INNOGY RENEWABLES UK LTD

CARNEDD WEN WIND FARM AND HABITAT RESTORATION SCHEME

Innogy Renewables UK Ltd Response to BEIS

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Contents

1. Introduction

1.1. The Secretary of State for Business, Energy and Industrial Strategy (BEIS) is in the process of making a re-determination of the applications under Section 36 of the Electricity Act 1989 and associated Habitat Regulations Assessment (HRA) for the Llanbrynmair Wind Farm and for Carnedd Wen Wind Farm and Habitat Management and Restoration Scheme. In the process of doing so, the Secretary of State wrote, on 6th September 2018, to Natural Resources Wales (NRW), requesting a response to three specific questions. NRW responded on 30th November 2018 and the Secretary of State on 19th December 2018 invited the applicants for the projects to review NRW's response and to consider the following matters raised:

- NRW has confirmed that red kite is currently listed as a qualifying feature of the Berwyn Special Protection Area ("SPA");
- While NRW confirmed that it was satisfied with the conclusions of the Secretary of State's HRA published on 23rd June 2015 and that the results of subsequent surveys carried out between 2016 and 2017, reported by BSG Ecology on 30th July 2018, did not raise any further concerns for the projects, it requested that consideration be given to running an updated collision risk model to inform the HRA.

1.2. The Secretary of State further requested that the applicants review an updated table of projects, provided by Powys County Council (PCC) to be included in the in-combination HRA and to offer their comments.

1.3. This document provides the response of Innogy Renewables UK Limited (Innogy) to the Secretary of State's request, dealing with each matter in the order listed above. It supplements a response to an earlier request by BEIS for further information: *Innogy: further representations to inform the Habitats Regulations Assessment, 23 March 2018*[1]*.*

2. Red kite

2.1. Innogy's 23 March 2018 response, based on the informal advice of NRW incorrectly stated that red kite were no longer a qualifying feature of the Berwyn SPA. Nevertheless, the response summarised the current status of the species and the modelled projected continuing growth of the Welsh population. Collision risk modelling of red kite within the combined Carnedd Wen and Llanbrynmair projects has since been undertaken, by BSG Ecology on behalf of both applicants, and is reported in detail in Sections 2 and 3 of the parallel response of RES UK to BEIS's 19th December letter. The results of the model for Carnedd Wen are presented in Appendix 1.

2.2. Applying a 99% avoidance rate, as recommended by Scottish Natural Heritage (SNH), it is predicted that the combined wind farm projects could give rise to one red kite collision every 9.8 years. Over Carnedd Wen alone, the predicted collision rate is one bird every 56.1 years, reflecting the lower suitability of the habitats within Carnedd Wen for this species. Against a background of a growing population, these rates are of negligible conservation significance.

2.3. Red kite occur frequently in the wider area, both within and without the Berwyn SPA. Breeding territories are consequently restricted by competition, and there are plentiful non-breeding juveniles

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1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/738036/Further_Information_on_behalf_of_Innogy_dated_23_March_2018_to_inform__the_Habitats_Regulations_Assessment.pdf

seeking to occupy any vacant territories. Given the limits to breeding territory size, it is not likely that either the Carnedd Wen site or the Llanbrynmair site represent land that is functionally linked to the Berwyn SPA[2]. Taking the absence of functional linkage and the negligible predicted collision rates for Carnedd Wen alone or when combined with Llanbrynmair, there would be no adverse effect on the integrity of the Berwyn SPA if the two sites were consented. On the same basis, there is no likelihood that the two projects could interact on an in-combination basis with any other projects.

3. Collision risk for other qualifying species

3.1. In addition to red kite, BSG Ecology also modelled collision risk for hen harrier based on the findings of surveys carried out between 2016 and 2018. Again, this modelling is reported in detail in RES UK's parallel response to BEIS. In summary, only five sightings were made of individual hen harriers at collision risk height, resulting in a predicted collision rate for the two sites combined of one bird in 1190 years. For Carnedd Wen alone, the predicted rate was one bird every 4228 years (see Appendix 2). Clearly, these predictions, based on such a low number of sightings, are not statistically robust, but are perhaps useful as a guide to the negligible magnitude of the actual rates. On the basis of these negligible rates, there would be no adverse effect on the integrity of the Berwyn SPA hen harrier population.

3.2. Only three, brief flights of peregrine at collision risk height were recorded during the 2016 to 2017 surveys: an insufficient number to permit modelling. No merlin were recorded at collision risk height. On the basis of these findings, there would be no adverse effect on the integrity of the Berwyn SPA peregrine or merlin populations.

4. Requirement for in-combination assessment

4.1. The table of wind farms and associated infrastructure projects provided to Innogy by PCC on 10 January 2019 appears to be a list of all wind farms, consented or in planning, in Powys rather than, as requested by BEIS, a list of those PCC considers should be taken into account in the HRA. Notwithstanding this, the predicted collision rates for hen harriers and the level of flight activity over the project areas by peregrine and merlin, which were too low to allow even indicative modelling, are such that there is no likelihood that Carnedd Wen and Llanbrynmair could contribute to any in-combination effects.

4.2. Similarly, the absence of functional linkage and the negligible predicted collision rates for Carnedd Wen alone or when combined with Llanbrynmair, are such that there is no likelihood that the two projects could interact with any other projects to have an adverse in-combination effect on the integrity of the Berwyn SPA.

[2] Functionally linked land is defined by Natural England as that which is regularly used by a significant proportion of a SPA qualifying species.

Appendix 1: Collision modelling results for red kite at Carnedd Wen

Scottish Natural Heritage: Calculating a theoretical collision risk assuming no avoiding action

Site Name: Carnedd Wen

(orange)	= data input required
(yellow)	= model calculates value

Stage 1: Number of birds flying through rotors

Input Parameters

Bird Dimensions

Species	Red kite
length (m)	0.63
wing span (m)	1.85
speed (m/sec)	8

Bird Flight Data

No of birds	26
Time spent in V_w (sec)	15857.60

Turbine Dimensions

Height of tower (m)	90
Blade length (m)	45
Max blade height (m)	135
Min blade height (m)	45
Depth of rotor (m)	3.651781

Wind Farm Dimensions

No of turbines	50
Site width (m)	4010
Site length (m)	7500
Area (m^2)	30075000

Method 1 - Birds using the windfarm airspace

(to be used for birds that fly across the site using a variety of different flight paths)

Step No	Description of Calculation		Calculation	Comments
1	Identify 'flight risk volume' V_w' which is the area of the wind farm multiplied by the height of the turbines	V_w =	4060125000 m^3	Area is equivalent to survey area and should include minimum of 500m buffer around turbines
2	Calculate the combined volume swept out by the rotors $V_r = N \times \pi R^2 \times (d + l)$ where N is the number of turbines, d is the depth of the	V_r =	1361805.46 m^3	

rotor front to back, and l is the bird length

3	Estimate bird occupancy n within V_w This is the number of birds multiplied by the time spent within V_w (per season/year)	n =	15857.60	secs per yr	Bird occupancy is based on observations of birds flying through rotor-swept area
4	Bird occupancy of V_r $n \times (V_r / V_w)$ bird-seconds	occupancy =	5.32	bird-seconds	
5	Time taken for a bird to make transit through and completely clear the rotors $t = (d + l) / v$ where v is bird speed (m/sec)	t =	0.54	seconds	Speed should be assessed in the field but published values are available
6	Calculate number of bird transits through the rotors = $n \times (V_r / V_w) / t$	transits =	9.94	bird transits per annum	

Number of bird transits through the rotors per annum = 9.94

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Input parameters regarding the turbine specification will need to be obtained from the design engineers or manufacturers.

W Band 11/02/2019

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	4	m
Pitch (degrees)	20	
BirdLength	0.63	m
Wingspan	1.85	m
F: Flapping (0) or gliding (+1)	1	
Bird speed	8	m/sec
RotorDiam	90	m
RotationPeriod	3.00	sec
Bird aspect ratioo: β	0.34	

Calculation of alpha and p(collision) as a function of radius

			Upwind:			Downwind:		
r/R radius	c/C chord	α alpha	collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
0.025	0.575	3.40	12.12	1.00	0.00125	10.55	1.00	0.00125
0.075	0.575	1.13	4.57	0.57	0.00428	2.99	0.37	0.00281
0.125	0.702	0.68	3.55	0.44	0.00555	1.63	0.20	0.00255
0.175	0.860	0.49	3.32	0.41	0.00725	0.96	0.12	0.00211
0.225	0.994	0.38	3.21	0.40	0.00904	0.49	0.06	0.00139
0.275	0.947	0.31	3.02	0.38	0.01039	0.83	0.10	0.00284
0.325	0.899	0.26	2.74	0.34	0.01114	0.98	0.12	0.00397
0.375	0.851	0.23	2.52	0.31	0.01181	1.07	0.13	0.00502
0.425	0.804	0.20	2.33	0.29	0.01239	1.13	0.14	0.00598
0.475	0.756	0.18	2.17	0.27	0.01289	1.16	0.14	0.00687
0.525	0.708	0.16	2.03	0.25	0.01332	1.17	0.15	0.00767
0.575	0.660	0.15	1.90	0.24	0.01366	1.17	0.15	0.00839
0.625	0.613	0.14	1.78	0.22	0.01391	1.16	0.14	0.00903
0.675	0.565	0.13	1.67	0.21	0.01409	1.14	0.14	0.00958
0.725	0.517	0.12	1.57	0.20	0.01419	1.11	0.14	0.01006
0.775	0.470	0.11	1.47	0.18	0.01420	1.08	0.13	0.01045
0.825	0.422	0.10	1.37	0.17	0.01413	1.04	0.13	0.01077
0.875	0.374	0.10	1.28	0.16	0.01398	1.01	0.13	0.01100
0.925	0.327	0.09	1.19	0.15	0.01375	0.96	0.12	0.01115
0.975	0.279	0.09	1.10	0.14	0.01344	0.92	0.12	0.01122

Overall p(collision) = **Upwind** **22.5%** **Downwind** **13.4%**

Average **17.9%**

Bird survey data

Date	Time observed (seconds)	Number of birds	Bird Occupancy in flight risk volume
TOTAL	3105	26	3105

TOTAL SURVEY TIME 864 hours or 3110400 seconds

Period when Red kite likely to be on site (see below) =

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31	28	31	30	30	30	31	31	30	31	30	31

Total days = 364 Total hours (corrected - see below) = 4412.55

Period when Red kite likely to be on site = 15885180 seconds (in each year)

Assumptions (write in any assumptions that have been included in the model)

Assumption 1: The flying period extends from dawn to dusk and includes 25% of night.

Assumption 2:

Assumption 3:

Assumption 4:

Proportion of time during which a collision may occur = 15885180 (in each year)

Red kite flight time = 3105 seconds in 3110400 seconds survey time

Therefore in 12 months = 15857.60 seconds

Note: This table is only relevant when calculating collision risk for goose species. It provides an adjustment for nocturnal flight behaviour for these species.

Number of hours geese are potentially active during winter (from Band et al, in press)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nox	Dec	
Mean Daylight hours		8	10	12	13	14	15	14	13	12	11	9	7	
Mean Nocturnal hrs*	5	0.8	0.7	0.6	0.55	0.5	0.45	0.5	0.55	0.6	0.65	0.75	0.85	
Combined Daily Mean		8.8	10.7	12.6	13.55	14.5	15.45	14.5	13.55	12.6	11.65	9.75	7.85	
No of days birds present		31	28	31	30	30	30	31	31	30	31	30	31	
Total hours each month		**272.8**	**299.6**	**390.6**	**406.5**	**435**	**463.5**	**449.5**	**420.05**	**378**	**361.15**	**292.5**	**243.35**	**4412.55**
Total hours per year		**4412.55**												

Method 1 - Birds using the windfarm airspace	(to be used for birds that fly across the site using a variety of different flight paths)
Number of bird transits through the rotors per annum =	9.94
Average collision risk for bird passing through rotor =	17.9%
Number of birds potentially killed by rotors per annum =	1.78

NB: The above calculation assumes no avoidance

Correcting for 95% avoidance rate:		Correcting for 98% avoidance rate:		Correcting for 99% avoidance rate:	
Number of birds potentially killed by rotors per annum =	**0.089130**	Number of birds potentially killed by rotors per annum =	**0.035652**	Number of birds potentially killed by rotors per annum =	**0.01783**
1 bird killed every	**11.219557 years**	**1 bird killed every**	**28.048893 years**	**1 bird killed every**	**56.097785 years**

Appendix 2: Collision modelling results for hen harrier at Carnedd Wen

Site Name

Carnedd Wen

Bird Dimensions

Species	**Hen harrier**	= data input required
length (m)	0.48	= model calculates value
wing span (m)	1.1	
speed (m/sec)	10	Sources of speed and dimension information: Brudered and Boldt (2001); BTO Bird Facts

Turbine Dimensions

Height of tower (m)	90
Blade length (m)	45
Max blade height (m)	135
Min blade height (m)	45
Depth of rotor (m)	3.651781003

Wind Farm Dimensions

No of turbines	50	
Site width (m)	4010	Both width and length include a 490m 'extension' to allow for the sweep of the blades and margin for flight line plotting error
Site length (m)	7500	

Turbine Specifications

K: [1D or [3D] (0 or 1)	1
NoBlades	3
MaxChord	4 *
Pitch (degrees)	20 *
Rotation period	3 *

Flight Characteristics

Flapping (0) or gliding (+1) 1

Night adjustment

What percentage of the night is the target species active? 5 **%**

Survey Data

Total survey time (hours) 864

Period when **Hen harrier** **likely to be on site.**

Type in the number of days in each month where the target species is present within the site:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31	28	31	30	30	30	31	31	30	31	30	31

Total number of months when Hen harrier **likely to be present:** 12

Enter the date of each record, the time the bird(s) was recorded in the collision risk area and the number of birds on a separate.
Bird occupancy is automatically calculated.

Date	Time observed (seconds)	Number of birds	Bird Occupancy in flight risk volume	
18/08/16	30	1	30	(the time in seconds is aggregated time for each species modelled)
27/09/16	15	1	15	

Total		45		2		45

Method 1 - Birds using the windfarm airspace (to be used for birds that fly across the site using a variety of different flight paths)

= data input required
= model calculates value

Step 1 **Go to Data Input**

Input data about the species that is being assessed - body length, wing span and flight speed
Input data on turbine dimensions
Input data on wind farm area
Input data on turbine dimensions and specification
Input all vantage point data for the species that is being assessed - number of birds and flight time within the study area
Input the number of days for each month where the species is likely to be present within the site
Input days for those months where the species is likely to be present within the site
Input the appropriate night time correction factor for the species being assessed, e.g. a 25% nocturnal flight time correction was proposed by Band et al for geese. This correction cannot be applied to all species, for example raptors.

Step 2 **Go to Collision Risk**

Final collision risk estimates are highlighted
Only use the collision risk estimate for the method that has been used

Scottish Natural Heritage: Calculating a theoretical collision risk assuming no avoiding action

Site Name: Carnedd Wen

= data input required
= model calculates value

Stage 1: Number of birds flying through rotors

Input Parameters

Bird Dimensions

Species	Hen harrier
length (m)	0.48
wing span (m)	1.1
speed (m/sec)	10

Bird Flight Data

No of birds	2
Time spent in V_w (sec)	229.82

Turbine Dimensions

Height of tower (m)	90
Blade length (m)	45
Max blade height (m)	135
Min blade height (m)	45
Depth of rotor (m)	3.651781

Wind Farm Dimensions

No of turbines	50
Site width (m)	4010
Site length (m)	7500
Area (m^2)	30075000

Method 1 - Birds using the windfarm airspace

(to be used for birds that fly across the site using a variety of different flight paths)

Step No	**Description of Calculation**		**Calculation**	**Comments**
1	Identify 'flight risk volume' V_w' which is the area of the wind farm multiplied by the height of the turbines	V_w =	4060125000 m^3	Area is equivalent to survey area and should include minimum of 500m buffer around turbines
2	Calculate the combined volume swept out by the rotors $V_r = N \times \pi R^2 \times (d + l)$ where N is the number of turbines, d is the depth of the	V_r =	1314098.49 m^3	

	rotor front to back, and l is the bird length				
3	Estimate bird occupancy n within V_w This is the number of birds multiplied by the time spent within V_w (per season/year)	n =	229.82	secs per yr	Bird occupancy is based on observations of birds flying through rotor-swept area
4	Bird occupancy of V_r n x (V_r / V_w) bird-seconds	occupancy =	0.07	bird-seconds	
5	Time taken for a bird to make transit through and completely clear the rotors t = (d + l) / v where v is bird speed (m/sec)	t =	0.41	seconds	Speed should be assessed in the field but published values are available
6	Calculate number of bird transits through the rotors = n x (V_r / V_w) / t	transits =	0.18	bird transits per annum	

Number of bird transits through the rotors per annum = 0.18

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Input parameters regarding the turbine specification will need to be obtained from the design engineers or manufacturers.

W Band 11/02/2019

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	4	m
Pitch (degrees)	20	
BirdLength	0.48	m
Wingspan	1.1	m
F: Flapping (0) or gliding (+1)	1	
Bird speed	10	m/sec
RotorDiam	90	m
RotationPeriod	3.00	sec
Bird aspect ratioo: β	0.44	

Calculation of alpha and p(collision) as a function of radius

			Upwind:			Downwind:		
r/R radius	c/C chord	α alpha	collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
0.025	0.575	4.24	12.93	1.00	0.00125	11.36	1.00	0.00125
0.075	0.575	1.41	4.83	0.48	0.00363	3.26	0.33	0.00245
0.125	0.702	0.85	3.79	0.38	0.00474	1.87	0.19	0.00234
0.175	0.860	0.61	3.56	0.36	0.00623	1.21	0.12	0.00211
0.225	0.994	0.47	3.45	0.35	0.00777	0.73	0.07	0.00165
0.275	0.947	0.39	3.15	0.31	0.00866	0.56	0.06	0.00153
0.325	0.899	0.33	2.81	0.28	0.00914	0.61	0.06	0.00197
0.375	0.851	0.28	2.55	0.25	0.00956	0.74	0.07	0.00277
0.425	0.804	0.25	2.33	0.23	0.00992	0.83	0.08	0.00351
0.475	0.756	0.22	2.15	0.21	0.01021	0.88	0.09	0.00418
0.525	0.708	0.20	1.99	0.20	0.01043	0.91	0.09	0.00478
0.575	0.660	0.18	1.84	0.18	0.01059	0.93	0.09	0.00532
0.625	0.613	0.17	1.71	0.17	0.01068	0.93	0.09	0.00580
0.675	0.565	0.16	1.59	0.16	0.01071	0.92	0.09	0.00620
0.725	0.517	0.15	1.47	0.15	0.01067	0.90	0.09	0.00655
0.775	0.470	0.14	1.36	0.14	0.01057	0.88	0.09	0.00683
0.825	0.422	0.13	1.26	0.13	0.01041	0.85	0.09	0.00704
0.875	0.374	0.12	1.16	0.12	0.01017	0.82	0.08	0.00719
0.925	0.327	0.11	1.07	0.11	0.00987	0.79	0.08	0.00727
0.975	0.279	0.11	0.98	0.10	0.00951	0.75	0.07	0.00729

Overall p(collision) = **Upwind** **17.5%** **Downwind** **8.8%**

Average **13.1%**

Bird survey data

Date	Time observed (seconds)	Number of birds	Bird Occupancy in flight risk volume
TOTAL	45	2	45

TOTAL SURVEY TIME 864 hours or 3110400 seconds

Period when Hen harrier likely to be on site (see below) =

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31	28	31	30	30	30	31	31	30	31	30	31

Total days = 364 Total hours (corrected - see below) = 4412.55

Period when Hen harrier likely to be on site = 15885180 seconds (in each year)

Assumptions (write in any assumptions that have been included in the model)
Assumption 1: The flying period extends from dawn to dusk and includes 25% of night.
Assumption 2:
Assumption 3:
Assumption 4:

Proportion of time during which a collision may occur = 15885180 (in each year)
Hen harrier flight time = 45 seconds in 3110400 seconds survey time
Therefore in 12 months = 229.82 seconds

Note: This table is only relevant when calculating collision risk for goose species. It provides an adjustment for nocturnal flight behaviour for these species.

Number of hours geese are potentially active during winter (from Band et al, in press)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nox	Dec	
Mean Daylight hours		8	10	12	13	14	15	14	13	12	11	9	7	
Mean Nocturnal hrs*	5	0.8	0.7	0.6	0.55	0.5	0.45	0.5	0.55	0.6	0.65	0.75	0.85	
Combined Daily Mean		8.8	10.7	12.6	13.55	14.5	15.45	14.5	13.55	12.6	11.65	9.75	7.85	
No of days birds present		31	28	31	30	30	30	31	31	30	31	30	31	
Total hours each month		**272.8**	**299.6**	**390.6**	**406.5**	**435**	**463.5**	**449.5**	**420.05**	**378**	**361.15**	**292.5**	**243.35**	**4412.55**
Total hours per year		**4412.55**												

Method 1 - Birds using the windfarm airspace	(to be used for birds that fly across the site using a variety of different flight paths)
Number of bird transits through the rotors per annum =	0.18
Average collision risk for bird passing through rotor =	13.1%
Number of birds potentially killed by rotors per annum =	0.02

NB: The above calculation assumes no avoidance

Correcting for 95% avoidance rate:		Correcting for 98% avoidance rate:		Correcting for 99% avoidance rate:	
Number of birds potentially killed by rotors per annum =	0.001183	Number of birds potentially killed by rotors per annum =	0.000473	Number of birds potentially killed by rotors per annum =	0.00024
1 collision every	845.614651 years	1 collision every	2114.036627 years	1 collision every	4228.07325 years