ambitions in both the UK and Scotland. Therefore, our plan has been carefully designed with the flexibility to deliver pathways to Net Zero. Our policy paper “Planning for Net Zero – Scenarios, Certain View and Likely Outturn” demonstrates that the investments which we are making are consistent with the UK Governments’ net zero emissions by 2050 target. In preparing our RIIO-T2 Business Plan, we ensured that our Certain View provides flexibility for the north of Scotland transmission network to accommodate greater volumes of renewable generation connections during the RIIO-T2 period. The strategic investments included in the Certain View –on the East Coast and near Tummel–are critical to ensuring that flexibility. While the need for these investments can be evidenced now, timely delivery also maintains long term net zero emissions pathways. Our approach to using a ‘Certain View’ means that there is strong evidence-based need and justification that the load related works are necessary for connections of renewable generation. These works are necessary to meet our legal and regulatory obligations to provide a connection to any customer who requests it.

Table 5: Sensitivity Analysis

Sensitivity	Test and impact observed – switching inputs
Ongoing efficiency assumptions	Switching efficiency assumption: increased or decreased. Test would have no impact on (feasible) option selection, the options move in parallel and have no impact on ordering within CBA.
Demand variations	No significant demand variation forecast.
Energy scenarios	<p>Sensitivities considered in the CION CBA assessment.</p> <p>As we have adopted a “Certain View” approach, as outlined in our “Planning for Net Zero – Scenarios, Certain View and Likely Outturn” policy paper, means that there is strong evidence-based need and justification that the load related works are necessary for connections of renewable generation. These works are necessary to meet our legal and regulatory obligations to provide a connection to any customer who requests it. Reference Section 3 for details.</p>
Asset utilisation	As outlined in the energy scenarios section, we are anticipating increasingly more generation

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	connecting to our Transmission network. As outlined in our "Planning for Net Zero – Scenarios, Certain View and Likely Outturn" policy paper our business plan has been carefully designed with the flexibility to deliver pathways to Net Zero. There is strong evidence-based need and justification that the load related works are necessary for connections of renewable generation. These works are necessary to meet our legal and regulatory obligations to provide a connection to any customer who requests it. We are unable to consider the known unknowns.
Timing / delivery	We have considered timing of investments as part of our CBAs.
Consenting / stakeholders	Where applicable we have considered consenting and stakeholder engagement as part of section 5 (Detailed Analysis) and the impact which this has had on the selection of the preferred solution.
Public policy / Government legislation	We have considered the impact of public policy, government legislation and regulations as part of the need (section 3), optioneering (section 4) and detailed analysis (section 5) and the impacts this has on the selection of the preferred solution. For example the projects have considered the impact of the UK Governments' Net Zero emission by 2050 target, SQSS and ESQCR.

5.3 Proposed Solution

Based on the Detailed Analysis undertaken, Blackhillock 400kV is selected as the preferred connection site for Moray West. This is due to the comparably lesser enabling works required, the ability to deliver the connection by the developer's required connection date, and the strongest performance in the CBA.

A Single Line Diagram (SLD) of the proposed connection at Blackhillock 400kV is shown before and after the proposed works in Appendix B.

The scope of the proposed solution includes the extension of the existing 400kV GIS double busbar and installation of two new 400kV GIS double busbar feeder bays complete with line circuit breakers,



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line disconnectors and associated busbar selector disconnectors at Blackhillock 400kV substation. The physical arrangement will mean that the new bays are fitted to the external ends of the existing board.

The Shared Use Enabling works for the connection of Moray West include the North East 400kV Upgrade.

5.4 Competition

The Moray West Offshore Windfarm Connection is not flagged as eligible for early or late competition due it being under Ofgem's £50m and £100m thresholds respectively.

5.5 Cost Estimate

The total cost for delivering the scope of works for the proposed solution is £8.01m.

Each Investment Decision Pack will contain a Cost Justification Paper that sets out how this total cost has been derived at both a scheme level and cost breakdown structure level. This document is being finalised for this scheme and will be submitted as part of the final Business Plan Submission in December 2019.

The current delivery date for the sole-use enabling works is 31st March/1st April 2024. This aligns with the current Moray West contracted connection date.

Moray West Offshore Windfarm Connection**6 Conclusion**

This Engineering Justification Paper confirms the need for undertaking construction works on the Blackhillock 400kV double busbar to accommodate the 800MW connection of Moray West Offshore Windfarm.

The proposed works include extension of the existing 400kV GIS double busbar and installation of two new 400kV GIS double busbar feeder bays complete with line circuit breakers and line disconnectors.

This scheme delivers the following outputs and benefits:

- Connect 800MW of renewable offshore wind to our transmission network in line with our goal to transport the renewable electricity that powers 10 million homes
- Provide a network connection tailored to meet our customers needs in line with our goal to deliver every connection on time.

The total cost for delivering the scope of works for the proposed solution is £8.01m and the current delivery date for the sole-use enabling works is 31st March/1st April 2024. This aligns with the current Moray West contracted connection date.

Moray West Offshore Windfarm Connection**7 Price Control Deliverable & Ring Fencing**

As set out in our Regulatory Framework paper (section 1.12 and Appendix 3) we support a key principle from Citizens Advice – one that guarantees delivery of outcomes equivalent to the funding received - to ensure that RIIO-T2 really deliver for consumers. At the project level this means that if we don't deliver the output, or a materially equivalent outputs, we commit to returning the ex-ante allowance for the output not delivered.

This means that if the funding for Moray West Offshore Windfarm Connection should be ring-fenced and if it does not go ahead, we will return the allowances of £8.01m full (minus any justified preconstruction expenditure).

It also means that we commit to delivering 800MW for the costs of £8.01m. If we do not deliver that 800MW or a materially equivalent output, we commit to returning a proportion of the ex-ante allowance. The detailed methodology should be decided at when developing the Close Out methodologies but should apply the same principles of uncertainty mechanisms - that any under delivery should be material.



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8 Outputs included in RIIO T1 Business Plan

There are no outputs associated with this scheme included in our RIIO-T1 plans.



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Appendices

Appendix A – Single Line Diagram showing ownership demarcation.

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Appendix B – Blackhillock 400kV Single Line Diagram

Before - Blackhillock 400kV Busbar before the Moray West Offshore Windfarm Connection and North East 400kV Upgrade

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After - Blackhillock 400kV Busbar after the Moray West Offshore Windfarm Connection and North East 400kV Upgrade

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