7.1 (TA) CARBON BALANCE SUMMARY

SUMMARY

The Development is expected to save 2,918,434 tonnes of carbon dioxide emissions over its 30 year lifetime. The carbon payback period is expected to be 3 years and 1 month. The minimum and maximum payback periods are estimated at approximately 10 months and 11 years 6 months respectively.

Based on the above figures the Development is considered to have a major beneficial effect on the environment from the production of renewable energy.

INTRODUCTION

1.1 This Technical Appendix provides a summary of the carbon balance for the Development.

1.2 It is widely recognised that wind farms and other renewable energy developments can potentially save carbon emissions during their operational life in comparison to energy generated from fossil fuels. One of the principal aims of renewable energy development is to reduce carbon emissions by generating carbon-free electricity. In order to achieve such savings it is important to ensure that the management of peat resource does not adversely affect the carbon balance of renewable energy projects.

1.3 The British Geological Survey (BGS) 1:50,000 mapping indicates that the Site is predominantly underlain by peat and this has been confirmed by on-site observations and peat depth probing. Peatlands are a form of carbon sink which hold large stocks of relatively poorly protected carbon and so have the potential to greatly increase overall long term carbon losses if they sustain damage as a result of poorly executed development.

1.4 As the Site contains a significant proportion of peat soils, the applicant has a responsibility to ensure that the proposed development does not cause a significant loss of this carbon reservoir. Reference should be made to Chapter 7(Ground Conditions & Hydrology).

1.5 Scottish Planning Policy (SPP) states within paragraph 205 that "Where peat and other carbon rich soils are present, applicants should assess the likely effects of development on carbon dioxide (CO_2) emissions. Where peatland is drained or otherwise disturbed, there is liable to be a release of CO_2 to the atmosphere. Developments should aim to minimise this release." (The Scottish Government, 2014).

METHODOLOGY

1.6 The methodology for assessing the Carbon Balance is based on "Calculating carbon savings from wind farms on Scottish peat lands - A New Approach" (Nayak et al, 2010).

1.7 The latest Scottish Government Carbon Calculator for Windfarms on Peatlands was used to estimate the carbon losses and gains from the Development. The carbon calculator is accessible online (see references section for Government website: Scottish Government Online Carbon Calculator Tool v1.4.0), the Kype Muir Extension calculator can be viewed using reference **GL6K-SD91-XJZP (V13)**.

1.8 The web-based version of the calculator supersedes all previous excel based versions of the tool. Data sources used and a summary of the justification for chosen values and parameters are detailed in Table TA 7.1.

1.9 Supporting calculations are included in "Technical Appendix 7.1.1 – Supporting Calculations".

BASELINE CONDITIONS

Information Gaps

1.10 Average peat depths were estimated using data from the peat probing exercise.

1.11 Water table depths are generic values characteristic of peat lands before wind farm development as discussed with SEPA on similar wind farm projects.

1.12 Extent of drainage around drainage features is also based on SEPA correspondence concerning similar wind farm projects. The potential negative effect of deforestation is well understood by Banks Renewables, which is why the decision was made to carry out keyhole felling only around infrastructure (as opposed to clear felling the Development).

1.13 In order to evaluate the worst case scenario, remediation of degraded bogs has not been considered therefore no allowance has been made for any improvement works of this nature. The Draft Habitat Management Plan recommends maximising opportunities for bog enhancement and restoration. The extent of the restoration that will take place as part of the Development is not known at this stage and therefore the improvement due to this has not been included in the calculation.

1.14 In order to evaluate the worst case scenario, restoration of the site after decommissioning has not been considered.

1.15 As no site specific temperature data was available, the nearest available weather stations were used. A breakdown of the estimate is included in Technical Appendix 7.1.2. Carbon emission factors used to calculate the carbon payback period were taken from DECC DUKES, 2017.

NON TECHNICAL SUMMARY OF RESULTS

1.16 The proposed Development consists of 15 turbines. The candidate turbine has a 4.2MW capacity and the Development is expected to produce approximately 221GWh of electricity per year, equivalent to the annual electricity consumption of nearly 57,000 homes or 39% of households in South Lanarkshire.

1.17 Through generating electricity by harnessing the power of the wind as opposed to burning a mix of fossil fuels, the wind farm is expected to provide a potential saving of approximately 3,158,970 tonnes of carbon dioxide emissions over the 30 year lifetime of the proposed development. The best case and worst case figures are estimated at approximately 2,030,760 and 3,854,670 tonnes respectively.

1.18 A wind farm "loses" carbon through turbine manufacture, backup generation and felling of forestry etc. The total expected carbon losses due to the Development are estimated at approximately 240,536 tonnes, with best case and worst case figures of approximately 98,329 and 775,136 tonnes respectively.

1.19 Taking the “losses” into account the wind farm is expected to save a total of 2,918,434 tonnes of carbon dioxide emissions over the 30 year lifetime. The best case and worst case are estimated at approximately 1,932,431 and 3,079,534 tonnes respectively.

1.20 Based on the above figures for carbon losses and carbon gains, it is expected to take 3 years and 1 month for the amount of carbon “saved” through not burning fossil fuels to equal the amount of carbon “lost” to build and run the wind farm. After this point, the carbon lost is said to be paid back and the wind farm will effectively be a carbon-free source of electricity generation. The minimum and maximum payback is estimated at 10 months and 11 years and 6 months respectively. This estimate constitutes a worst case scenario - before replanting of forestry and measures to improve the carbon sequestration and restore the site after decommissioning are taken into consideration. The likely carbon payback is therefore likely to be even shorter.

1.21 Due to the short payback times expected, it is considered that the Development will have a beneficial effect on the environment compared to generating electricity using fossil fuels.

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Table TA 7.1: Carbon Balance Data Sources

Input	Value			Source	Justification
	Expected	Min	Max		
No. of turbines	15	15	15	Applicant – Project information sheet	Site specific value
Lifetime of wind farm (years)	30	30	30	Applicant – Project information sheet	Fixed value
Power rating of turbines (turbine capacity) (MW)	4.20	4.00	5.00	Applicant – Project information sheet	Site specific value
Capacity factor	40	27	41	Applicant – Project information sheet	Site specific value
Extra capacity required for backup (%)	5	0	15	Dale et al 2004, Energy Policy, 32, pg1949-56	Best available data
Additional emissions due to reduced thermal efficiency (%)	10	10	10	Dale *et al.* 2004, Energy Policy, 32, Pg 1949-56	Best available data.
Type of peatland	Acid bog	Acid bog	Acid bog	Site survey	Site specific value.
Average air temperature at site (^{o}C)	11.52	6.23	12.96	CIBSE TRY data for Glasgow and Met Office Historical data for Paisley	No on-site data yet available/
Carbon Content of dry peat (% by weight)	53.23	19.57	64.28	Scottish Soils Knowledge and Information Base (SSKIB)	Assume peat to be blanket peat as this gives worst case carbon content
Average extent of drainage around drainage features at site (m)	37.50	25.00	50.00	Generic values characteristic of peatlands before wind farm development based on SEPA correspondence on similar wind farm projects	Shallow ditches proposed, unlikely to significantly lower groundwater

Input	Value			Source	Justification
	Expected	Min	Max		
Average water table depth at site (m)	0.10	0.05	0.30	Generic values characteristic of peatlands before wind farm development based on SEPA correspondence on similar wind farm projects	Best available data.
Dry soil bulk density (g cm^{-3})	0.13	0.07	0.29	Unpublished data from the National Soil Inventory of Scotland (2007-2009).	Assume it is decomposed peat as this gives worst case estimate.
Time required for regeneration of bog plants after restoration (years)	10	10	10	Nayak *et al*., 2010	Best available data.
Carbon accumulation due to fixation by bog plants (t C ha^{-1} yr^{-1})	0.25	0.12	0.31	Turunen *et al*., 2001; Botch *et al.,* 1995; SNH Guidance	Best available data
Area of forestry plantation to be felled (ha)	134.40	134.00	135.00	ES Chapter 9	Site specific value
Average rate of carbon sequestration in timber (tC ha-1 yr-1)	3.60	3.15	3.60	Turunen et al., 2001	Best available data
Coal-fired plant emission factor (t CO_2 MWh^{-1})	0.925	0.925	0.925	DECC DUKES 2017, Table 5D	Best available data
Grid-mix emission factor (t CO_2 MWh^{-1})	0.348	0.348	0.348	DECC DUKES 2017, Table 5D	Best available data
Fossil fuel-mix emission factor (t CO_2 MWh^{-1})	0.477	0.477	0.477	DECC DUKES 2017, Table 5D	Best available data
Number of borrow pits	4.00	4.00	4.00	Project factsheet	Site specific value
Average length of pits (m)	120	120	120	Project Factsheet	Site specific value
Average width of pits (m)	126.50	126.50	126.50	Project Factsheet	Site specific value
Average depth of peat removed from pit (m)	0.84	0.29	1.70	Refer to Figure 7.2.5	Site specific value.

Input	Value			Source	Justification
	Expected	Min	Max		
Average length of turbine foundations (m)	26.00	19.50	32.50	Project Factsheet	Site specific value.
Average width of turbine foundations (m)	26.00	19.50	32.50	Project Factsheet	Site specific value.
Average depth of peat removed from turbine foundations (m)	1.38	0.00	2.30	Refer to Figure 7.2.5	Site specific value.
Average length of hard-standing (m)	68.00	67.00	69.00	Project Factsheet	Site specific value.
Average width of hard-standing (m)	40.00	39.00	41.00	Project Factsheet	Site specific value.
Average depth of peat removed from hard-standing (m)	1.40	0.00	2.30	Refer to Figure 7.2.5	Site specific value.
Total length of access track (m)	11,307	11,305	11,309	Project Factsheet	Site specific value.
Existing track length (m)	2,264	2,264	2,264	Project Factsheet	Site specific value.
Length of access track that is floating road (m)	2,432	2,432	2,432	Project Factsheet	Site specific value.
Floating road width (m)	5.00	5.00	5.00	Project Factsheet	Site specific value.
Floating road depth (m)	0.60	0.50	0.70	Project Factsheet	Site specific value.
Length of floating road that is drained (m)	0.00	0.00	0.00	Refer to Figure 7.2.5	Diffuse drainage incorporated into floating track design.
Average depth of drains associated with floating roads (m)	0.00	0.00	0.00	Refer to Figure 7.2.5	Diffuse drainage incorporated into floating track design.
Length of access track that is excavated road (m)	6,611	6,610	6,612	Project Factsheet	Site specific value.
Excavated road width (m)	5.00	5.00	5.00	Project Factsheet	Site specific value
Average depth of peat excavated for road (m)	1.12	0.00	2.20	Refer to Figure 7.2.5	Site specific value.
Blocking of artificial gullies/ditches?	No	No	No	Site visit	Site visit showed low potential for enhancement

Input	Value			Source	Justification
	Expected	Min	Max		
Control grazing?	No	No	No	Site visit	Site visit showed low potential for enhancement
Reintroduction of species?	No	No	No	Site visit	Site visit showed low potential for enhancement