Annex G15

Collision Risk Model Report

WYG Environment
part of the WYG group

RWE Npower Renewables Ltd

Clocaenog Forest Wind Farm

Collision Risk Model Report

August 2010

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Document Control

Project:	Clocaenog Forest Wind Farm: Autumn/Winter 2008/09 Bird Survey Report
Client:	RWE Npower Renewables Ltd
Job Number:	A044276-1
File Origin:	C:\Documents and Settings\gemma.woodall\Desktop\Templates - portrait.doc

Document Checking:

Prepared by:	Adrian George	Signed:
Checked by:		Signed:
Verified by:		Signed:

Issue	Date	Status
1		Issue 1
2	10/08/10	Issue 2
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1.0 Introduction

1.1 Background

RWE Npower Renewables Ltd has signed an agreement with the Welsh Assembly Government to allow them to seek planning permission to develop a wind farm on land managed by Forestry Commission Wales (FCW), on behalf of the Assembly Government, at Clocaenog Forest (TAN 8 Strategic Search Area A).

WYG Environment was commissioned by RWE Npower Renewables Ltd in April 2008 to carry out collision risk modelling for goshawk and peregrine to inform the Environmental Impact Assessment (EIA) for the proposed wind farm. This report presents the results of the collision risk model.

1.2 Site Description

The site is located within Clocaenog Forest, most of which lies within Denbighshire with a small area in the south of the site lying within Conwy County Borough, Wales. Clocaenog Forest is located approximately 13km south of Denbigh, with the nearest large settlements being Denbigh to the north and Ruthin to the north-east. A plan showing indicative site boundaries is provided in Appendix A, Figure 1.

The site comprises an upland plateau with an altitude of between 380m and 502m AOD. It extends to approximately 1,463Ha dominated by commercial coniferous plantation, at various growth stages. Within the site there are also smaller areas of scrub and heather moorland habitats. The Llyn Brenig Reservoir lies 3km to the west of the site and there is also a network of small water courses across the site, including the Afon Clywedog, Afon Alwen and a number of tributary streams, as well as numerous small ponds and a fishing lake.

The site is largely bordered by further coniferous plantation, although in places it is bordered by more open habitats, mainly improved or semi-improved grassland used as sheep pasture with an area of heather moorland forming part of the Mynydd Hiraethog SSSI located immediately adjacent to a section of the western site boundary. There are no statutorily designated sites within the indicative site boundary. The existing Tir Mostyn wind farm is located immediately adjacent to the north and north-western parts of the site.

2.0 Methodology

The extent to which birds are able to avoid collision with wind turbines has not yet been quantified for many species, however, a number of studies (e.g. Crockford 1992[1]; Benner *et al*. 1993[2]; Winkelman 1994[3]; Percival Undated[4] and Hötker *et al*. 2006[5]) suggest that collisions are rare events and occur mainly at sites where there are unusual concentrations of birds and turbines, or where the behaviour of the certain species leads to high-risk situations. Collisions are also possible with respect to turbine towers, meteorological masts (particularly where these are anchored by metal guys) and overhead power lines.

The Band Collision Risk Model (CRM) (Band *et. al.* 2007[6]) was used to estimate collision risk based on recorded activity levels and flight behaviour. Modelling was undertaken for two species – goshawk and peregrine – for which suitable and sufficient field data was recorded during vantage point (VP) watches during the 2008 breeding season and the 2008 – 2009 winter period (WYGE 2008[7], WYG 2009[8]). Modelling collision risk under the Band CRM is a two-stage process. Stage 1 estimates the number of birds that fly through the rotor swept disc (i.e.: the area covered by the rotor blades). Stage 2 predicts the proportion of these birds that would be hit by a rotor blade. Combining both stages produces an estimate of collision fatality in the absence of any avoiding action by birds.

The model is generally robust (Chamberlain *et al*. 2005[9]; 2006[10]) but avoidance rates have a strong influence on estimated collision risk and these rates are generally poorly known. Chamberlain *et. al.* (2005) expresses concern over the lack of knowledge about avoidance rates and suggests that until more is known

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[1] Crockford, N.J. (1992) *A review of the possible impacts of wind farms on birds and other wildlife.* JNCC report no. 27. Peterborough.
[2] Benner, J. H. B., Berkhuizen, J. C., de Graaf, R. J. and Postma, A. D. (1993) Impact of wind turbines on birdlife. Report no. 9247. Consultants on Energy and the Environment, Rotterdam, The Netherlands.
[3] Winkelman, J. E. (1994) Bird/wind turbine investigations in Europe. *Proc. of the National Avian Wind Power Planning Meeting, Denver, Colorado*, pp 43-48. In Benner, J.H.B., Berkhuizen, J.C., de Graaf, R.J. and Postma, A.D. 1993. *Impact of wind turbines on birdlife*. Report no. 9247. Consultants on Energy and the Environment, Rotterdam, The Netherlands.
[4] Percival, S.M. Undated. Appeal by Npower Renewables Ltd for planning permission to erect a 15-25 MW wind farm on land at Hockley Farm, Hockley Lane, Bradwell-on-Sea, Essex. Unknown.
[5] Hotker, H., Thomsen, K-M & Koster, H. (2006) The impact of renewable energy generation on biodiversity with reference to birds and bats – facts, gaps in our knowledge, areas for further research and ornithological criteria for the expansion of renewables. NABU Report, Germany.
[6] Band, W., Madders, M. & Whitfield, D.P. (2007) Developing field and analytical methods to assess avian collision risk at wind farms. In de Lucas, M, Janss, G. and Ferrer, M. (eds) "Birds and Wind Power". Lynx Edicions, Barcelona.
[7] WYGE (2008) Clocaenog Breeding Bird Survey, for RWE Npower Renewables Ltd, Unpublished Report.
[8] WYG (2009) Clocaenog Winter Bird Survey, for RWE Npower Renewables Ltd, Unpublished Report.
[9] Chamberlain, D., Freeman, S., Rehfisch, M., Fox, T. & Desholm, M. (2005) Appraisal of Scottish Natural Heritage's Wind Farm Collision Risk Model and its Application. *BTO Research Report 401*. British Trust for Ornithology, Thetford, Norfolk.
[10] Chamberlain, D.E., Rehfisch, M.R., Fox, A.D., Desholm, M. & Anthony, S.J. (2006) The effect of avoidance rates on bird mortality predictions made by wind turbine collision risk models. Ibis 148 *(Suppl. 1)*, 198-202.

about avoidance, collision risk modelling has limited value. Collision risk has been modelled on a precautionary 98% avoidance rate and a more realistic rate of 99% based on information within Madders & Whitfield (2006[11]).

At Clocaenog Forest, models were constructed employing flight data gathered from six vantage points during baseline studies in 2008 and 2009. The area of the wind farm envelope was established as 1584.5Ha and the area visible from each vantage point (viewshed area) was calculated for all vantage points[12], this was then 'ground-truthed' resulting in a total adjusted viewshed of 1822Ha[13]. 'Ground truthing' was undertaken to establish visibility of the viewshed to include plantation woodland heights that are not accounted for within the computer modelling programme, which bases heights on ordnance survey contour lines. In order to correct for several potential biases, allowances have been made within the modelling. These include:

- The use of flight data for the area occupied by the proposed turbines (plus a turbine buffer zone of 200m) to ensure that only flights liable to incur a potential risk of collision were included. The size of buffer was chosen to encompass rotor blade length, possible shifts in proposed turbine location due to micro-siting and, crucially, potential spatial errors in flight recording accuracy due to the effects of parallax;

- The inclusion of flight data for the area within 2Km of vantage points (hereafter referred to as viewshed) only to allow for differences in detection rates at long range between species and observers (Madders & Whitfield (2006) state that bird detection rates vary between species e.g. based on species size, species colouration and habitat).

Flight times used within the CRM were calculated from the proportion of the length of each flight that was within the 200m turbine buffer and 2Km viewshed multiplied by the total duration of each flight (i.e. effectively assuming a constant speed for each flight). Time spent at different flight heights was estimated from interval data for flights that entered the turbine envelope. Flying time estimated to occur within the rotor swept height (20-150m recording band based on turbine specifications provided by RWE Npower

[11] Madders, M. & Whitfield, D.P. (2006) Upland raptors and the assessment of wind farm impacts. Ibis 148, 43-56.
[12] Using ReSoft WindFarm Release 4.1.1.1 (Viewer Height 1.6m and 5m Height Above Ground)
[13] Note that all vantage points viewshed maps were 'ground-truthed', with the exception of VP E. This was unable to be undertaken on the day of the 'ground-truthing' visit. It is considered likely (based on the outcome of the other 5 'ground-truthing' exercises, that differed by +/- 25Ha) that this would not have considerably altered the final viewshed figure.

Renewables 2010[14]) was used to determine the period that goshawk and peregrine were at risk of collision with the rotors.

CRM was undertaken for each species based on the breeding and non-breeding season (with these adjusted to make them specific for the species in question). For the purposes of the modelling process, the goshawk breeding season was taken as the period February – August inclusive, with the non-breeding season taken as the period September – January inclusive. The peregrine breeding season was taken as the period March – August inclusive, with the non-breeding season taken as September – February inclusive (based on data within Kenward 2006[15] and Ratcliffe 1993[16] and *Pers. Obs.*).

During the survey period it was assumed that birds were 'available' to collide with turbines for 365 days per year (split between breeding/non-breeding seasons at above species specific ratio). The hours per day that birds were 'available' to collide with turbines was also split between breeding/non-breeding seasons at above species specific ratio; availability is based on the average length of daylight and activity within site.

In order to complete the modelling the wind turbine parameters were entered into the CRM, including the number of turbines (no.), hub height (m), rotor diameter (m), rotation period (sec), maximum chord (m) i.e. the maximum width of the turbine blade which is typically greatest closest to the hub, maximum rotor depth (m), pitch (°) and operation period (%). In order to complete the CRM, the wind turbine Nordex N90 was utilised (based on specific details provided by Green (*Pers. Comm.*[17])). The Nordex N90 wind turbine has a 90m rotor diameter and can have a hub height of 100m, thus meeting the upper limits of the turbine specifications within Version 3 of the RWE Npower Renewables data sheet (RWE Npower Renewables 2004), and is likely to act as a 'worse-case scenario' with turbines with a smaller rotor diameter likely to reduce the collision risk further (based on a reduced rotor swept area). Some turbine parameters (e.g. pitch and rotation period) are variable; in these cases a mean figure has been utilised within the CRM (e.g. the pitch on the Nordex N90 can vary between 0 and 90°, so a pitch of 45° has been used within the model, likewise the rotation period can range between 9.6 and 16.00 rpm, so a mean figure has been used – and converted to seconds). Wind turbines were assumed to be operative for 75% of the time due to wind

[14] RWE Npower Renewables (2010) Clocaenog Project Data Sheet. Version 5. .
[15] Kenward, R. (2006) The Goshawk. T & AD Poyser. London, pp 233-235.
[16] Ratcliffe, D. (1993) The Peregrine Falcon. Second Edition. T & AD Poyser. London.
[17] Edward Green. Sales Manager, Nordex UK Ltd.

speed, inclement weather (e.g. temporary shutdowns due to ice) and maintenance, based on quoted figure within Band *et al*. (2007) and Green (*Pers. Comm*.).

Goshawk

The breeding population of goshawk in Wales was estimated to be 200 pairs in 1995 (Hardey *et al* 2006[18]). Goshawk is included on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The British and Welsh populations have both experienced considerable increases over the last 30 years however, and as a result the species is not considered a conservation priority in Wales.

Kenward (2006) reviewed several population studies within Scandinavia, Europe and North America. These studies used various methods to estimate mortality rates in different age groups of goshawk (such as ringing recoveries, radio-tagging and feather analysis at breeding sites). Background mortality levels are considered to be in the region of 15-21% in adults (i.e.: between 30 and 42 adults in Wales each year), 31-35% in second year birds and as high as 40-42% in juveniles. With a minimum of 10 adults and second year birds occurring at Clocaenog Forest, based on maximum count during the vantage point watches (WYG 2009), natural mortality would be in the region of one bird every 4.8 months (based on a mean of 25% mortality rate of second year and adult birds combined).

For the purpose of the CRM goshawk biometrics was averaged across the sexes (Snow & Perrins 1998[19]) and an average flight speed of 10 m/s was used (Bruderer & Boldt 2001[20]). An avoidance rate of 98% was initially used although this rate is considered highly precautionary, with 99% considered likely to be the most realistic minimum avoidance rate.

The CRM for goshawk produced estimates of one bird strike every 2.9 breeding seasons and one bird strike every 14.3 non-breeding seasons at a highly precautionary 98% avoidance rate, and one bird strike every 5.9 breeding seasons and one bird strike every 28.6 non-breeding seasons at a more realistic avoidance rate of 99%. During the proposed 25 year lifespan of the Clocaenog wind farm, it is estimated that there will be 4.2 (breeding season) and 0.8 (non-breeding season) goshawk collisions (based on 99% avoidance rate).

[18] Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. & Thompson, D. (2006) Raptors a field guide to survey and monitoring. The Stationary Office, Edinburgh.
[19] Snow, D. W. & Perrins, C.M. (1998) The Birds of the Western Palearctic. Volume 1 Non-Passerines. Concise Edition, Oxford University Press.
[20] Bruderer, B & Boldt, A. (2001) Flight characteristics of birds: I. radar measurements of speeds. Ibis 143, pp 178-204.

SNH (2005[21]) state that due to the foraging behaviour of goshawk, where it spends a high proportion of time below tree canopy height (and therefore out of sight) it is considered unlikely that useful VP observations can be collected to accurately inform the CRM. It is therefore likely that the proportion of time that goshawk flights are recorded at collision risk height is an over-estimation against the proportion of the overall flying time, thus skewing the CRM. It is therefore considered likely that the number of birds thought potentially likely to collide with the turbines (based on the CRM output) is an over-estimation and the actual figure would likely be much lower. Evidence of known goshawk collisions with wind turbines is very low, e.g. 1 in Germany (Hotker *et al.* 2006 and Kingsley & Whittam 2005[22]).

In addition, at Clocaenog Forest, the natural background mortality of one bird every 4.8 months (based on a mean of 25% mortality rate amongst second year and adult birds combined), would equate to 62.5 birds (second year and adult birds) over the 25 year lifespan of the wind farm (and would be much higher with the inclusion of juvenile birds – likely to raise the background mortality into the region of 100 – 120 birds over the 25 year wind farm lifespan). During the 25 year wind farm lifespan, it is estimated that there will be 4.2 (breeding season) and 0.8 (non-breeding season) goshawk collisions (based on 99% avoidance rate). This represents a very small proportion of birds in relation to background mortality rates.

It is therefore considered likely that Clocaenog wind farm will have a negligible impact to the Welsh and Clocaenog Forest populations of goshawk.

Peregrine

The Welsh breeding population of peregrine was estimated to be 264 in 2002 (Hardey *et al* 2006). Recent evidence suggests Peregrine populations within Wales have increased in the south and decreased in the north of the country (*e.g.* Banks *et al.* 2003[23]).

Chris Mead at the British Trust for Ornithology produced a life table for peregrines ringed as nestlings in Britain and Ireland up to the 1990 breeding season (Ratcliffe 1993). Based on this data, the 46 recoveries during 1923-75 gives 30% mortality for first year birds, 25% for second year birds and about 19% as an

[21] Scottish Natural Heritage (2005) Survey Methods for use in Assessing the Impacts of Onshore Wind farms on Bird Communities. SNH Guidance Document.
[22] Kingsley, A. & Whittam, B. (2005) Wind Turbines and Birds: A Background Review for Environmental Assessment. Bird Studies Canada.
[23] Banks, A.N., Coombes, R.H. & Crick, H.Q.P. (2003) *The Peregrine Falcon Breeding Population of the UK & Isle of Man in 2002.* Research Report 330. BTO, Thetford.

annual average for fully adult birds of all ages (i.e.: approximately 50 adults in Wales each year). The recent population surveying of peregrines in Wales (2002) is considered to have substantially under-recorded the potential true population figure by at least 50 pairs (Dixon *et al*. 2008[24]). Taking this into account, a more accurate population for Wales may in fact be in the region of approximately 315 pairs. This shortfall in breeding pairs recorded is likely to be due to survey effort, but this revised figure may still be an under-estimation of the true Welsh breeding population. With a minimum of four adults at Clocaenog Forest, based on vantage point watches (WYG 2009), natural mortality would be in the region of one bird every 15.8 months (based on an average 19% mortality rate for fully adult birds of all ages).

Three peregrine wind turbine collisions in Europe have been documented; a peregrine was found dead as a result from an apparent collision during a nine year study on the effects of wind turbines on breeding moorland birds on the Orkney Isles (Meek *et al.* 1993[25]) and two birds were found dead in Belgium up to 2004 (Durr 2004[26]).

For the purpose of the CRM peregrine biometrics was averaged across the sexes (Snow & Perrins 1998) and an average flight speed of 14 m/s was used (Provan & Whitfield 2006[27]). An avoidance rate of 98% was initially used although this rate is considered highly precautionary, with 99% considered likely to be the most realistic minimum avoidance rate.

The CRM for peregrine produced estimates of one bird strike every 8.1 breeding seasons and one bird strike every 194.9 non-breeding seasons at a highly precautionary 98% avoidance rate, and one bird strike every 16.1 breeding seasons and one bird strike every 389.9 non-breeding seasons at a more realistic avoidance rate of 99%. During the proposed 25 year lifespan of the Clocaenog wind farm, it is estimated that there will be 1.6 (breeding season) and 0.06 (non-breeding season) peregrine collisions (based on 99% avoidance rate).

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[24] Dixon, A., Richards, C., Haffield, P., Roberts, G., Thomas, M. & Lowe, A. (2008) *The National Peregrine Survey 2002: How Accurate are the Published Results for Wales?* Welsh Birds 5: 276–283.
[25] Meek, E.R., J.B. Ribbands, W.G. Christer, P.R.Davy & Higginson, I. (1993) The effects of aerogenerators on moorland bird populations in the Orkney Islands, Scotland. Bird Study 40: 140-143.
[26] Durr, T. (2006) Vogelverluste an Windenergieanlagen in Deutschland Daten aus der zentralen Fundkartei der Staatlichen Vogelschutzwarte im Landesumweltamt Brandenburg zusammengestellt: Tobias Durr; Stand vom: 08. February 2006. Hotker, H., Thomsen, K-M & Koster, H. (2006) The impact of renewable energy generation on biodiversity with reference to birds and bats – facts, gaps in our knowledge, areas for further research and ornithological criteria for the expansion of renewables. NABU Report, Germany.
[27] Provan, S. & Whitfield, D. P. (2006) Avian flight speeds and biometrics for use in collision risk modelling. Report to Scottish Natural Heritage from Natural Research (Projects) Ltd.

At Clocaenog Forest, the natural background mortality of one bird every 15.8 months (based on an average 19% mortality for fully adult birds of all ages), would equate to 19 birds over the 25 year lifespan of the wind farm. During the proposed 25 year wind farm lifespan, it is estimated that there will be 1.6 (breeding season) and 0.06 (non-breeding season) peregrine collisions (based on 99% avoidance rate). This represents a very small proportion of birds in relation to background mortality rates.

It is therefore considered likely that Clocaenog wind farm will have a negligible impact to the Welsh and Clocaenog Forest populations of peregrine.

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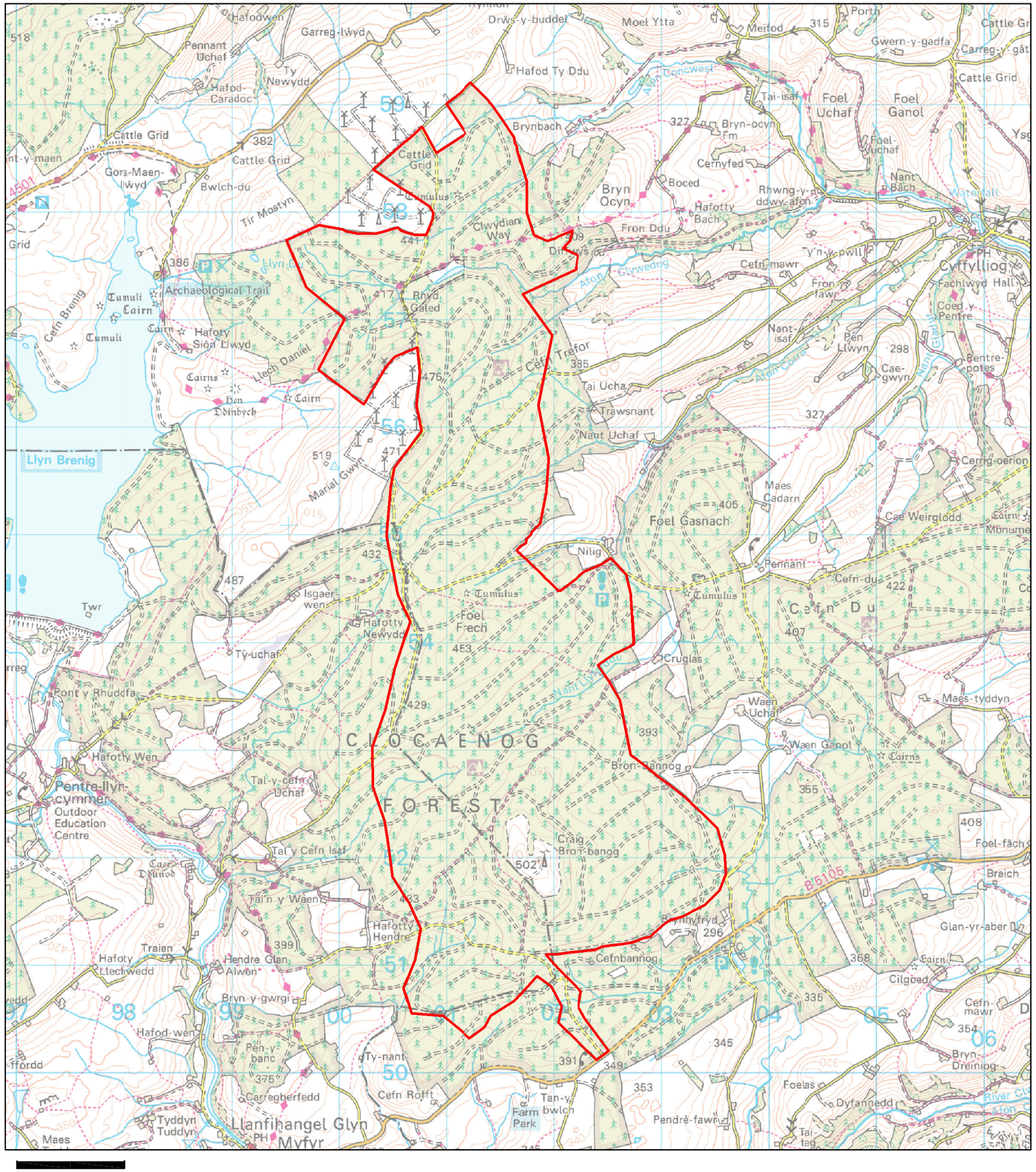

SCALE 1km

LEGEND:

SITE BOUNDARY

REV	DESCRIPTION	BY	CHK	APP	DATE

Client:

NPOWER RENEWABLES LTD

5th FLOOR, LONGCROSS COURT
47 NEWPORT ROAD
CARDIFF
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TEL: +44 (0)29 2082 9200
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Project:

COLCAENOG FOREST WIND FARM

Drawing Title:

SITE BOUNDARY

Scale @ A3	Drawn	Date	Checked	Date	Approved	Date
NTS	PJ	11.08.10	CM	11.08.10		

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