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Report of the Intersessional Working Group on Wind Turbines and Bat Populations

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Terms of Reference

Assessment of the evidence of the impact of wind turbines on bat populations and, if appropriate, development of guidelines for assessing potential impacts on bats and for the establishment of wind turbines in accordance with the ecological requirements of bat populations. Investigate current research and identify future requirements.

Possible negative impacts

Wind turbines may have negative impacts on bat populations, as well as their prey and habitats, such as:

- destruction and disturbance of habitats and commuting corridors
- destruction or disturbance of roosts
- increased collision risk for bats in flight
- through emission of ultrasound noise

Several hypotheses have been advanced to explain why bats collide with wind turbines since, *a priori*, this probability seems to be very small (Ahlén 2003): (1) bats concentrate in certain areas (e.g., for feeding or migrating), (2) bats may be attracted by the sound of the blades, (3), bats may use wind turbines structures to rest, (4) migrating bats do not use echolocation to navigate, (5) air turbulence may attract bats.

European species affected

We consider that 20 of 35 species can be affected by these projects.

Summary of data by species

Table 1 shows aspects of bat behaviour that influences the risk of collision (see page 2).

Summary of studies

Table 2 summarises the results of studies done in Europe on this subject (see pages 3-5).

Table 1 - Bats behaviour in relation to windfarms

Species	Hunting close to habitat structures	Migration or long distance move-ments	High flight	Low flight	Max. height (m) of ultrasonic detection (D980) (data from Michel Barataud)	Max. height (m) of ultrasonic detection (D240) (* means during hunting) (data from Lothar Bach)	Eventually disturbed by turbine ultra-sounds	Attracted by light	Roosting inside nacelle	known loss of hunting habitat	risk of loss of hunting habitat	Known collision	Risk of collision
Rhinolophus ferrumequinum	X			X	10								
Rhinolophus hipposideros	X			X	5								
Rhinolophus euryale	X			X	5								
Rhinolophus mehelyi													
Rhinolophus blasii													
Myotis myotis		X	X	X	30	20						species not confirmed	**X**
Myotis blythii		X	X	X	?								**X**
Myotis punicus					?								
Myotis daubentonii	X		(in tree tops)	X	30			?				X	**X**
Myotis emarginatus	X	?	X	X	15								
Myotis nattereri	X			X	20	15							
Myotis mystacinus	X			X	15	20							**X**
Myotis brandtii	X			X		20						X	**X**
Myotis alcathoe	X			X	20								
Myotis bechsteinii	X			X	25	15*							
Myotis dasycneme		X		X		30							
Myotis capaccini				X									
Nyctalus noctula		X	X		100	150	X	X	?		**X**	X	**X**
Nyctalus leisleri		X	X		60-80		X	X	?		**X**	X	**X**
Nyctalus lasiopterus		?	X		100		?				**X**		**X**
Eptesicus nilssonii			X			50		X	X			X	**X**
Eptesicus serotinus		?	X		50		X	X	X	X		X	**X**
Vespertilio murinus		X	X			50					**X**	X	**X**
Pipistrellus pipistrellus	X		X	X	30		?	X	X			X	**X**
Pipistrellus pygmaeus	X	X	X	X	?	30	?	X	X			X	**X**
Pipistrellus kuhlii	X		X	X	30		?	X	X			X	**X**
Pipistrellus nathusii	X	X	X	X	30-40		?	X	X			X	**X**
Hypsugo savii	X		X	X	40-50		?	X	X			X	**X**
Plecotus auritus	X			X	30	10*						X	**X**
Plecotus austriacus	X			X	30	10*						X	**X**
Plecotus macrobullaris	?			X	30								
Plecotus kolombatovici													
Barbastella barbastellus	X			X	30	20							
Miniopterus schreibersii	?	X	X	X	30			X					**X**
Tadarida teniotis			X		150-200		X	X				X	**X**

Table 2 - Studies done in Europe

Study (author, year, area)	time	type of turbines	methods	results	Habitat-types
Ahlén, 2002 and **Ahlén**, 2003, Sweden	August/September 2002	different	160 turbines (Gotland 66, Öland 39, Blekinge 4, Skane 51)	- 17 bats (Enil 8, Vmur 1, Nnoc 1, Pnat 5, Ppip 1, Ppyg 1)	different, from open with shrubs underneath to farmland (with hedgerows)
			- 1 control / turbine	- 0,1 bats/control	
			- search area 50m around turbine	- Gotnad 12, Öand 2, Blekinge 2, Skane	
				- distance 3-25m (mean 12m) around turbine	
				half species are resident	
				bats often feed close to blades	
				species found dead are the ones observed hunting close to blades	
Alcalde, 2003, Navarra - Spain	1995-2003	height: 40m (older model) and 60-80m	around 1000 turbines	50 bats (mainly Hsav (25), Nnoc, Nlas, but also Ppip, Pkuh, Ppyg, Eser)	close to hedgerows
				mainly August and September	
		blade: 20m (older model) and 34m	search area with radius equal to turbine height	presence of turbines does not change habitat use	
				number of flying bats increase with temperature and decrease with wind intensity	
				bats use mainly areas close to trees	
Bach, 2002, Lower Saxony, Germany	April 1998- September 2002	1 windfarm, 70 turbines, height 45m, blade diameter 30m	- landscape use of Eser and Ppip - systematicall detector census in the whole parc and the surroundings - 7 time / year - start one year before the turbines were built untill three years afterwards.	- no visible effect of the landscape use of Ppip - no visible negative effect of the use of flight paths of Eser and Ppip - Ppip changed the hunting behaviour close to the turbines and get used to the moving blades - the number of Eser that preferred to forage at hedges without turbines increased during the years - the number of Eser that hunted further away than 100m to turbines increased during the years **after all:** - Eser seemed to leave the parc after the turbines were built	farmland with many hedgerows 10-100m from turbines
Benzal & Moreno, 2001, Navarra - Spain			4 wind farms with turbines along 12,6km	dead: Ppip, Pkuh, Hsav, Eser, Nnoc	
				Ppip, Pkuh, Hsav, Eser, Nnoc, Tten fly around turbines, although only a few hunt there	
				bats use mainly areas close to trees	
Cosson, 2004, France	IBA, Ramsar site, possible ZPS. Bird study. Mortality checked from July 23 to December 16, 2003	8 turbines N80 height 100m	control done for every turbine on a 1ha area from July to Dec. According to J.E. Winkelman's method 16 control of 8 turbines	15 bats (Pnat 11, Nnoc 2, P spec. 2). M=4,74/week 0,1 bats/control	open cultivated polder on one side and oyster beds on the other

Dürr, com pess, Brandenburg - Germany	2001-2003	Different types	- 2001: 38 turbines (66 controls)	- 36 bats (0,04 bat/control)	- different
			2002: 79 turbines (394 controls)	- mainly Pnat, Ppip, Nnoc	- often close to hedgerows
			- 2003: 147 turbines (550	- at all types of turbines,	
			- ± unsystematically research between February and December, but mainly in August/September	mainly 1. & 2. august decade	
			- search area 50m around turbine (mainly!)		
Endl et al., 2005, Sachsen, Germany	March 2004 - November 2004	16 windfarms, 92 turbines, height 65-80m, blade diameter 47-80m	- detector census: 5-8 x /year (April-October) - collision control: 5-8 x /year (April-October) (mean 24-day-rhythm) - search area ~ blade diameter around turbine - chicken experiment - search efficiency control by bringing out dead paper bats!	- mean mortality: 1,5 bats / turbine / year (range: 1,1-4,6) - in 2 other wind farms: 1,34 and 4,56 bats / turbine / year - Ppip: higher collision rate close to forest - Nnoc + Pnat: collision also high far from forest	open farmland but mostly very close to forest or hedges (0-150m)
Grünkorn et al., 2005, Schleswig-Holstein, Germany	September 2004 - mid of November 2004	3 Windfarms, 24 turbines total height 100m; 2 turbines total height 120m	- **methodological study** - 16 controls (every 5th day) - search area: turbine height - experiments with birds of different size - bird-fall experiments - search efficiency control by bringing out dead birds of different size	- wee need to search an area of the total turbine height - area should be searched for small birds/bats in a up and dow transects 10m wide for small birds (bat size) (search area 10m each site) - few vegetation cover (<10%): found rate 44 % - hight vergetation cover (>30 %): found rate 8 % for small birds (bat size) (search area 5m each site) - hight vergetation cover (>30 %): found rate 10 % **no dead bat were found**	farmland, open arae with few trees, bushes
Haase & Rose, 2004	March-April & August-October 2004	heigt: 60m, 70m, 89m; blade diameter: 48m; 58,5m; 58,5m	- 3 controls/turbine/month - bat activity per detector in the area around the turbines (ca. 500-1000m around the turbines)	- 2 bats (Nleis 1, Plaurit 1) - 0,06 bats/control - no observed activity of Nleis, Nnoc, and Ppip close to the turbines.	farmland, 50-200m close to hedgerows and forest
Kusenbach, 2004, Thüringen - Germany	25. August - 23. September 2004	Different types (size mostly unknown!)	94 turbines (18 wind farms)	7 bats (Pnat 3 male/ad., Vmur 2 male/ad., Nnoc 1 female/juv., Chirop. spec. 1)	- 20-100m from hedgerows
			- 110 controls (1-3/turbine)	- 0,06 bats/control	- sometimes close to forest (3 x 200m)
			- chicken experiment	- 6 of 7 bats found in suspected bat migration corridor.	- known bat migration corridors
				- distance to windturbine: 3-15m	

				- 1 bat with oily substance on the body chicken experiment - 30 % found bach after 1 day - 15% found bach afer 2 days	
Latorre & Zueco, 1998 and **Martinez-Rica & Serra-Cobo**, 1999 Aragao - Spain			1 year	1998: 6 bats (P spec 5; Tten 1) estimation of numer of dead bats: 274,05 bats/year estimation of number of dead bats: 10,15 bats/turbine/year no deaths detected under electric lines 1999: total 7 dead bats (P spec 5, Hsav 1, Tten 1)	
Lekuona, 2001 and **Petri & Munilla**, 2002, Navarra - Spain	March 2000-March 2001	height: 40 m	400 turbines	3 bats (Chirop. spec. 1, Ppip 1, Hsav 1) (2 in August, 1 in March)	different
		blade diameter: 40 m	- bird study!	disappearance rate: July - 57% 24h and 70% 48h; November - 67% 24h and 80% 48h	
		10 wind farms; 400 turbines	4 parcs: 1 control/week March 2000-March 2001	average distance (cadavers): 25m	
			1 parc: 1 control/week between June2000-March 2001	detection rate:July 13,2% and 11,6% November	
			search area 50m around turbine;many times only a small radius, due to vegetation	estimation of death rate in 2 farms: 3,09 and 13,36 bats/turbine	
				estimation of number of deaths: 749 bats (using Winkelman´s index)	
Schröder, 1997, Lower Saxony, Germany	February & March 1997	47 turbines in different wind farms with different types of turbines	- studying possible ultra sound of turbines with a bat detector (Pettersson D980) - checked frequency window: 14-100 kHz - measurements distances: 20m, 50m, 100m from turbines	- 12 x no ultrasound emission - 5 x few ultra sound emission - 13 x clearly ultra sound emission between 14 - 30 kHz - 13 types of turbines with ultra clearly sound emission **but:** the same turbine type with and without ultra sound emission	
Trapp et al, 2002, Oberlausitz - Germany				34 bats (Vmur 6, Ppip 3, Pnat 10, Nnoc 12, Nleis 1, Chirop. Spec. 2)	
Traxler et al., 2004, Lower-Austria	September 2003-September 2004	3 Windfarms, 4 turbines	5 turbines, - 1 control / day / turbine - search area 100m around turbine - search efficiency control by bringing out dead birds!	14 bats (11 Nnoc, 2 Pnat, 1 Plaus) - collission rate (according Winkelmann) mean 5,33 bats/turbine/yea (Oberdorf: 0; Prellenkirchen 8,0; Steinberg 5,33 bats/turbine/year) - mean collision at wind speed 5-6 m/sec. - highest colission-rate in August - bats hunting around moving blades in early afternoon	farmland, 50-200m close to hedgerows and forest,

Questionnaire

Increasing consideration is given in several Party and Range States to the installation of WT to implement the stipulations of the Kyoto Targets and to reduce their dependencies on fossil fuels, and the number of WT installed is likely to strongly increase in the near future. However, the importance of bat populations as part of the biological diversity is still neglected by the majority of States. More consideration is given to birds, their populations and migration routes. But increasing effort is visible to study bats as a major object of impact studies before the set-up of WT, although knowledge about the best methods seems to be a needed subject for further studies. However, research projects to study the influence of WT on bat populations are not yet undertaken (although planned by 2 States) by any of the States.

In many States, the planning and installation of WT is organized on a regional level by regional authorities and therefore their advice and demands towards WT developers is very diverse and study methods (if applied) are not standardized.

Conclusions and recommendations to Advisory Committee

Although there are few studies in Europe, we consider that 20 of 35 species can be affected by wind turbines; it is important to underline that some species are non-migrating.

Although dead bats are being found in several countries, it is actually impossible to evaluate the impact on bat populations because in most cases monitoring is not yet being carried out using proper methodologies.

We also do not know if the problem will persist with the new generation of turbines (higher, with a blade-ground distance frequently >50m).

The possible explanations for the collisions are not yet understood:

- bats concentrate in certain areas (e.g., for feeding or migrating)

  Bats were observed to hunt very closely to the blades and were seen flying between them (Ahlén 2003; Endl *et al*. 2005; Bach 2002, Brinkmann pers. comm.). Some times, a concentration of flying insects surrounding the turbines was observed maybe due to the heat radiated from the turbine (Ahlén 2003).

- bats may be attracted by the sound of the blades

  There is no evidence of acoustic attraction (Ahlén 2003), although that possibility cannot be rejected. Schröder (1997) observed that some turbine models emit ultrasound on 32kHz.

- bats may use wind turbines structures to rest

  There is no evidence of this use (Ahlén 2003), although that possibility cannot be rejected.

- migrating bats do not use echolocation to navigate

  Ahlén (2003) observed that passing bats of migrating species sound normal but have a slower echolocation rhythm. This observation is typical of bats flying in open spaces.

- air turbulence may attract bats
- the high speed of the blade tips cannot be measured right by bats

Some fields of research should be developed, such as:

- study of bat behaviour around windturbines with thermal imaging cameras or infrared cameras
- study of bat migration by radar (if possible): routes and height of flight
- study of the long-term impact of turbines on bat populations

In order to reduce the negative impacts, some measures have been suggested:

- wind farms should not be placed in areas with a high concentration of bats (such as flying corridors of migrating bats, feeding areas, and areas close to important roosts)
- wind farms should not be placed in forests
- wind farms should be placed in areas away from trees/hedgerows
- wind farms should not be placed on mountain passes (cols) or on narrow ridges
- the construction of turbines should be changed in order to reduce insect attraction; tests regarding design and colour should be developed
- distribution of turbines within wind farms should be analysed
- turbines where more cadavers were found should be eradicated or stopped during critical seasons

In conclusion, the group found that there is evidence that wind turbines affect many bat species. We therefore recommend the development of guidelines for assessing potential impacts on bats and for the establishment of wind turbines in accordance with the ecological requirements of bat populations.

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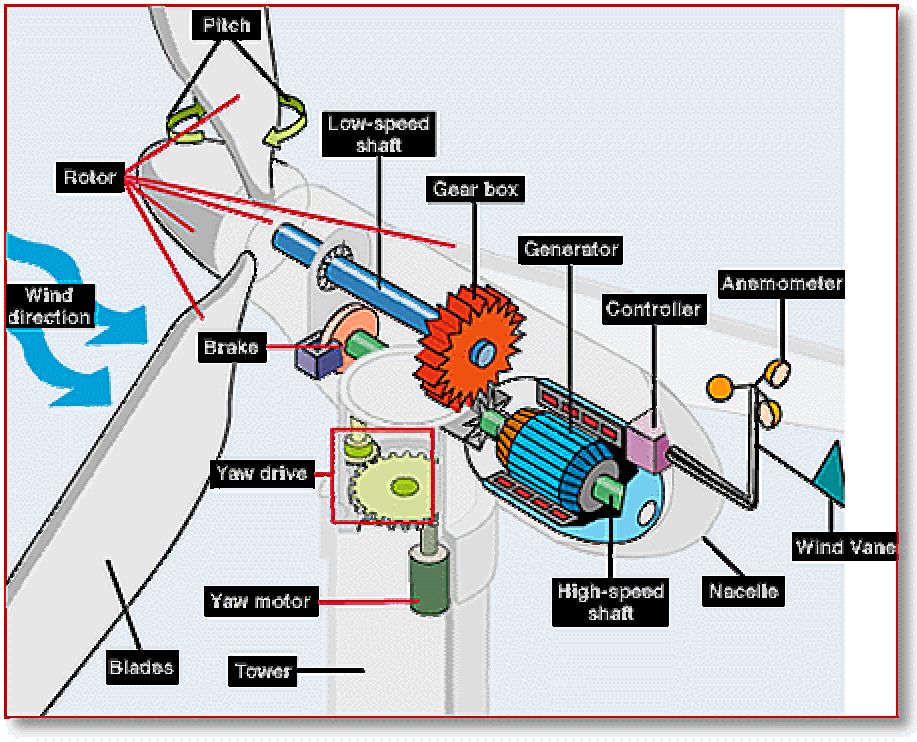
Annex 1

Scheme of wind turbine



Annex 2

Analysis of questionnaires (questionnaires returned by 29 Party states and by 6 Range states):

Part A: General Information

No WT present in 2 Party States (Albania, Georgia) and in 3 Range States (Armenia, Bosnia+Herzegovina, Liechtenstein)

- Less than 50 WT in 8 Party States and in 1 Range State
- Between 50 and 100 WT in 4 Party States
- More than 200 WT in 8 Party States and in 2 Range States

For the States having replied to the questionnaire, answers were mainly given regarding inland WT. For UK, answers also apply to off-shore WT; increasing interest is given by Norway to coastal settings .

In most States, the development and installation of WT is part of the National Policy as contribution to "green" energy supply; mainly by supported by funding.

With only 3 exceptions, the national and/or regional Ministries of Environment are involved in planning and approval of WT installations.

In a number of States, the regional authorities are the competent ones and decide exclusively about planning and approval procedures. Therefore the questionnaire cannot completely be filled out, especially regarding the questions on impact studies (part C) with nation-wide standardized methods lacking.

Part B: Planning process

The picture is very diverse within the States:

- 13 States give recommendations regarding the site selection for WT (potential sites and no-go areas), 9 States do not give any advice.
- 10 States restrict the number of WT per site, 12 don't.

Of the 10 States with more than 200 WT, 6 States identiy potential and no-go sites, and only 4 States restrict the number of WT per site.

Only 3 States having more than 200 WT, and 1 State with less than 10 WT, give guidance to wind farm developers to minimize negative impacts on bats. However, 11 States have set up rules about buffer areas to prevent negative impacts of WT on protected areas, such as Natura 2000 sites.

Part C. Impact studies

Impact studies are required in most States and they are usually undertaken by the wind farm developers on demand of the regional/national government.

- 10 States are asking for impact studies on bats and birds, but several comments given suggest that the importance of bat surveys is less developed and more concern is given to birds. Additionally, in some States the impact studies are initiated on a regional level and therefore requirements are different and are not standardized.
- 8 further States only ask for studies about birds,
- in 3 States, biological assessments are required in general, or only in special cases (e.g. when a Natura 2000 site is concerned), without specifiying the target species,
- and 2 States do not ask any studies at all.

The results of Part C 3 are not included in the Excel spread-sheet since they would require too much space. They are presented as follows:

Altogether 8 States were able to answer the detailed questions on the criteria of impact studies on bats. In all of those studies, the main criteria was the presence of bats, followed by the presence of roosts near the planned WT (7), the presence of foraging habitats (6) and the death of bats by collision (6).

Barrier effects and influences on bat population size are studied in 5 States, influences on flight paths and migration corridors, as well as the presence of roosts within WT are study objectives in 4 States.

The influences of vibration and ultrasound noise are dealt with in 3 States, behavioural effects only in 2 States.

The impact studies were done all season (6 States) or during a restricted time of the year (4 States). The methods of the studies are standardized in 4 States, and not standardized in 7 States.

Of those States asking for impact studies, all are done before the installation of the WT, but only 2 States continue the survey after the installation.

The majority of studies is done during less than one year.

A long-term monitoring programme of bats is obligatory in only 3 States.

The majority of States takes into account the results of the impact studies for their planning and installation of WT. However in only one case, a negative result of an impact study on bats led to the cancellation of a planned WT installation.

Only 2 States have started research programmes to investigate the influence of WT on bat populations.

Table 3 summarises the results of the questionnaires.

Table 3 - Questionnaires

Parties	Reply	A1,2: Status WT	A3:National policy	A4: Regional legislation	A5: MoE involved	B1a: site selection	B1b: size wind farms	B1c: advice impacts on bats	B2: buffer areas	C1: impact studies bats	C5: time of study	C6a: time scale	C6b: long-term monitoring	C7: studies applied	D: research	future WT
Albania	yes	no WT														
Belgium (Flanderen)	yes	to 100	/	yes	yes	yes/no	yes	no	yes	no	/	/	/	/	no	
Bulgaria	yes	< 50	not involved		yes	no (not yet)	no	no	no (not yet)	no	/	/	/	/	no	increasing
Croatia	yes	< 50	yes		yes	no	yes	no	no	no	/	/	/	/	no	
Czech Rep.	yes	< 50	favourable	yes	yes	yes	yes	no	yes	no	/	/	/	/		
Denmark	yes	> 200	not involved		yes	yes/no	yes	no	/	± no (not specified)	before	< 1 year	no	yes	no	
Finland	yes	to 100	favourable		yes	yes	yes	no	yes	no (not yet)	/	/	/	/	no	
France	yes	> 200 (593)	favourable	yes	yes	no (sometimes yes)	no	yes	yes (no)	yes	before (after)	< + > 1 year	yes	yes	yes (no)	
Georgia	yes	no WT														
Germany	yes	> 200	favourable	yes	yes	yes/no	no	yes	no	± yes	before .	< 1 year	no	yes	yes	
Hungary	yes	< 50	favourable	yes	yes	yes	no	no	yes	± yes	before	< 1 year	(yes)	(yes)	no	
Ireland	yes	> 200	favourable		yes	yes/no	yes	no	no	± yes	before	< 1 year	(yes)	yes	no	
Latvia	yes	< 50 (32)	favourable		yes	no	no	not yet	yes	yes	before	< 1 year	/	yes	no	
Lithuania	yes	to 100	favourable		yes	yes	no	no	no	no	/	/	/	/	no	
Luxembourg	yes	< 50	favourable		yes	no	no	no	no	no (available data used)	before	< 1 year	no	no	no	
Macedonia	**no**															
Malta	**no**															
Moldova	**no**															
Monaco	yes	no WT														
Netherlands	yes	> 200	favourable	yes	no	yes	no	yes	yes	yes	before	< 1 year	no	yes	no	
Norway	yes	to 100	favourable		yes	no	no	no	no	no	/	/	/	/	no	increasing (2600)
Poland	**no**															
Portugal	yes	> 200	not involved		yes	yes	yes	no	no	yes	before + after	< + > 1 year	yes	yes	no	increasing
Romania	**no**															
Slovak Rep.	yes	< 50	not involved	yes	yes	yes	yes	no	no	no	/	/	/	/	no	
Slovenia	yes	< 50	favourable	yes	yes	no	no	no	yes	yes: 1	before	< 1 year	no	yes	no	
Sweden	**no**															
Ukraine	yes	> 200 (609)	favourable		yes	no	no	no	no	no	/	/	/	/	no	increasing
United Kingdom	yes	> 200	favourable	yes	yes	yes	yes + no	no	no	yes	before + after	> 1 year	yes	yes	no	increasing (offshore)
Range States																
Armenia	yes	no WT														
Bosnia+Herzeg.	yes	no WT														
Italy	yes	> 200	favourable	yes	no	/	/	/	yes	yes	before	/	/	/		
Liechtenstein	yes	no WT														
Russian Fed.	yes	> 200	not involved	yes	no	no	no	no	yes	yes	before	< 1 year	no	no	no	
Switzerland	yes	< 10	not favoured	yes	yes	yes	yes	yes	yes	(yes)	before	< 1 year	no	yes	no	no interest

Annex 3

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