



CONVENTION ON MIGRATORY SPECIES

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RENEWABLE ENERGY AND MIGRATORY SPECIES

Summary

Within the framework of a joint initiative between the Secretariats of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), on behalf of the entire CMS Family; the International Renewable Energy Agency (IRENA); and BirdLife International UNDP/GEF Migratory Soaring Birds project, a review of the deployment of renewable energy technology and its actual or potential impacts on migratory species is being undertaken, and a set of guidelines on how to avoid or mitigate those impacts is being compiled.

The present document provides information on progress on the implementation of the initiative. It also includes a draft resolution on renewable energy and migratory species, submitted for review to the 18th Meeting of the Scientific Council (Annex 1). The Executive Summary of a draft review report on the interactions between renewable energy technologies deployment and migratory species is made available as Annex 2.

RENEWABLE ENERGY AND MIGRATORY SPECIES

(Prepared by the UNEP/CMS Secretariat)

1. The production of energy from renewable sources has the potential to make a significant contribution to mitigating climate change. In this regard, renewable energy solutions may contribute to alleviate climate change-related pressures on natural resources, including migratory species. However, renewable energy technologies can also have environmental impacts. This is acknowledged in several decisions by CMS and CMS Agreements¹. Significant data have been gathered, for instance on the impact of wind farms on certain species of birds and bats, and various solutions have been devised which can ensure avoidance and mitigation of adverse impacts. However, some of this information is scattered and not readily available. Furthermore, there is insufficient knowledge on the deployment of most of the other renewable energy technologies and their potential impacts on migratory animals.

2. Based on this rationale, the Secretariats of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), on behalf of the entire CMS Family; the International Renewable Energy Agency (IRENA) and BirdLife International UNDP/GEF Migratory Soaring Birds project have joined forces to carry out a review of the deployment of renewable energy technology and its actual or potential impacts on migratory species, and produce a set of guidelines on how to avoid or mitigate those impacts.

3. The Terms of Reference of a joint project “*Renewable Energy Technologies Deployment and Migratory Species*” were developed by the CMS and AEWA Secretariats and the IRENA Innovation and Technology Centre (IITC) in consultation with the advisory bodies of CMS and AEWA. Draft Terms of Reference were sent by the Secretariat to the members of the Scientific Council for comments in September 2012.

4. A call for tenders based on the Terms of Reference was advertised by the IRENA Secretariat on behalf also of the other partners of the project in early 2013. Scientific Council members were informed by the Secretariat and invited to disseminate them. The chairs of the CMS Scientific Council and of the AEWA Technical Committee also participated in the evaluation of the applications and the selection of the consultant. The study was commissioned to Bureau Waardenburg bv (in collaboration with Boere Conservation Consultancy, Brett Lane & Associates and ESSGroup).

5. The implementation of the project was divided in three phases:

Phase 1 The inception/scoping phase

Phase 2 Study of aspects of conflict and approach for guidelines report

Phase 3 Analysis of conflict hotspots worldwide and guidelines report

6. A kick-off meeting between the project partners and the consultant was convened on 16 September 2013 with the objectives of discussing the background for the project and the common approach, assigning responsibilities and agreeing on detailed actions and a timetable for the first two phases of the project. A draft of the Inception Report was consulted with the Scientific Council as well as other CMS Family advisory bodies and BirdLife and IRENA

¹ A list of relevant Resolutions by CMS and CMS Agreements can be found in the preambular section of the draft resolution annexed to this cover note.

networks during October/November 2013, and subsequently finalized on the basis of the comments received. The purpose of the report was to present a more detailed approach to implementing the project agreed through discussion among all partners and stakeholders, further detailed specification of activities, deliverables and timelines.

7. Within the implementation of the 2nd phase of the project, a draft review report on the interactions between renewable energy technologies deployment and migratory species was made available by the consultant for consultation with CMS Family secretariats and advisory bodies, and BirdLife and IRENA networks. The draft report was transmitted by the Secretariat to Scientific Council members for comments on 20 January 2014. Comments received were compiled by the Secretariat and transmitted to the consultant for consideration. A revised draft of the report, reflecting progress by end of May 2014 in addressing the comments received, is made available to the 18th Meeting of the Scientific Council (ScC18) as document UNEP/CMS/ScC18/Inf.10.2.1. With respect to the initial draft circulated in January 2014, this version also incorporates a draft compilation of examples of potential impact hotspots for migratory species. The draft executive summary of the report is annexed to this document (Annex 2).

8. Within the implementation of the 3rd phase of the project, the preliminary draft of a compilation of guidelines on how to avoid or mitigate impacts on migratory species of the deployment of renewable energy technologies was compiled by the consultant. It is made available to ScC18 as document UNEP/CMS/ScC18/Doc.10.2.2 for its consideration.

9. The implementation of the project “*Renewable Energy Technologies Deployment and Migratory Species*” was made possible thanks to financial contributions from the Governments of Germany and Norway through the CMS and AEWA Secretariats, from BirdLife International through the UNDP/GEF MSB project and from IRENA.

Action requested:

The Scientific Council is invited to:

- (a) Note the joint initiative between the Secretariats of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the African-Eurasian Waterbird Agreement (AEWA), on behalf of the entire CMS Family ; the International Renewable Energy Agency (IRENA) and Birdlife International on renewable energy technology deployment and migratory species.
- (b) Note the progress made in the compilation of a review report on the interactions between Renewable Energy Technology Deployment and Migratory Species, and provide comments as appropriate (UNEP/CMS/ScC18/Inf.10.2.1).
- (c) Consider the draft guidelines document “*Renewable Energy Technologies and Migratory Species: Guidelines for sustainable deployment*”, and provide guidance towards its further development and finalization with a view to its submission to COP11 for consideration and adoption (UNEP/CMS/ScC18/Doc10.2.2).
- (d) Review the draft Resolution on renewable energy and migratory species annexed to this cover note (Annex 1).

DRAFT RESOLUTION

RENEWABLE ENERGY AND MIGRATORY SPECIES

Recognizing the importance to society of an adequate and stable energy supply and that renewable energy sources can significantly contribute to achieving this, and *aware* that renewable power generation, especially from wind energy, large solar panel power stations and biomass production, is projected by the International Energy Agency to triple by 2035;

Recognizing that increased use of technologies to exploit renewable energy may potentially affect many migratory species listed by CMS and other legal frameworks, and *concerned* about the cumulative effects of such technology on the movement of migratory species, their ability to utilize critical staging areas, the loss and fragmentation of their habitats, and mortality from collisions with infrastructural developments;

Recalling Article III 4(b) of the Convention which requests Parties to endeavour, *inter alia*, “to prevent, remove, compensate for or minimize, as appropriate, the adverse effects of activities, or obstacles that seriously impede or prevent the migration of species” and *noting* the relevance of this obligation to renewable energy developments, especially given that adverse impacts of renewable energy technologies can be substantially minimized through careful site selection and planning, thorough Environmental Impact Assessments (EIAs), and good post-construction monitoring to learn from experience;

Aware of decisions by CMS and other MEAs, including CMS Agreements, as well as of relevant guidelines, on reconciling renewable energy developments with the conservation of migratory species, including:

- CMS Resolution 7.5 on ‘*Wind Turbines and Migratory Species*’;
- CMS Resolution 10.19 on ‘*Migratory Species Conservation in the Light of Climate Change*’;
- CMS Resolution 10.24 on ‘*Further Steps to Abate Underwater Noise Pollution for the Protection of Cetaceans and Other Migratory Species*’;
- ASCOBANS Resolution 6.2 “*Adverse Effects of Underwater Noise on Marine Mammals during Offshore Construction Activities for Renewable Energy Production*”;
- AEWAs Resolution 5.16 on ‘*Renewable Energy and Migratory Waterbirds*’ which stressed the need to address or avoid adverse effects on migratory waterbirds and contains operational recommendations of relevance to many other migratory species;
- AEWAs ‘*Guidelines on How to Avoid, Minimize or Mitigate Impact of Infrastructural Developments and Related Disturbance Affecting Waterbirds*’ (Conservation Guidelines no. 11);
- EUROBATS Resolution 7.5 “*Wind Turbines and Bat Populations*” and Guidelines for consideration of bats in wind farm projects;
- Bern Convention Recommendation No. 109 on minimizing adverse effects of wind power generation on wildlife and the guidance of 2003 on environmental assessment criteria and site selection issues related to wind-farming as well as the best practice guidance on integrated wind farm planning and impact assessment presented to the 33rd meeting of the Bern Convention Standing Committee in 2013;

- Ramsar Resolution XI.10 “*Guidance for Addressing the Implications for Wetlands of Policies, Plans and Activities in the Energy Sector*”;
- SBSTTA 16 Recommendation XVI/9 “*Technical and Regulatory Matters on Geo-engineering in Relation to the Convention on Biological Diversity*”; and
- UNDP/GEF Migratory Soaring Bird Guidance on wind and solar energy;

and recognizing the need for closer co-operation and synergetic implementation amongst the CMS Family, other MEAs and relevant national and international stakeholders of decisions and guidelines to reconcile energy sector developments with migratory species conservation needs;

Acknowledging the critical need for liaison, communication and strategic planning to be jointly undertaken by those parts of governments responsible respectively for environmental protection and energy development to avoid or mitigate negative consequences for migratory and other species and their habitats;

Welcoming document UNEP/CMS/Inf.11.XX ‘*Renewable Energy Technology Deployment and Migratory Species: an Overview*’, which summarizes knowledge of actual and possible effects of renewable energy installations on migratory species, *noting* its conclusion that relatively few scientific studies are available on the short-term, long-term and cumulative impacts of renewable energy technologies, and *acknowledging* the urgent need for further research on the impact on migratory species of renewable energy technologies particularly in relation to ocean- and solar energy;

Noting also that document UNEP/CMS/Inf.11.XX highlights the urgent need to collect data on the distribution of migratory species, their population size and migration routes as an essential part of any strategic planning and impact assessment, prior to and/or during the planning phase of development of renewable energy deployments, and also stresses the need to monitor regularly mortality arising from those developments;

Noting the discussion at the 18th meeting of the Scientific Council on the drafts of document UNEP/CMS/Inf.11.XX and document UNEP/CMS/Conf.11.XX *Renewable Energy Technologies and Migratory Species: Guidelines for Sustainable Deployment*’ and aware that input from other advisory bodies of the CMS Family has been incorporated into both documents;

Convinced of the relevance of the above-mentioned guidelines for sustainable deployment of renewable energy technologies to the implementation of the CMS programme of work on climate change and migratory species submitted for consideration and adoption by the 11th Meeting of the Conference of the Parties in document UNEP/CMS/Conf.11.XX;

Noting relevant international decisions and guidance with regard to mitigating the specific impacts of power lines on birds, including:

- CMS Resolution 10.11 on “*Power Lines and Migratory Birds*”;
- ‘*Guidelines on How to Avoid or Mitigate the Impact of Electricity Power Grids on Migratory Birds in the African-Eurasian Region*’ adopted by CMS COP10, AEWA MOP5 and the CMS Raptors MoU MoS1;
- AEWA Resolution 5.11 “*Power Lines and Migratory Waterbirds*”;

- Bern Convention Recommendation No. 110 on minimizing adverse effects of above-ground electricity transmission facilities (power lines) on birds;
- Budapest Declaration on bird protection and power lines adopted in 2011 by the Conference “*Power Lines and Bird Mortality in Europe*”; and
- UNDP/GEF Migratory Soaring Bird Guidance on power lines;

Welcoming the good co-operation and partnerships already established at both international and national levels between stakeholders including governments and their institutions, energy companies, non-government organizations (NGOs) and Secretariats of MEAs, and the concerted efforts made to address energy developments which conflict with species conservation; and

Acknowledging with thanks the financial support of the Governments of Germany and Norway through the CMS and AEWAs Secretariats, of BirdLife International through the UNDP/GEF Migratory Soaring Birds project and of IRENA towards the compilation of the report ‘*Renewable Energy Technology Deployment and Migratory Species: an Overview*’ and the guidelines document ‘*Renewable Energy Technologies and Migratory Species: Guidelines for Sustainable Deployment*’;

*The Conference of the Parties to the
Convention on the Conservation of Migratory Species of Wild Animals*

1. *Endorses* the document ‘*Renewable Energy Technologies and Migratory Species: Guidelines for Sustainable Deployment*’ (UNEP/CMS/Conf.11.XX);
2. *Urges* Parties and *encourages* non-Parties to implement these Guidelines as applicable, and as a minimum to:
 - 2.1 apply appropriate Strategic Environment Assessment (SEA) and EIA procedures, when planning the use of renewable energy technologies, avoiding existing protected areas in the broadest sense and other sites of importance to migratory species;
 - 2.2 undertake appropriate survey and monitoring both before and after deployment of renewable energy technologies to identify impacts on migratory species and their habitats in the short- and long-term, as well as to evaluate mitigation measures; and
 - 2.3 apply appropriate cumulative impact studies to describe and understand impacts at larger scale, such as at population level or along entire migration routes (*e.g.* at flyways scale for birds);
3. *Urges* Parties to implement, as appropriate, the following priorities in their development of renewable energy technologies:
 - 3.1 **wind energy:** undertake careful physical planning with special attention to the mortality of birds (in particular of species that are long-lived and have low fecundity) and bats resulting from collisions with wind turbines and the increased mortality risk to cetaceans from permanently reduced auditory functions, and consider means of reducing disturbance and displacement effects on relevant species, including deploying measures such as ‘shutdown on demand’ as appropriate;

- 3.2 **solar energy:** avoid protected areas so as to limit further the impacts of deploying solar power plants;
 - 3.3 **ocean energy:** give attention to possible impacts on migratory species of increased noise and electromagnetic field disturbance especially during construction work in coastal habitats, and injury;
 - 3.4 **hydro-power:** undertake measures to reduce or mitigate known serious impacts on the movements of migratory aquatic species, such as through the installation of measures such as fish passageways; and
 - 3.5 **geo-energy:** avoid habitat loss, disturbance and barrier effects in order to continue to keep the overall environmental impacts at their current low level;
4. *Instructs* the Secretariat to convene a multi-stakeholder Task Force on Reconciling Selected Energy Sector Developments with Migratory Species Conservation (the Energy Task Force), in order to:
- promote the benefits of existing decisions
 - encourage Parties to implement current guidance and decisions
 - develop any necessary new guidelines and action plans as appropriate
 - make recommendations on suitable responses to specific problems and gaps in knowledge
- and in convening the Energy Task Force, to work in conjunction with the Secretariats of AEWAs, other relevant CMS instruments and the Bern and Ramsar Conventions, involving Parties and other stakeholders such as NGOs and the energy industry in line with the Terms of Reference annexed;
5. *Urges* Parties and *invites* UNEP and other relevant international organizations, bilateral and multilateral donors as well as representatives of the energy industry to support financially the operations of the Energy Task Force, including through funding for its coordination and provision of financial assistance to developing countries for relevant capacity building and the implementation of relevant guidance; and
6. *Instructs* the Secretariat to report progress on behalf of the Energy Task Force, including on implementation and, as much as possible, on assessment of the efficacy of measures taken, to COP12 in 2017.

Annex

Terms of Reference for the Multi-stakeholder Task Force on Reconciling Selected Energy Sector Developments with Migratory Species Conservation (*Energy Task Force*)

1. Background and purpose

The Energy Task Force is convened in line with the mandate provided by CMS Resolution 11.## to assist Parties or Signatories to CMS, AEWAs, EUROBATS, ASCOBANS, ACCOBAMS, the Raptor MoU, the Bern Convention, the Ramsar Convention and other relevant MEAs to fulfill their obligations with regard to avoiding or mitigating possible negative impacts of energy sector developments on migratory species.

2. Goal

All energy sector developments are undertaken in such a way that negative impacts on migratory species are avoided.

3. Role

The role of the Energy Task Force will be to facilitate the involvement all relevant stakeholders in the process of reconciling energy sector developments with the conservation of migratory species where all developments take full account of the conservation priorities.

4. Scope

The geographical scope of the Energy Task Force will be global. Initially, it will be convened with an African-Eurasian scope although not excluding relevant cases in progress from other regions, and will gradually expand to other parts of the world. The timing and extent of geographic expansions shall be decided by the Energy Task Force members, and shall depend on funding being available.

The Energy Task Force will cover all migratory taxa as identified by CMS and its associated instruments. Initially, the Energy Task Force will focus on migratory birds and will gradually expand to other taxonomic groups. The timing and extent of taxonomic expansions shall be decided by the Energy Task Force members, and shall depend on funding being available.

The Energy Task Force will cover the issues of power line impacts and impacts of renewable energy technology deployments (wind, solar, hydropower, geothermal, biomass and ocean energy) with initial focus on power lines, hydro, wind and solar energy technologies. Proposals for extension of the types of energy sector developments to be covered may be made and shall be considered by the Energy Task Force, and shall depend on funding being available.

5. Remit

The Energy Task Force will:

- 5.1. Promote implementation of the relevant guidelines adopted in the frameworks of the participating MEAs;
- 5.2. Set priorities for its actions and implement them;
- 5.3. Assist in resource mobilization for priority actions, including from the energy industry;
- 5.4. Monitor the implementation of relevant guidelines and their effectiveness, as well as existing impediments for adequate implementation of such guidelines, and submit progress reports to the governing bodies of the participating MEAs;

- 5.5. Stimulate internal and external communication and exchange of information, experience, best practice and know-how;
- 5.6. Strengthen regional and international networks;
- 5.7. Stimulate more research for the renewable energy technologies deployment where substantial gaps in knowledge have been identified in the Review Report (UNEP/CMS/Conf.11.XX).

6. Membership

The Energy Task Force is open-ended. Its member organizations will comprise the Secretariats of the participating MEAs, representatives of relevant government institutions in the field of environment and energy in the Parties to the participating MEAs, representatives of the energy industry, relevant academic institutions, NGOs and other interested stakeholders.

7. Governance

The Energy Task Force will:

- 7.1. Operate by seeking consensus, as much as possible, among the group.
- 7.2. Once it has been convened, operate in accordance with a *modus operandi*, which shall be established by its members.
- 7.3. Report to the CMS Conference of the Parties and governing bodies of the other participating MEAs, as requested by them.

8. Operation

Funding permitting, a coordinator will be appointed from the Energy Task Force members under an arrangement with the CMS Secretariat to support the Chair, the Vice-Chair and the Energy Task Force members, as appropriate.

The coordinator will *inter alia*:

- organize the meetings of the Energy Task Force;
- maintain and moderate the Energy Task Force communication platform (website and internal online workspace);
- facilitate implementation of decisions of the Energy Task Force, as necessary;
- facilitate fundraising and resource mobilization in support of the activities of the Energy Task Force; and
- facilitate engagement with stakeholders within and beyond the Energy Task Force.

Meetings of the Energy Task Force will be convened at appropriate intervals, as considered necessary and funding permitting.

Between meetings business will be conducted electronically through an online workspace within the Energy Task Force's website, which will provide the primary mode of communication and operation of the Energy Task Force.

9. Financing

Funding for the operations of the Energy Task Force, including the coordinator post, as well as the implementation of identified priorities will be sought from various sources, including from member organizations.

ANNEX 2

Renewable Energy Technology Deployment and Migratory Species: an Overview

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Renewable Energy Technology Deployment and Migratory Species: an Overview

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commissioned by: International Renewable Energy Agency, Convention on Migratory Species, African-Eurasian Waterbird Agreement and Birdlife International, UNDP/GEF/Birdlife Msb project

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Executive summary

Due to growing concerns about climate change and energy security, there is an increasing effort across the globe to switch over to renewable energy sources. This includes bioenergy, geothermal energy, hydropower, ocean energy, solar energy and wind energy.

Notwithstanding the socio-economic benefits and positive impacts on biodiversity through climate change mitigation, the deployment of renewable energy technologies (RET) could also have negative impacts on wildlife, including migratory species, if not properly planned and designed. Wind turbines, for example, can cause direct mortality in birds and bats due to collisions with turbine rotors or towers. Typical fatality rates could be in the order of several up to several tens of individuals of birds or bats per turbine per year.

Migratory species characteristically have geographically separate breeding and non-breeding ranges connected by migration routes. Individuals and populations can therefore be affected at several points during their life cycle: in breeding areas, during migration or at migratory stopover sites, or in non-breeding areas. Impacts can be cumulative and result from combinations of comparable or different renewable energy deployments, as well as from other developments and environmental pressures.

When the potential impacts on species are known, appropriate measures can be taken to minimize these impacts. More specifically, the challenge is to identify which species are likely to be adversely affected, the locations at which adverse impacts are most likely to occur, and the specific features of the environment and man-made structures that pose the greatest risks, so that adverse effects can be avoided or mitigated. This information is particularly important in the early stages of Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) processes. However, most of the available information is scattered and not necessarily readily accessible. Furthermore, there is insufficient knowledge on the potential impacts of most RET deployments on migratory animals. An overview of the magnitude of the potential or actual conflict between migratory species and RET deployment and identification of measures to avoid or mitigate any conflict at a global scale is lacking.

Therefore, the International Renewable Energy Agency, the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the African-Eurasian Waterbird Agreement (AEWA), on behalf of the entire CMS Family, and BirdLife International have commissioned a review of RET deployment and their possible impacts, negative and positive, on migratory species, and guidelines for mitigating and avoiding possible conflicts with migratory species.

This review aims to present an up-to-date overview of the nature, scale and impact of RET on migratory species, including a summary of the aspects involved and gaps in knowledge. Technical and legislative solutions as well as suggestions for evaluating and monitoring the effectiveness of mitigation and preventive measures are covered in the separate guidelines document 'Renewable Energy Technologies and Migratory Species: Guidelines for sustainable deployment'.

This review focuses on the six commonest sources of renewable energy (bioenergy, geothermal energy, hydropower, ocean energy, solar energy and wind energy), and the possible impacts of their deployment on the migratory species listed by the CMS Family, and focussing on the technologies that are commercially available. The review especially covers impacts in the *operational* phase of RET. Impacts in the exploration and construction phases (*e.g.* infrastructure) are also summarised, but in less detail as these are in most cases not limited to renewable energy and are already reviewed in other studies. However, in a few specific cases where construction activities for renewable energy deployment (*e.g.* offshore wind turbine construction) may seriously impact migratory species, these are further elaborated in the review.

Each of the six main renewable energy sources is dealt within a separate chapter in this review, which presents:

- A general description of its worldwide importance and distribution and the technologies to deploy that renewable energy source.
- A review of the possible impacts on migratory species and summarised in an impact matrix.
- Examples of mitigation and compensation measures.
- Positive effects.
- Gaps in knowledge.

For a summary of the main conclusions for each renewable energy deployment we refer to the conclusion paragraphs of the individual chapters 2 - 7. A simple summarisation of impacts is difficult given the highly variable ecological characteristics of the species involved and the diverse settings in which impacts occur. In general, the species groups where impacts are most likely to occur include migratory birds, mammals and fish (table S1). The main (potential) impacts of RET deployment on migratory species are habitat loss, habitat degradation, disturbance, barrier effects and direct mortality.

Impacts are often site- and species-specific. For example, the number of bird fatalities in a wind farm depends on the risk of a certain species to collide with a wind turbine and on the flight intensity through the wind farm. These aspects are related on the one hand to ecological characteristics (*e.g.*, species and their preferred habitat and specific behaviour), on the other hand to technological characteristics of the wind farm (*e.g.* configuration and type of wind turbines). Also, it is important to note that population level vulnerability is influenced by demographics, *i.e.* migratory species with a long life-expectancy and a low reproductive rate, such as large bodied birds and mammals, are the most likely to experience population level effects.

Table S1. Summary of the main impacts of renewable energy technologies deployment on migratory species groups (mammals, birds, fish, reptiles, insects). Due to differences in scale and distribution worldwide effects differ substantially. - = impact on population level is negligible.

Energy source deployed	Regionally or locally high impact, but with no significant impact on the overall species population	Impacts on population level known	Impacts on population level likely
biomass	habitat loss for all species groups	- (only small scale)	- (only small scale)
geothermal	few bird, mammal and fish species	-	-
hydropower	many fish species and some bird species	several fish species, one extinction	fish, fresh water cetaceans
ocean energy	fish, sea turtles, birds, crustaceans and squid	-	-
solar power	habitat loss for all species groups	- (only small scale)	- (only small scale)
wind energy	many species of birds, bats	few bird species	birds and bats

Proper planning at the national and international levels through SEAs followed up by site or project specific EIAs combined with sound environmental research is essential to minimise the impacts of RET deployment on migratory species. Information on exact migration routes is generally scarce, but essential in the planning phase of renewable energy deployments. Modelling can be a helpful instrument for this as well as existing online databases of the key migration stopover sites and known migration corridors (*e.g.* CSN tool and BirdLife MSB project). Pre- and post-construction monitoring are important to provide information for the planning decisions, both for already planned and future projects, as well as to evaluate mitigation measures and predicted impacts. Such post-construction monitoring is now an obligatory standard for *e.g.* large wind farms and new power lines in NW-Europe in order to be able to ‘keep the finger on the pulse’.

So far, few mitigation measures are actually in place. What is especially needed are measures that can greatly reduce risks to migratory species with minimal influence to operational procedures, such as is the case with wind turbines and bats. Reducing wind turbine operation during periods of low wind speed, when most bat fatalities occur, has been shown to decrease bat mortality with 44 - 93%, while total annual power output only decreased with less than 1%.

Finally, this review shows that relatively few systematic studies on the impacts of RET deployment on migratory species have been undertaken. The primary gaps in knowledge of potential impacts of RET deployment and migratory species lie in the detailed understanding of specific migration routes and the importance of particular habitats and regions as stopover, nesting, and feeding sites as well as how RET deployment may cumulatively affect these.

Detailed information in these areas will be imperative to the careful siting of renewable energy projects to avoid, for example, important migration corridors. As the size or total number of RET deployments increases, the impacts can be expected to grow. To date, very few attempts have been made to model or study impacts at the larger scale, such as population level or entire migration routes (*e.g.* intercontinental “flyways” for birds). Most such studies are theoretical rather than evidence-based. The same applies to studies of cumulative impacts. For example,

potential barrier effects to migratory birds, fish and marine mammals may increase in the near future as more offshore wind farms become operational. The cumulative assessment of impacts at population scale during the full life cycle (reproduction-, migration-, and non-reproduction phases) is currently a major conservation challenge. Although the review shows a few examples where population effects of RET deployment have been proven (*e.g.* hydropower and fish and wind energy and raptors), most impacts of renewable energy deployment on migratory species have not yet lead to changes at population level.