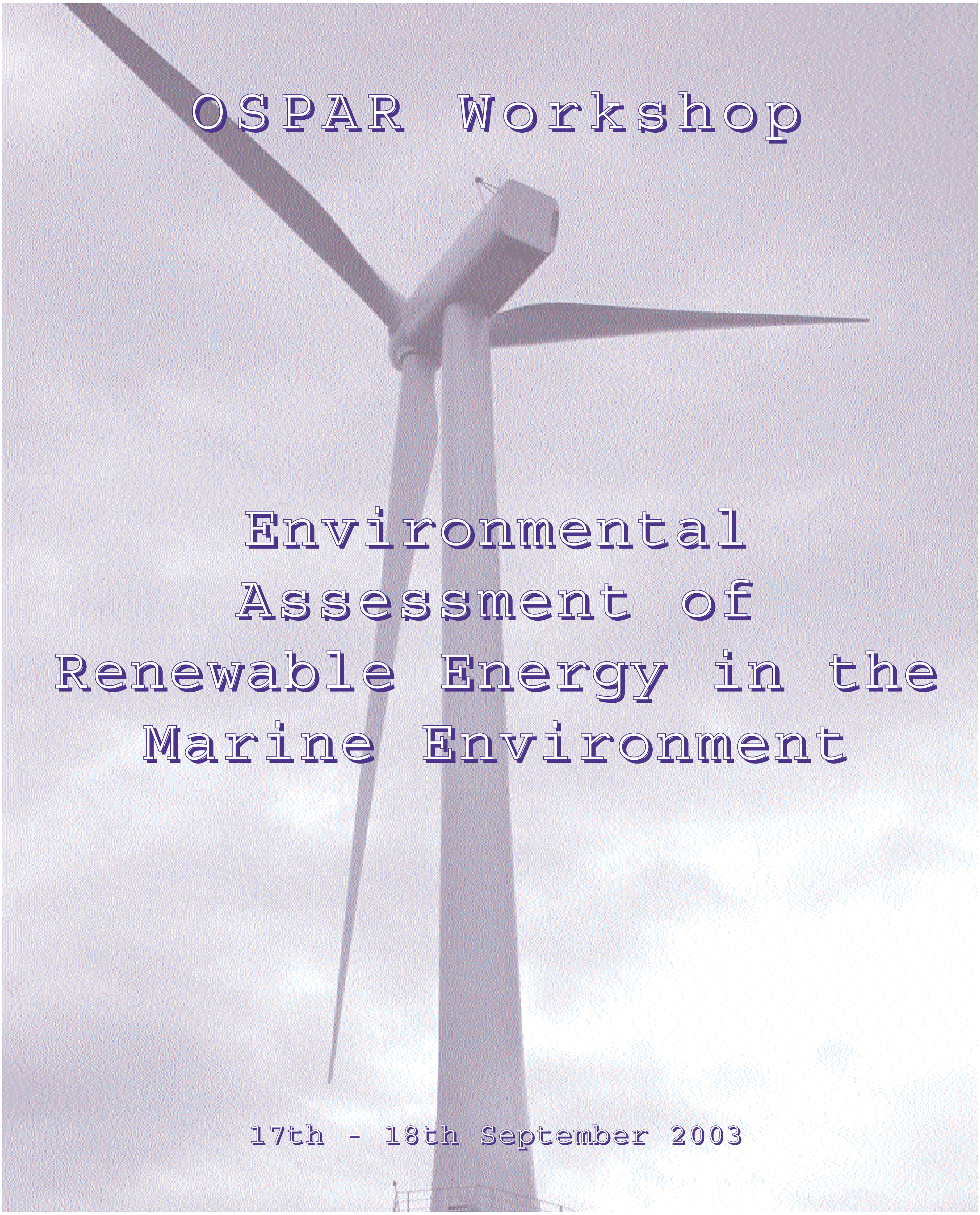


OSPAR Workshop

Environmental Assessment of Renewable Energy in the Marine Environment

17th - 18th September 2003

dti

defra
Department for Environment Food and Rural Affairs

CEFAS
The Centre for Environment, Fisheries & Aquaculture Science

EXECUTIVE SUMMARY

The global environmental benefits from renewable energy technologies to reduce emissions of greenhouse gases, particularly if accompanied by energy efficiency initiatives, are widely accepted. However, any large construction project will have environmental impacts so it is imperative that they be located and built in an environmentally responsible way. As interest in constructing renewable energy generation facilities in offshore locations increases, regulators need to ensure that adequate measures and controls exist to keep adverse marine environmental impacts to a minimum.

Regulators in different countries are facing the same challenges but to date have been progressing on their own with very little exchange of experiences. This has led to duplication of effort and the unintentional withholding of important data sets from the wider scientific community.

This workshop of 63 delegates was convened to bring together for the first time regulators, NGOs and other stakeholders with an interest in marine environmental impact assessment from around Europe to share experiences and discuss best practice for offshore renewable technologies. Although it had the broader heading of offshore renewable energy the discussions focussed on wind power as this is the most advanced of the technologies. The workshop was co-funded by the UK Departments for Trade and Industry (DTI) and Environment, Food and Rural Affairs (Defra). The workshop was developed and administered by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS).

Presentations were given on:

- current practice of assessing environmental impacts and consenting offshore renewable energy projects (UK, Netherlands, Denmark & Ireland),
- current and proposed research (UK, Sweden, Denmark, Netherlands and Germany),
- approaches to marine environmental monitoring,
- EIA & SEA and
- how the OSPAR Convention applies to renewable energy.

The approach to offshore renewable energy development is markedly different between the countries represented at the workshop. Sweden, Denmark, The Netherlands and Germany are taking a precautionary approach with relatively few wind farm developments and proposals in the first instance with the opportunity to feedback and incorporate the data and experiences in the planning process. The UK has a larger number of relatively small scale wind farm developments planned around its coast, the environmental impacts for which were assessed individually, but has a second phase of larger developments planned further offshore tied in with an SEA programme. However, despite these different approaches the problems identified in EIA and SEA for offshore renewable energy developments are very similar.

Four discussion groups ran throughout the two-days under the headings: Physical Processes; Nature Conservation & Biology; Fisheries and Other Users and Environmental Decision Making (including EIA & SEA Requirements). The aim of these groups was to explore in depth for these disciplines improvements for:

- guidance on environmental assessment;
- monitoring and mitigation;
- research (including identification of gaps and funding opportunities) and
- data exchange and networking.

The groups also discussed the OSPAR initial measures and background documents on offshore wind farms to make proposals for their revision.

The environmental impact assessment of any development in the marine environment requires a multidisciplinary approach. As such there were some constraints imposed on the groups and some inevitable duplication with some similar topics arising and in some instances the problems identified by one group would have solutions in another (and *vice versa*). Despite these constraints the groups were able to openly discuss the issues and form the basis of recommendations on where our knowledge and experience is lacking and ways forward. The plenary sessions allowed for exchanges between the groups.

The main conclusion and recommendation of the workshop was that data exchange and networking needed to be improved. Various mechanisms such as expert groups or web-based fora were proposed and although no definitive decision was made at the workshop a recommendation distilled from the discussion group notes is made in this report.

It was also concluded that Table 1 of the OSPAR problems and benefits document needed to be gone through in detail to provide guidance on the potential impacts from offshore wind farm developments and their significance. A second smaller workshop is being planned for later this year to take this recommendation forward.

It was also concluded that better guidance at a national level (but co-ordinated at the OSPAR/European level) was required for both regulators and developers on how to undertake and assess marine environmental impacts of offshore renewable energy developments. Such guidance would benefit greatly from the outputs of the second workshop.

The offshore renewable energy industry is gaining momentum with ambitious hopes for larger developments than those possible from current technologies. The regulators must therefore act now to ensure that all tools at their disposal to assess environmental impacts are used efficiently and that sufficient resources are allocated for the development of new tools and that approaches are consistent throughout Europe.

Contents

INTRODUCTION

Renewable energy is viewed as the clean green future energy source and the development and implementation of the new technologies is a challenge for all those involved. However, identifying and evaluating the environmental impacts of a potential resource saving industry is a novel challenge.

Construction has started on the first offshore wind farms in the North East Atlantic and most of the OSPAR states with coastal waters are involved. Construction and operation of offshore wind and other renewable energy developments will have environmental impacts and it is important that these are anticipated, assessed and that best environmental practice and best available techniques are used in their siting, construction, operation and decommissioning. National and international regulatory controls mean that all such developments will require a formal Environmental Impact Assessment (EIA). Industry, regulators, environmental assessors, statutory consultees and other stakeholders in each country all have to overcome similar problems.

Proficient and consistent application and consenting procedures are required to help the regulators and offshore renewable energy industry to develop quickly whilst ensuring sustainable use of the marine environment consistent with the OSPAR Convention and European legislation.

OSPAR has developed and agreed Guidance on a Common Approach for Dealing with Applications for the Construction and Operation of Offshore Wind-Farms (Reference Number: 2003-16) and this guidance is to be kept under review in light of knowledge and experience gained in its application.

Nevertheless, as shown in the OSPAR Revised Draft Background Document on Problems and Benefits Associated with the Development of Offshore Wind Farms (Reference Number: BDC 03/4/2 As Amended), there remain significant gaps in our knowledge regarding the problems associated with the development of offshore wind farms and balancing these against the benefits. Included in this are the identification and development of best environmental practices for the location, construction, operation and removal of offshore wind farms. These issues need to be considered and addressed with a view to facilitating the development of offshore farms and the protection and sustainable use of the marine environment.

The main objective of this two-day workshop was to explore manageable assessment procedures for offshore renewable energy developments.

The workshop brought together scientific advisors, statutory consultees, Government Departments, and Agencies, and others involved in permitting and conducting research across the North-East Atlantic into a forum to enable discussion of best practice in the assessment of the impact of renewable energy in the OSPAR maritime area. Networking at the event and this report of the workshop provides the platform to establish a co-ordinated system for the exchange of information among OSPAR contracting parties and observers with regard to the assessment of, and research on, renewable energy in the marine environment.

We know that there are gaps in our scientific understanding of the processes that are acting when we are considering building offshore renewable energy installations but many regulators and decision makers have to act now despite these gaps. The workshop provided the forum to discuss what these gaps are and see how they can be most effectively plugged and what mitigating conditions are being imposed. In particular, it was hoped to facilitate the exchange of ideas about the research that is going on in different countries so that our research can be complimentary, rather than duplicating what is going on elsewhere.

In the assessment of renewable energy in the UK we are just in the process of completing the first round of assessing the environmental consequences of issuing permits for offshore wind farms. We are now seeking to evaluate how effective our assessment and decision-making processes have been and to identify whether we can do better in the future. Our aim is to develop an agreed approach to the assessment and evaluation of environmental impacts.

The workshop was organised by the UK Centre for Environment, Fisheries and Aquaculture Science (CEFAS). It was funded jointly by two UK Government Departments – the Department of Trade and Industry (DTI) and the Department for Environment, Food and Rural Affairs (Defra). Support from OSPAR is welcomed and as an official OSPAR workshop the output of our deliberations will go forward and be used within OSPAR and its member states. The workshop was held at the Five Lakes Hotel, Golf and Country Club, Tollshunt Knights, Near Maldon, Essex, UK on the 17th and 18th September 2003.

WORKSHOP AIMS

The workshop was to examine the problems associated with the development of offshore wind farms and discuss, *inter alia*, the best way to develop BAT, BEP or guidance on location and construction of offshore energy, as appropriate.

Although focused around the current problems of licensing wind farm construction, the workshop was also to address generic issues that would equally apply to other forms of renewable energy in the marine environment (i.e. wave and tidal). This would help to put the regulators and industry in a state of readiness when other forms of renewable energy require consent.

The workshop objectives were to:

- Provide a platform to enable exchange of information among OSPAR countries and observers with regard to the assessment of and research on renewable energy in the marine environment
- Acknowledge scientific gaps in understanding
- Identify future research needs and avoid duplication of effort
- Evaluate development of environmental decision making processes/regulatory processes to date and identify solutions for the future
- Evaluate and consider best practice guidance for effective consultation
- Initialise an ongoing network of participation and co-operation between participants
- Develop an agreed approach for the environmental assessment of renewable energy proposals

The following 2 documents were provided to all delegates as background for the discussions at the workshop (Appendix 4):

1. OSPAR - Guidance on a Common Approach for Dealing with Applications for the Construction and Operation of Offshore Wind-Farms (Reference Number: 2003-16)
2. OSPAR - Revised Draft Background Document on Problems and Benefits Associated with the Development of Offshore Wind Farms (Reference Number: BDC 03/4/2 As Amended)

WORKSHOP STRUCTURE

Day one
- Introduction
- Keynote speakers
- Workshop discussion groups
- Brief presentation and discussion of group outputs

Day two
- Analyses of Day 1 outputs in 'expert' discussion group sessions
- Plenary session, findings and conclusions

For the discussion groups on Day One delegates were split into 4 predetermined groups of roughly equal numbers. Each group of delegates then spent 15 minutes in each of the following discussion groups for brainstorming of ideas:
- Physical Processes
- Nature Conservation and Biology
- Fisheries and Other Users
- Environmental Decision Making (including EIA and SEA Requirements)

There then followed a brief session where delegates were given a free choice to join the group that most suited their experience to further discuss and refine the outputs of the brainstorming sessions. As prompts for these discussion groups the following list of points to consider were provided:
- Baseline data requirements
- Monitoring requirements
- Mitigation
- Existing completed and/or ongoing R&D
- R&D gaps and needs
- R&D funding opportunities

The objective of the Day Two discussion groups was to continue with the expert groups in order to discuss in detail and prioritise the outputs of the Day One sessions.

To assist these discussions each of the groups were given the following pointers:

Topics to consider	-	Environmental assessment
	-	Monitoring and mitigation
	-	Research
	-	Data exchange/networking

Under these topics the following questions were posed (not for direct answers but to stimulate discussion):

Environmental assessment
- Is there sufficient guidance on the assessment of the impact of offshore energy installations on the marine environment for regulators and developers?
- If not, what should be developed?

Monitoring and mitigation
- Is there sufficient guidance?
- If not, what is required?

Research
- Can any research synergies be identified, if so what are they?
- What are the gaps (Annex 1, Section 1 of the OSPAR Problems and Benefits document)?
- What are the priorities for filling these gaps?
- Who should address them and how?

Data exchange/networking

- How should data exchange/access be provided for?
  - Information for developers
  - Information for regulators
  - Information for other stakeholders
- Future networking opportunities or meetings of this group?

Where guidance was considered to be lacking the groups were asked to consider:

- At an international level:
  - Is the OSPAR guidance sufficient?
  - If not, what is required?
  - The draft document on problems and benefits
    - What comments do you have?
    - How should Annex 1, Section 4 be developed?
- At a national level:
  - Is there a need for additional guidance, e.g. a good practice guide?

Chair:

Lindsay Murray
Centre for Environment, Fisheries and Aquaculture Science

PROGRAMME OF PRESENTATIONS

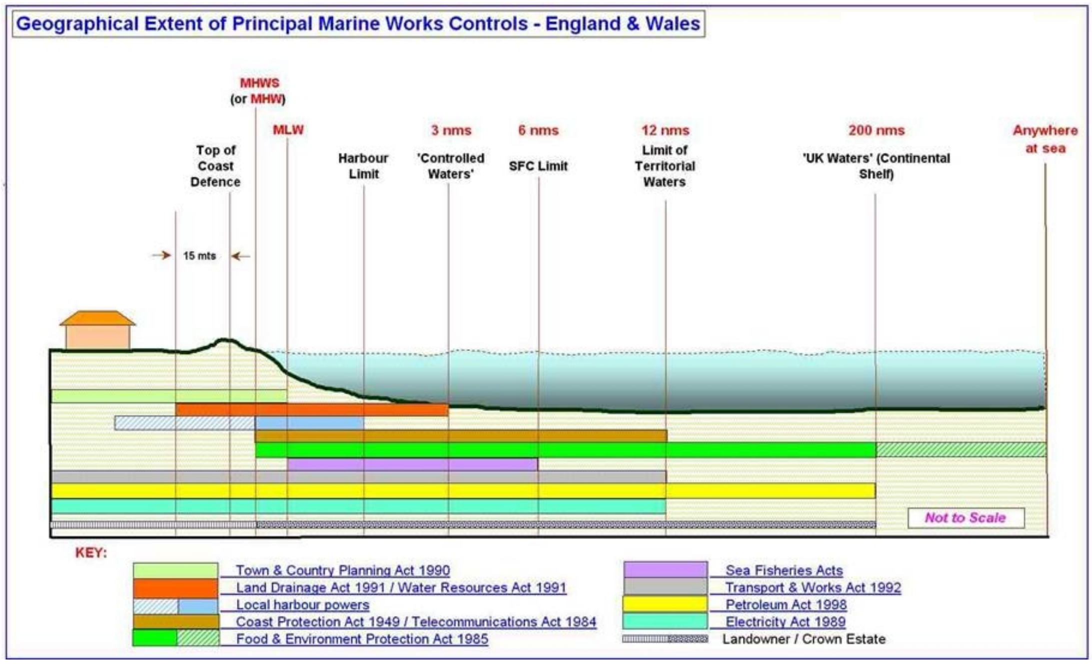
10:00	*Registration and coffee*
10:30	**Introduction and welcome from chair:** Lindsay Murray, Centre for Environment, Fisheries and Aquaculture Science, UK
	Current practice
10:35	**Current practice - UK:** Adrian Judd, Centre for Environment, Fisheries and Aquaculture Science (Collated from contributions from the UK regulatory authorities)
10:40	**Current practice - The Netherlands:** Ronald van den Heuvel (presenter) and Saskia van Gool, North Sea Directorate, Ministry of Transport, Public Works and Water Management, Netherlands
10:50	**Current practice - Denmark:** Steffen Nielsen, Danish Energy Authority
11:00	**Current practice - Ireland:** Tom Burke, Department of Communication Marine & Natural Resources, Ireland
	Current and proposed research
11:10	**The role of Defra in funding research:** Paul Leonard, Science Directorate, Department for Environment, Food and Rural Affairs, UK
11:15	**Environmental Monitoring at Scroby Sands offshore wind farm site:** Jon Rees, Centre for Environment, Fisheries and Aquaculture Science, UK
11:25	**COWRIE project update:** Carolyn Heeps, Crown Estate, UK
11:35	**Bio-Wind:** Torleif Malm (presenter), Institute of Botany, University of Stockholm, Jörgen Hansen and Jens K. Petersen, Danish National Environmental Research Institute
11:45	**Overview of current and proposed research in the Netherlands:** Mariska Harte (presenter), National Institute for Coastal and Marine Management, National Institute for Coastal and Marine Management, Saskia van Gool, North Sea Directorate, MINVENW and Walter van den Wittenboer, Novem
11:55	Offshore wind energy research projects in Germany: Cornelia Viertl, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany
	Approaches to Monitoring
12:05	**Monitoring the environmental impacts of offshore windfarms (1):** Mike Elliott (presenter), Institute of Estuarine and Coastal Studies, University of Hull, UK, Piers Larcombe, Centre for Environment, Fisheries and Aquaculture Science, UK and Jens Kjeruff Petersen, National Environmental Research Institute, Denmark
12:15	**Monitoring the environmental impacts of offshore windfarms (2):** Anne Grethe Ragborg, Danish Forest and Nature Agency
12:25	*Lunch*
	Directives and Conventions
13:30	**EIA and SEA at the European Level:** Karl Fuller, Centre for Environmental Assessment, UK
13:40	**How the OSPAR Convention applies to renewable energy:** Amparo Agrait, Deputy Secretary, OSPAR
13:50	**Introduction to workshop sessions:** Lindsay Murray, Centre for Environment, Fisheries and Aquaculture Science

1. Current Practice: UK

The regulatory framework

In the UK, there are separate systems for England and Wales, Scotland and Northern Ireland. The current situation for just England and Wales will be described, but the underlying drivers and principles of environmental assessment are the same throughout the UK.

The diagram below illustrates the geographical extent of the principal controls on marine works in England and Wales.



The main Government bodies involved in the development and regulation of offshore renewables are the Crown Estates Commissioners, DTI and the MCEU. The Crown Estates, who are the landowners of most of the sea bed, provide leases to the developers. DTI are responsible for consenting environmental controls and licensing of energy facilities. MCEU is a joint unit for regulating marine consents. It is comprised of the Department for Transport, the Welsh Assembly Government and Defra (who are responsible for consents in England, but also act on behalf of the Welsh Assembly in this respect).

Drivers for offshore renewable energy

The UK announced its renewables obligation in January 2002 and the Energy White Paper 'Our Energy Future – Creating a Low Carbon Economy' (www.dti.gov.uk/energy/whitepaper/) was presented to Parliament in February 2003. The short term aim is for 10% of UK electricity supply to come from renewable sources by the year 2010. Suppliers in England and Wales will be required to obtain an increasing proportion from renewable energies, year on year. Progress will be reviewed in 2003 and 2006. A strategy will be elaborated for the decade to 2020 by which time it is hoped to double the 2010 target.

Wind energy

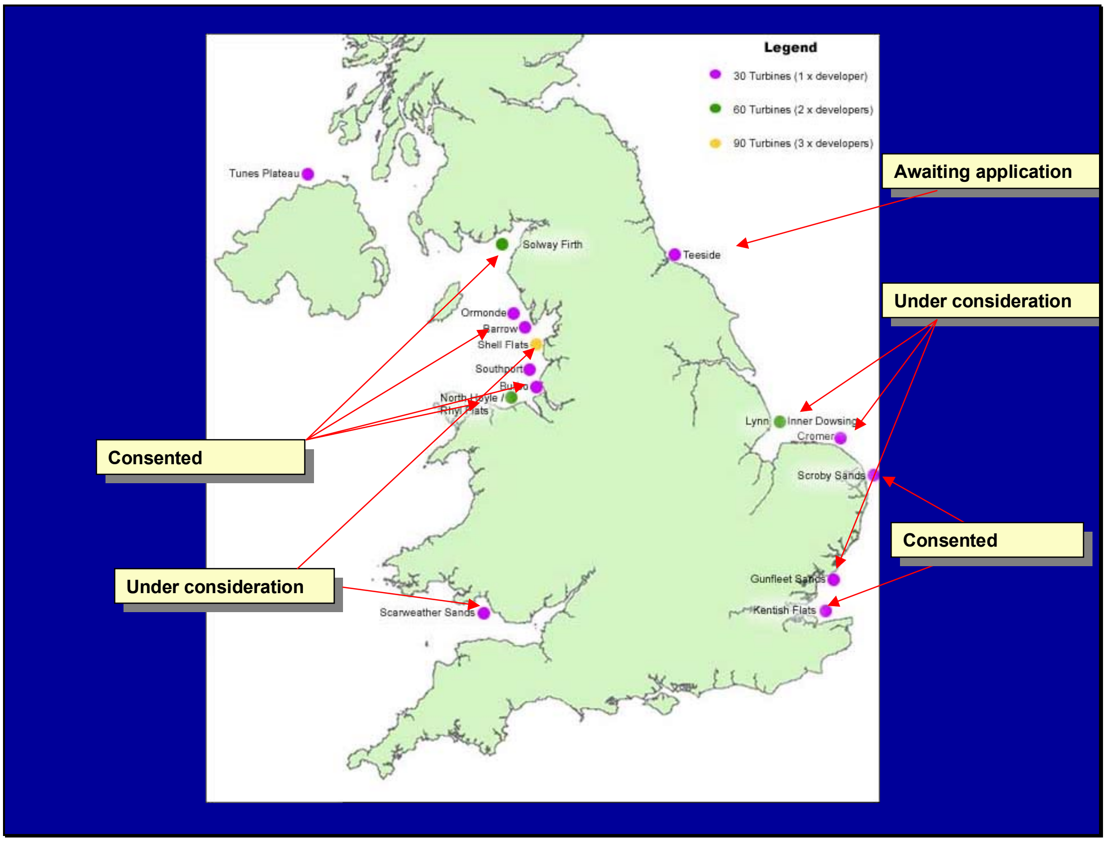
In the UK, wind is the most advanced of the offshore renewable technologies. The first round of consents for offshore wind started in December 2000.

There were a number of ground rules set for potential developers in Round 1:

- Developers had free choice of a 10 km^2 site anywhere in UK territorial waters;
- Sites had to be at least 10km apart;
- There had to be a minimum generation capacity of 20MW
- A maximum of 30 turbines per site
- Others include:
  - sufficient financial standing,
  - offshore and wind turbine experience
  - financial deposit (to be described in the presentation by Carolyn Heeps)

The current situation

In Round 1, a number of suitable sites were identified - primarily those which were windiest and relatively close to shore and thus easy to develop. Of those, a number have already been consented – see map below.



Construction of one of these (North Hoyle on the north coast of Wales) has begun and its foundations and half the turbines are already in place. It is due to be commissioned in November/December 2003.

Assessment

The environmental benefits of renewable energy technologies are unquestionable, but the potential for adverse environmental impacts must be acknowledged and assessed. In deciding whether to grant consent, the benefits of the development must therefore be evaluated against any potential adverse impacts. Consents must also include conditions to ensure that construction is carried out in the most environmentally responsible manner possible, that any potential impacts are minimised and that appropriate monitoring is carried out. As well as assessing individual development proposals, it is important to consider cumulative impacts so strategic planning is also required.

Areas of potential adverse impact

As for any environmental impact assessment, there are a number of areas that need to be considered, including:

- Nature conservation
- Sedimentary processes
- Benthic ecology
- Fisheries resources
- Commercial fishing
- Ornithology
- Sea mammals
- Navigational interests
- Aviation and defence
- Visual environment
- Recreational use
- Marine archaeology
- Decommissioning

The consultation process

Consenting marine works involves extensive consultation process which includes:

- Government departments (e.g. DTI, DEFRA, DfT, MoD);
- CEFAS – for scientific advice to the government on fisheries, benthos, sedimentary processes, hydrodynamics and coastal processes;
- Sea Fisheries Inspectorate;
- Local Authority interests – for planning, amenity/leisure, environmental health;
- Crown Estate;
- Nature Conservation Bodies (EN, CCW) – for sites of nature conservation importance (SPAs, SSSIs, SACs, MNRs)
- Environment Agency – for water quality, migratory fish, coastal processes
- Other interest groups and NGOs

Only when planning and Food and Environment Protection Act 1985 (& Coast Protection Act 1949 where applicable) consents have been agreed is the developments final consideration for consent under the Electricity Act 1989 or Transport and Works Act 1992 given.

Lessons learnt from Round 1

Many of the developers had little offshore experience as this is a new industry with very limited experiences to draw on. At the EIA stage, construction techniques and methodologies were often unclear so a number of options were presented which had to be speculatively assessed. As there were very few studies on the marine environmental impacts of offshore wind farms, monitoring studies were an essential condition of development consents.

The importance of adequate, fit-for-purpose environmental baseline data and modelling on which to base predictions of environmental impacts (quantitative & qualitative) also became apparent.

Government and industry need to work together to ensure that gaps in our scientific knowledge are filled. There also needs to be clear guidance from Government on EIA scoping and a clear strategic planning framework for offshore renewable energy development (SEA).

Look forward

DTI have initiated an SEA process and are developing a strategic planning framework for future rounds. The approach is to examine requirements for the site allocation process (i.e. consider competition issues, site security, economic factors to encourage optimal development of the industry). A framework will then be developed that minimises financial risk to the developers (by ensuring that they pursue the areas with least environmental impacts). The aim is to work towards an appropriate legal framework that enables Government to discharge its responsibilities for allocating rights, but in a way that recognises and addresses potential conflicts of interest and potential adverse impacts.

Future Offshore: a strategic framework for the offshore wind industry (available on DTIs website). This document proposes that future rounds should focus on 'strategic regions' where development opportunities are apparently most promising. Three such regions have been identified for Round 2 (Liverpool Bay, Greater Wash and Outer Thames). It proposes that site allocation rounds should be conducted so that developers can gain security to conduct exploration activities. Legal measures are required to ensure opportunities beyond territorial waters can be exploited

The SEA process for the three 'strategic regions' has been completed. It advises on the appropriate scale and location of development within the regions and aims to reduce risk to developers by providing guidance on site selection. It also encourages co-operation between developers to help share infrastructure or exploration costs. In this way it helps to ensure that development proceeds in a controlled way whilst impacts are becoming understood.

Compiled by:	More information:	Presented by Adrian Judd
- Adrian Judd: Centre for Environment, Fisheries and Aquaculture Science, UK **- Brian Hawkins** Marine Consents and Environment Unit, UK **- Mike Brook** Department of Trade and Industry, UK	www.cefas.co.uk www.mceu.gov.uk www.dti.gov.uk/energy	

2. Current Practice: The Netherlands

Current situation

There are currently no wind farms on the Dutch Continental Shelf. However, one permit was issued in 2002 and is likely to be realised in 2004/2005. This is the Q7 wind farm which will be 23 km offshore and have 60 turbines of 2MW each. There is also one application in progress for which permit is foreseen in early 2004, with realisation in 2005. This is the Near Shore Wind Farm, which will be 8 km offshore and have 36 turbines of 2.75 MW each. This is a demonstration project originally initiated by the Dutch Cabinet, but now taken over by market parties.

Policy

The Dutch target is for 6000 MW to be supplied by offshore wind by 2020. Wind farms will only be allowed outside the 12 mile zone. An offshore wind location policy is under development. This will be a concession scheme, the essence of which is to maintain a documentation of control about locations. This is required as wind farms take up a lot of space and there are extensive other uses of the Dutch Continental Shelf. It is hoped that this concessions scheme will be translated into legislation by the end of 2004. Until then, no new applications will be accepted.

Permit procedure

The permit procedure always starts with an Environmental Impact Assessment (EIA) followed by the application for a permit. Within this procedure, there are four official consultation rounds for the public. The permit is issued by the Ministry of Transport, Public Works and Water Management. As in the UK, many other Ministries are also involved, including the Ministries of Economic Affairs, Environment, Agriculture, Nature and Food Quality, as well as the National Coastguard regarding shipping safety.

The permit includes conditions that ensure protection of the natural environment and safety for other uses at or near the location, such as oil and gas, aggregate extraction, cables and pipelines, fisheries and shipping. Within the permit, provisions are made to ensure protection of any marine archeology that may be present at the location. Because of the big gaps in knowledge regarding the effects of offshore wind energy each initiator will be obliged to execute a Monitoring and Evaluation Programme (MEP). These are described in more detail in the talk by Mariska Harte.

Discussion issues

1. How do you determine a location policy for dealing with other (potential) users? Once a concession is granted does this give the initiator exclusive right to that location? What happens if, for example, a cable company comes along and wants to lay a cable through this concession area?

2. How to comply with the Birds and Habitats Directives is a big discussion issue in the Netherlands. The offshore area itself doesn't fall directly under the so-called Special Protected Areas, but offshore wind farms will need to be evaluated under the Directives as "external influences". The Directives talk about "significant effects", but what is "significant"? They also require "compensating and mitigating measures" but how do you deal with that in practice?

3. The monitoring programme has already been mentioned. However, for evaluation of effects, reference criteria are needed. For example how many birds may collide with a wind farm before you need to take action?

4. The Dutch permits require the initiator to provide a bank guarantee so that the Government at any time can remove a wind farm if the initiator is not capable of doing it

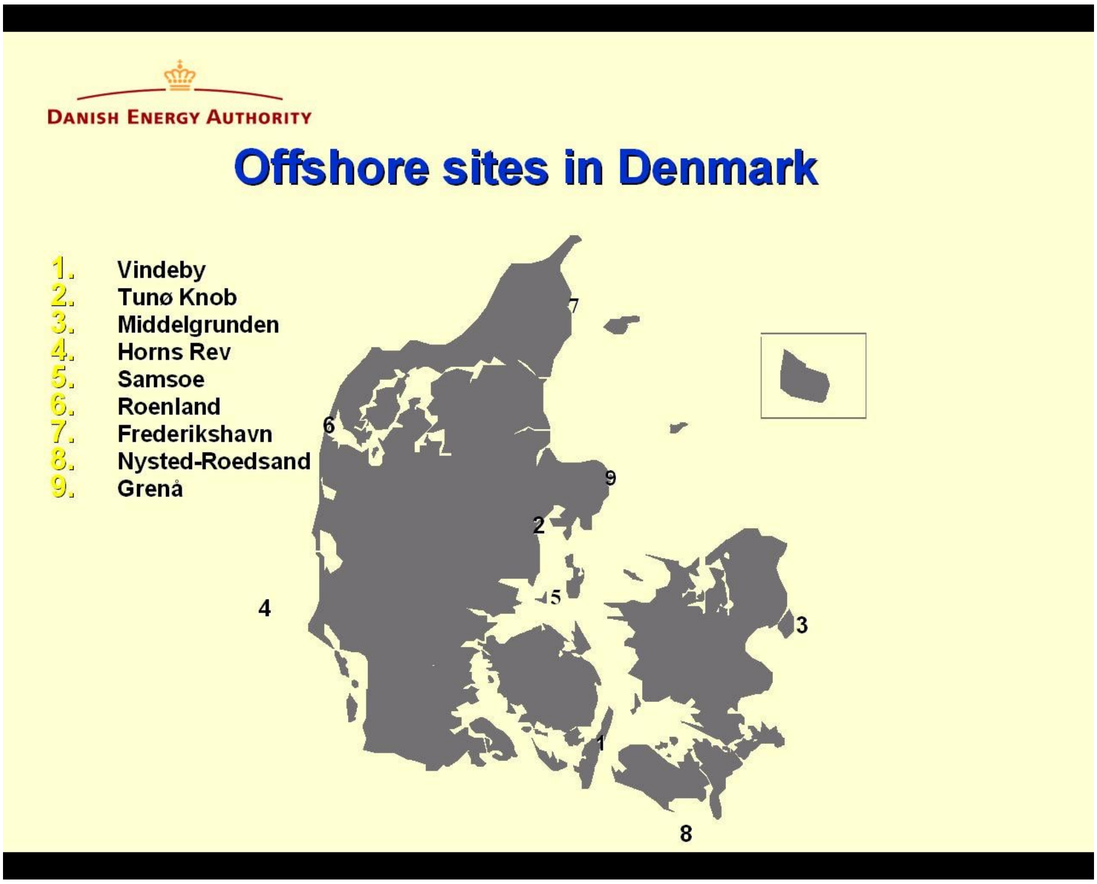
themselves. These bank guarantees are not very popular with the industry. How do other countries deal with this issue?

Compiled by:	More information:	Presented by Ronald van den Heuvel
- Ronald van den Heuvel and **- Saskia van Gool** Ministry of Transport, Public Works and Water Management North Sea Directorate, The Netherlands		

3. Current Practice: Denmark

Currrent situation

Due to the shortage of suitable terrestrial sites, Denmark has a long term policy for development of offshore wind energy. Its offshore interests began in 1991 with the launch of a small pilot project. Connection began in the year 2000 and it now has eight wind parks which produce about 420 MW of electricity. Construction of a ninth will begin once final consent details have been resolved.



In 1994 a project was initiated to look at offshore interests in Danish waters. This took account of:

- Landscape
- Limited water depth
- Prohibitive interests:
  - Maritime protection/traffic
  - Bird protection areas and other protected areas
  - Areas of archaeological importance
  - Oil and gas pipelines and existing cables
  - Areas with raw materials
  - Military practice areas
- Relative interests
  - Fishing interests
  - Visual impact
  - Yachting

In the late 90's an action plan was produced. This specified that offshore wind energy should be concentrated in a number of designated areas, and that some action could be acceptable around a typical near-shore installation. There are therefore economic and sectoral issues as well as environmental issues to be considered.

Current Process

It has been laid down in the Electricity bill for liberalising the Danish electricity market that offshore developments should be put out to public tender in the future. A public tender is currently being prepared for one offshore wind-farm of 150 MW. Four potential areas are also currently being screened. Since the 90's, developers have tended to go in for larger turbines so there has had to be a move towards deeper waters

They have been asked for suggestions for other interests and also some supplementary areas. An inshore utilisation for the placement of offshore wind farms has been prepared. They have also been asked to come up with ideas for likely problems, such as visual impact, navigation, nature and environment, shipping and safety issues, and other economic activities such as aggregate extraction.

Relevant recommendations are then laid out as requirements in tender conditions and the winner gets permission to prepare EIA.

Main Authorities

- The Danish State has all competence within the 12 NMZ and in the Danish EEZ
- Off-shore wind-power is consented and approved by the Danish Energy Authority, Ministry for Economic and Business Affairs in co-operation with other authorities:
  - Danish Forest and Nature Agency (Ministry of the Environment)
  - Danish Maritime Authority (Ministry for Economic and Business Affairs)
  - Ministry of Defence
  - The Royal Danish Administration of Navigation and Hydrography (Ministry of Defence)
  - Danish Civil Aviation Administration (Ministry of Transport)
  - Danish Coastal Administration Agency (Ministry of Transport)
  - National Working Environment Authority (Ministry of Employment)
  - Counties
  - Municipalities

Compiled by:	More information:	Presented by Steffen Nielsen
- Steffen Nielsen: Danish Energy Authority, Ministry of Economic and Business Affairs		

4. Current Practice: Ireland

Background

In 1999, industry pushed for the Irish Government to develop a policy for offshore wind. Lack of knowledge of the emerging industry and its impacts was a serious constraint. The initial policy was approved in July 2000 and the first licences to investigate the suitability of sites were issued in August of that year. There is quite a degree of interest in the Irish Sea, in particular, where there is a huge wind resource.

From the Coastal Zone Management Division's perspective, there are two issues. The first is to obtain a commercial return on use of State-owned seabed; the second is to protect the marine environment. The first is not relevant to this workshop, so only the second will be considered.

Environmental Impact Statements

In Ireland, an EIS is required for all offshore wind farms. As wind farms multiply, EISs will be required to address cumulative impacts, both visual and environmental. Consultation with interested parties (other users, environmental groups, local authorities, coastguard, aviation authority etc,) is actively encouraged prior to preparation and publication of an EIS.

Two EISs have been considered to date. Full public consultation has been completed in each case and was very successful with not one objection received. In one of the projects, fishermen actually wrote supporting the project and pressing for speedy completion of the lease!

A lease has been issued for Arklow Bank Wind Park and work is currently underway on construction of the first phase, which will produce 26 MW. In the longer term, it can under the terms of its lease accommodate 200 turbines producing up to 520 MW. Arklow Bank is a narrow strip about 27 Km long and 7 Km offshore at its nearest point. It is partially exposed at low water and subject to severe swells and seas. It is entirely sand and the top 3-4 metres of sand are highly mobile. There are little or no fish in the area.

A further application is being negotiated at present for a development on the Codling Bank, which is similar in size to Arklow Bank. Codling Bank is in deeper water some 13 Km offshore and is an important whelk fishery (it is the world's biggest supplier of whelk to the Korean market). The bottom is rock and gravel.

The two projects could not, from an environmental standpoint, be more different.

The consenting process

Complex applications are considered by an expert group known as the Marine Licence Vetting Committee (MLVC) which is comprised of experts in marine sciences, chemistry, marine engineering, safety of navigation, fishing and fisheries, etc. Because of their unfamiliarity with the offshore wind industry, they enlisted the help of consultants to assess the EIS for the first application (Arklow Bank) but did not require it for the second one.

The MLVC makes a formal report to the Minister, advising whether or not the application should be approved from an environmental standpoint and recommending the environmental conditions to attach to any permit. It is virtually unknown for any Minister to ignore or amend these recommendations.

Environmental Protection

A number of environmental conditions were attached to the Arklow Bank permit. However, as this is new and as yet untested technology in such exposed waters it is possible that the unforeseen may happen. The Minister therefore retains power to order cessation of work, removal of turbines or anything necessary to prevent unacceptable and unforeseen environmental impacts continuing.

The current position

The lease issued for Arklow Bank is available on the Department's website. It should be read in conjunction with the tri-partite agreement between the Minister for Communications, Marine and Natural Resources, Sure Partners Ltd (a subsidiary of Airtricity) and Arklow Energy Ltd (a subsidiary of General Electric Wind) which allowed for the subletting of the construction and operation of Phase 1 of the development as there are small changes in the tri-partite agreement which impact on the lease (www.dcmnr.ie/display.asp/pg=158).

The policy is being reviewed at present and will be revised to include guidelines from the Irish Aviation Authority and Commissioners of Irish Lights relating to safety of navigation, aviation and maritime traffic. Each application will continue to be considered separately by both bodies.

Compiled by:	More information:	Presented by Tom Burke
- Tom Burke: Department of Communication, Marine and Natural Resources, Ireland	www.dcmnr.gov.ie For relevant policy document, see : www.dcmnr.gov.ie/display.asp/pg=156	

5. CURRENT RESEARCH: THE ROLE OF DEFRA IN FUNDING RESEARCH

Defra (UK Department for Environment, Food and Rural Affairs)

Defra has 10 objectives, of which the following apply to the marine environment:
Objective 1: "To protect and improve the marine environment and conserve and enhance biodiversity, and to lead integration of these with other policies across Government and internationally."
Objective 6: "To promote sustainable management and prudent use of natural resources domestically and internationally."

Why do we need science?

Defra has a range of policies and is looking for scientific robustness to underpin them. That requires research to improve our understanding of the marine environment and thus help make rational decisions about its protection. It also helps to ensure that we do the most appropriate environmental assessment and thus minimise environmental impact, as well as helping us to be effective in international negotiations.

Drivers

In 2002 the first Marine Stewardship Report "Safeguarding our Seas" was published (Defra, 2002). This made recommendations in the following key areas:

- sustainable exploitation of marine resources
- environmental protection
- ecosystem approach
- greater integration
- precautionary principle

In 2004, progress will be reported in the "State of the Seas Report". This will include examples of how we are delivering scientific-based evidence, improving stewardship of data and promoting the ecosystem-based approach. It will also aim to show how Departments are integrating their policies and the science that underpins their decisions.

The main international driver is the OSPAR biodiversity objective ("to protect and conserve the ecosystems and the biological diversity of the maritime area which are, or could be, affected as a result of human activities, and to restore, where practicable, marine areas which have been adversely affected") which is particularly relevant to this meeting.

Current Defra-funded Wind farm Research Projects

Defra has a wind farm R&D group and funds two projects that will be described later:

- Development of Generic Guidance for Sediment Transport Monitoring Programmes in Response to Construction of Offshore Wind farms
- Assessment of the Significance of Changes to the Inshore Wave Regime as a Consequence of an Offshore Wind Array

Compiled by:	More information::	Presented by Paul Leonard
- Paul Leonard: Science Directorate, Department for Food and Rural Affairs, UK	www2.defra.gov.uk/research/project_data/ www.defra.gov.uk/environ/water/	

6. CURRENT RESEARCH: ENVIRONMENTAL MONITORING AT SCROBY SANDS OFFSHORE WIND FARM SITE

Generic Coastal Process issues and how they fit into the legislation

CEFAS reviews Environmental Impact Assessments to help form the Government Views (GV) for each application for a licence under the Food and Environment Protection Act (FEPA) 1985. One part of this review is evaluation of coastal processes and how they are affected by any structure in the environment, including offshore wind farm (OWF) applications. CEFAS also advises on the fieldwork plan and statistical analyses through a pro-active approach.

All applications are considered on a site by site basis taking account of the coastal processes that are likely to operate in the particular area and whether the structure is likely to cause changes to sediment transport patterns, rates and pathways or affect re-suspension rates.

Impacts during the construction phase

Coastal processes my be affected by various aspects of the construction, including cable laying and driving in of monopiles. The installation/support vessels may also cause sediment re-suspension due to propeller wash. Some of the sites are very shallow (8 or 9 metres water depth), so a vessel with a 4 or 5 m deep hull may also cause re-suspension due to “ducting” of the tide underneath.

Impacts during operation

Additional acceleration of the currents around the monopiles re-suspends sediment material to create large pits called scour pits. The dynamics of these pits (size, shape, mobility) needs to be assessed as does potential for remediation. Scour pits are exacerbated by waves and there is a non linear interaction between the two so a small increase in waves produces a huge increase in sediment transport. This will cause pits to be generated very quickly but they will decrease again when the storm has passed. Predictions at Scroby Sands indicate that some of these pits can be up to 5m deep.

The structures may have an impact on the tide and wave regime (e.g. tidal shadow affects, wave interference patterns). Re-mobilisation of potentially contaminated sediments into the water column may also be a problem, especially in the muddier areas such as the Irish Sea. Consideration also needs to be given to the impact of potential changes in sediment type and mobility on the benthos (moving towards an Ecosystem approach).

On a larger scale, geomorphological changes within the coastal line and near-shore need to be considered. Many wind farm sites are quite close to beaches where there is a large flood defence problem. This is the case in the Scroby Sands area, where considerable expenditure is required each year to protect the beach frontage.

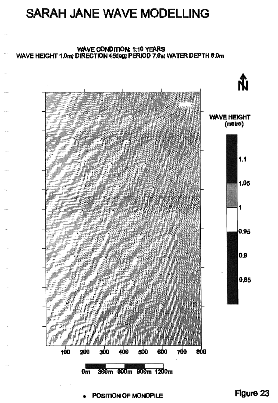
Scroby Sands

There were a number of reasons for the monitoring of the Scroby Sand offshore wind farm site. The numerical modelling within the EIA had raised concerns about the possible wave inference patterns generated from the monopiles. These cause “Newton’s rings” where “constructive and deconstructive” interference from individual waves produces larger waves in some areas and smaller ones in others. This impacts on the sediment transport regime and could produce localised areas with alternatively high degree of scour or build-up (construction and deconstruction). This alteration in sediment transport could have an impact on coastal defences.

The Scroby Site was close to the coast and identified as a “worst case” scenario in an ABPmer report on wind farms for ETSU. There was also a lack of calibration data for numerical models on the top of sandbanks where the dynamics are of particular concern. This is a very harsh environment in terms of the current regime with tides alone up to 120 cm/s over 2 or 3 hours and moderate waves (4-5m over 50 years return).

Tools and techniques

Wave diffraction modelling



The figure opposite shows some of the wave modelling data from the EIA for the Scroby Sands wind farm. The monopiles are near the top and the dark and light bands are the “constructive and deconstructive” interference along the wake of the monopile.

Note the oblique angle of incidence. The interference pattern is likely to be even more highly developed under a “moderate event” (1:10 yr storm)

Source: Halcrow ES, Vol 8, Fig 23 (Powergen Renewables Offshore Wind Ltd).

Fieldwork programme

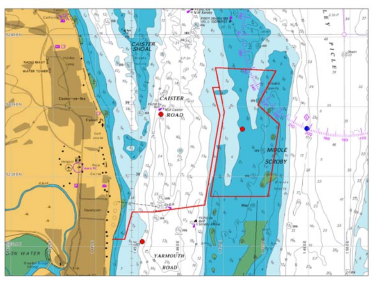
Three major field work campaigns are planned. There will also be regular sidescan sonar and bathymetric surveys.

The first campaign was completed in April/May 2003. In-situ suspended sediment surveys will be undertaken during construction of the monopiles, which is scheduled for October 2003. Construction of the towers, turbines, blades and cabling is due to start in April 2004. The second main fieldwork campaign is planned during the wave season in December 2003/January 2004 as this when the potential impact in terms of sediment transport is likely to be apparent. The follow-up fieldwork will be post-construction in summer 2004.

Instrumentation

The following instrumentation was used at Scroby Sands:

- CEFAS MiniLander
- Sidescan sonar
- X-band radar



In the chart opposite, the wind farm is shown in red with the cable running ashore at Great Yarmouth on the East coast.

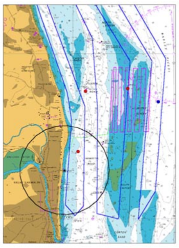
Four CEFAS MiniLanders were deployed – one offshore as a control site, one on top of the bank, one at Caister Bank area and one near to Yarmouth as a natural calibration device for the x-band radar.

CEFAS MiniLander

Instrumentation:

- CEFAS ESM2 Burst logger -Suspended sediment sensors (2 x OBS), temp and conductivity
- FSI current meter
- Upward Looking ADCP
- Passive Sediment trap (Booner tube)

X-band radar



This measures wave height and period. It only has a range of about $2^1/_2$ km. As the modelling showed that the most sensitive direction is when the waves are from the north east, the best place for the radar was determined to be the tower at the end of Yarmouth pier.

Initial Results from April 2002 survey

The figure opposite is from a bathymetric survey. The ridge in the centre is Scroby Bank and the red dots are the proposed monopile locations. An interesting feature is the scour hollows associated with charted wrecks, the size of which indicate that scour holes are something that we will need to be very careful about and monitored with a view to remediation.

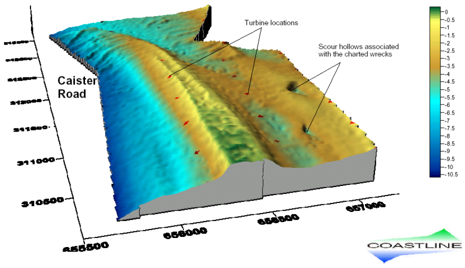


Figure 1: Scroby Sands April 2002 rendered surface image. Depths to Chart Datum. Positions to OSGB36.

The photograph opposite (courtesy of PowerGen) is from a photographic survey for seals in the area.

This view of the bed-forms will be a very useful baseline when it comes to looking at direct impacts of the construction.

Outputs

Monitoring of the coastal processes around Scroby OWF will identify if any significant changes can be linked with the OWF in terms of the morphology, bed-forms/sediment patterns and wave climate.

Quantification of the wave and current regime on top of the sandbanks will enable better calibration of numerical models and sedimentological disturbance due to construction. The data will be made available to all of the developers via a website.

Future scale of wind farms

The second round of offshore wind farm applications in the UK will potentially impact on significantly larger areas. These have not been traditionally monitored for coastal processes as they have little impact on coastal defence (e.g. the Southern North Sea Sediment Transport Study only went 10 km off the coast) so there is little information on which to base assessments. Large scale sediment transport patterns in these areas are not known and individual monitoring schemes will have to be placed into the correct spatial/temporal context.

Finally, developers should be encouraged to install environmental monitoring packages on all wind farms in future in order to improve our knowledge in some of these areas.

Compiled by:	More information:	Presented by Jon Rees
- Jon Rees: Centre for Environment, Fisheries and Aquaculture Science, UK	www.cefas.co.uk	

7. CURRENT RESEARCH: COWRIE PROJECT UPDATE

COWRIE (Collaborative Offshore Wind Research Into Environment)

As part of the pre-qualification process for Crown Estate agreement to lease, all of the developers in Round 1 were required to put down a deposit of £300,000 as an incentive to get them moving on the consenting process. This refundable deposit was put into a separate trust fund and the interest accruing is creating the fund for the COWRIE steering group to administer.

The COWRIE group is made up of a range of experts all of whom are involved in the Round 1 consenting process. It includes English Nature, CCW, CEFAS, RSPB, JNCC, DTI, industry and the British Wind Energy Association. The aim of the COWRIE steering group was to identify generic environmental research requirements in order to fill gaps and uncertainties in our knowledge about the potential impact of offshore wind farm development.

The terms of reference of the steering group were to:

1. Develop and implement a programme of short to medium term generic studies that would produce an early outcome and deliverables
2. Identify site-based studies that related to the industry as a whole (i.e. it must be possible to demonstrate that the study did not advantage any individual developer)
3. Develop monitoring tools and best practice
4. Make reports and outcomes widely accessible. This is being done via a COWRIE section on the Crown Estates website.

The fund currently stands at about £400,000.

Priority Generic Issues

The group came up with a “wish list” of issues for consideration. From this, four priority generic projects were identified and offered to a preferred tender list. The projects are described below.

1. Potential impact of electromagnetic fields on fish from the cabling associated with wind farms

Contractor: Centre for Marine and Coastal Studies, Liverpool University

Completion date: July 2003

Outline:
- Desk based study and calculations
- Modelling, ground truthing

Outputs:
- Stage 1 technical report
- guidance on mitigation measures

This was the shortest of the four projects and has already reported (a copy of the report was provided to all delegates). It is also on the COWRIE section of The Crown Estate web-site. The aim of the project was to build on a previous study that was commissioned by CCW. It was considered necessary to go back to the physics of generation of electromagnetic fields from cables. Much of the project was therefore desk-based study, with an element of modelling and ground-truthing. It looked at cabeling issues in terms of the 33 kvolt and 132 kvolt cables. The project came up with a number of conclusions regarding some of the technical issues. It also considered possible mitigation, such as the benefits of burial at certain depths as well as conditions of perfect shielding of the cables themselves. However, further work is needed, particularly into the biological aspects of the electromagnetic fields.

2. Displacement of common scoter (*Melanitta nigra*) from benthic feeding areas

Contractor: School of Ocean Sciences, Bangor University

Completion date: June 2005

Outline:
- Modelling effects due to habitat loss and change
- Link non-breeding distribution with environmental variables
- Identify characteristics of preferred feeding areas

Outputs:
- Interim reports
- predictive model and guidance

This was seen as a high priority as there were significant gaps in our knowledge about the potential impact of wind farms in terms of displacement and loss of habitat. It was particularly relevant to the proposed wind farms in the North West where there are significant numbers of common scoter. The aims of the project are to model effects due to habitat loss and change, link non-breeding distribution with environmental variables and identify characteristics of preferred feeding areas. The main outputs will be a predictive model and guidance. The project, which has just started, is not due for completion until June 2005, but there will be an interim report that will be made available on the website. Because the research is funded by industry it is important that the guidance produced by this research goes back to the industry to help inform them as well as the regulatory bodies.

3. Comparison of bird survey methodologies

Contractor: NIOZ

Completion date: December 2003

Outline:
- Comparisons of variety of techniques
- Design standardised methodologies incl. recording parameters and correction factors

Output:
- one-stop guidance
- pre-workshop report available on The Crown Estate website

The aim of this project is to produce a one-stop guidance document on bird survey methodology. This will be done by a two-stage approach. The first is a desk study and workshop. The workshop, which will be attended by all of the key people in terms of bird survey methodology is to be held at Aberdeen University on 24 November 2003. It will be informed by a pre-workshop report which has already been produced by NIOZ. The aim of the workshop is to compare of variety of techniques and then come up with a consensus in terms of guidance on methodological approaches to bird surveys. These will be used to design standardised methodologies, including recording parameters and correction factors. Its conclusions will be written up and disseminated very quickly. This is important as announcement of Round 2 is due at the beginning of December and, once developers have been awarded sites they will be eager to get on with their environmental assessments. The second stage of the project will be co-ordinated field testing (mainly boat based) determined by the outcome of stage 1.

4. Impacts of subsea noise and vibration on marine life as a result of the turbines from construction through to operation

Contractor: Subacoustech Ltd.

Outline:

- Desk based study and site measurements
- Determine hearing spectra and sensitivity to noise and vibration
- Determine sound pressure level and frequency spectrum during phases of wind farm project

This project was able to start before drilling and piling began on the North Hoyle wind farm site. This enabled them to undertake baseline surveys then monitor noise during the drilling phase and piling phases. They will then carry on these studies during the operational phase. There will also be studies at other sites, including operational noise measurements at Blyth on the Northumberland coast.

Round 2

Developers have already provided co-ordinates of the sites that they will be bidding for. This is still confidential information but it is clear that there is a significant amount of interest for Round 2 sites. Deadline for the tender process is 15th October 2003. It will be run in a very different way to Round 1 where developers came forward with their proposed sites and had to pre qualify under different procedures, whereas Round 2 sites will be awarded through competitive tender.

Crown Estates are very aware of the potential loss of data generated by developers undertaking their EIAs so, as part of the leasing arrangement in Round 2, they are making it a leasing requirement that developers will provide all their data to the Crown Estates. The aim is to make the data much more accessible in order to avoid duplication as well as filling in gaps and uncertainties. Crown Estates will also encourage the data to be given to national databases as it very apparent that in Round 1 none of the data were being handed over.

There will be non-refundable option fees for Round 2 that are potentially going to generate a significant amount of money. On the basis of what has been done with the COWRIE trust fund, Round 2 will also have a separate trust fund that will be made up of the option fees themselves. In this case, the fees that the developers pay will be in relation to the scale of the development. It will be similar to COWRIE but will potentially be much larger and will be put towards research, education and particularly data conservation.

Compiled by:	More information:	Presented by Carolyn Heeps
- Carolyn Heeps: UK Crown Estates Commissioners Chair of COWRIE Steering Group	www.crownestate.co.uk/ estates/marine/windfarms/	

8. Current Research: Bio-Wind.

Bio-Wind

Bio-Wind is a project founded by the Swedish Energy Agency to study the impact of wind farms in the Baltic Sea and Kattegat on the marine biodiversity.

In Sweden there are three small (5-10 turbines) wind farm sites in the Central Baltic Sea.

- The Outer Shoal Strait of Kalmar
- The Goat Track Gotland (the oldest park in the Central Baltic Sea)
- The Outer Stone Shoal Blekinge

The central Baltic Sea is a unique environment both in time and space. The basin is very cold, brackish (7 ‰ S) and completely tideless. As a result, the species diversity is very low (5 - 10 % of that in the Atlantic) with a mix of marine and fresh water species. It is therefore impossible to extrapolate data from the North Sea to the Baltic Sea.

Due to lack of predation and competition, the natural communities are dominated by a few very abundant species such as blue mussels and bladderwrack.

The aims of the project are to determine:

How will artificial structures in a temperate environment, particularly the brackish Baltic Sea, change the natural community structure, and species composition?

How can the submarine parts of the windmills be designed to favour the establishment of perennial macro algae such as bladder wrack and Furcellaria.

Experimental design

To determine the effect of different substrates, samples (e.g. sandstone, limestone) were attached, both horizontally and vertically, to road blocks. These were then placed at key sites in the Baltic. This experiment started in May 2003 and will last for two years.

Settlement on existing wind farm monopiles, which are made of smooth steel, is also being investigated. Preliminary results show that there is a dominance of benthic animals and very little algal growth. The monopiles rapidly become covered by blue mussels and little else. As the mussels grow, they fall to the sea bed and dominance gradually changes from algae to blue mussels.

Contrary to the expectation that noise and vibration might scare fish, this study showed that the bridge pillars and monopiles actually attract fish, especially two-spotted goby *Gobiusculus flavescens*. Common gobies are also found at the base of the pillars.

Future studies

There is a proposed development at Klasådern, Gotland Central Baltic Proper. This will consist of sixteen 3.5 MW turbines, four Km from land. It will have gravity footings in 12-6 m depth on a hard bottom of smooth limestone.

The aim of the proposed study is to investigate how wind farms in the Baltic Sea may act as artificial reefs. The study will be carried out simultaneously on three different levels:

- Micro level: Colonisation rate on the footing, manipulation of the surface structure (benthic animals and algae)
- Meso level: Effects of each structure on the site, manipulation of the erosion and ballast rocks surrounding the structures (benthic animals and algae, stationary fish species, mainly different gobids)
- Macro level: Effect of the whole farm on the ecosystem, interactions between the single windmills (mainly pelagic fish species such as herring and cod)

The results of these studies will mainly be disseminated in scientific papers.

Compiled by:	More information:	Presented by Torleif Malm
- Torleif Malm: Department of Botany, University of Stockholm **- Jörgen Hansen** and **- Jens K. Petersen:** Danish National Environmental Research Institute		

9. Overview of current and proposed research in the Netherlands

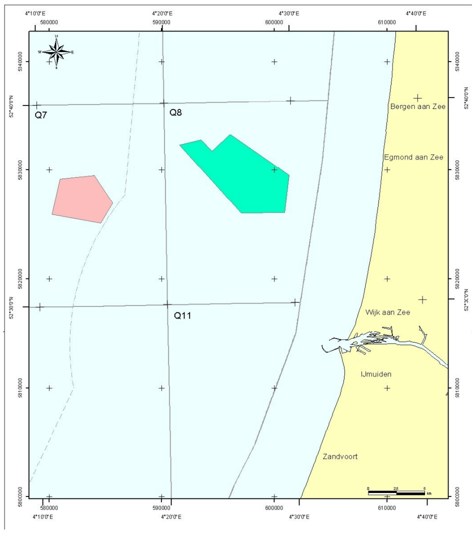
Present situation

The current situation in the Netherlands is shown in the map opposite.

The green area is the Near Shore Wind Farm, which is a demonstration project initiated by Government. It will be about 8km offshore with 36 turbines producing 99 MW. There is an extensive monitoring and evaluation programme (MEP).

The red area is the Q7-Wind Farm, a private initiative. This will be about 23 km offshore and have 60 turbines producing 120 MW. The EIA was followed by a small monitoring programme.

No wind farms have yet been built in the Netherlands.



Monitoring programmes

The Near Shore Wind Farm has a very extensive monitoring programme. This has been put together by several parties, including NGOs and research institutes. It is being conducted by the Institute for Coastal and Marine Management and the Ministry of Economic Affairs. It covers the following:

- Birds: collision risk, flight patterns and intensity, disruption of habitat/foraging area, barrier effect
- Impact of underwater noise on mammals and fish
- Variation and density of sub-aquatic habitat and refuge function
- Morphological changes
- Direct consequences for fisheries
- Landscape valuation
- Risks to shipping
- Consequences for mining

Full details are on the website.

Current research

No wind farms have been built yet but baseline studies are being carried out on:
- Benthos: boxcore samples and epifauna trawls
- Demersal fish fauna: beam trawl hauls
- Pelagic fish fauna: acoustic surveys and trawl hauls
- Sea mammals: T-pods, hydrophones and visuals
- Birds: radar studies and boat transect counts

There are also generic studies on:
- direct effects on fishery - economics of closure of wind farm area to fishing
- possibilities for monitoring bird collisions at sea

Topics for discussion

- A great deal of research is needed to help answer questions but budgets are limited so how do you prioritise? If you have more parks in the future and everybody has to do research because their permit obliges them to, do you need everyone to do the same research or do you divide it up so that everyone can benefit from the results? Can we learn from the COWRIE model?

- Opportunities for learning from each other. Planning starts now but results have still to come.

- How do you cope with mitigation and compensation?

"How can we use each others' results and how can we do it now? Planning starts now and we are being asked questions – "how do we do this, how do we do that?" We don't have answers yet but we we do have to make choices already. What are the right choices – its really hard."

Compiled by:	More information:	Presented by Mariska Harte
- Mariska Harte: Netherlands National Institute for Coastal and Marine Management, MINVENW **- Saskia van Gool:** North Sea Directorate, MINVENW **- Walter van den Wittenboer:** Novem	www.offshorewind.nl	

10. Offshore Wind Energy Research Projects in Germany

The Future Investment Programme (ZIP) includes a research programme for ecological research on offshore wind parks, the timeframe is 2001-2003 and the budget is € 4.2 Million for the following projects:

MINOS

LA fur den Nat. Park SH Wattenmeer

The most clearly formulated objection to offshore wind parks is the effects they might have on birdlife and marine mammals. The harbour porpoise (*Phocoena phocoena*), common seal (*Phoca vitulina*), grey seal (*Halichoerus grypus*) and the birds roosting in the offshore area are thus at the centre of the investigations in the interdisciplinary "MINOS" project. The project will supply information on the populations of birds and marine mammals in the offshore area including:

- their population size,
- their temporal-spatial pattern of utilisation,
- their reactions to the effects of noise pollution.

www.minos-info-de

BEOFINO

Alfred Wegener Institut (AWI)

The main focus of this project is to investigate possible impacts of future offshore wind turbines on the marine environment and to develop methods and criteria for the evaluation of such impacts. The following aspects will be considered:

- Impact of the wind turbines on birds migration and collision risk of birds with the turbines
- Impact of the wind turbines on the benthic community
- Impact of electro-magnetic fields on marine organisms.

www.io-warnemuende.de/projects/beofino/beofino_de.htm

EIA, SEA, EA Habitat Directive

TU Berlin

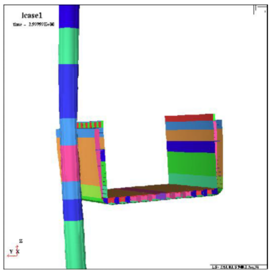
The competing forms of use of resources have to be considered within the licensing procedure according to the "Offshore Installations Ordinance" applied in the "Exclusive Economic Zone" (EEZ). The project deals with:

- the adaption of Environmental Impact Assessment (EIA), guidance for the application of EIA within the licensing procedure is completed
- Assessment according to Habitats Directive, guidance
- and future Strategic Environmental Assessment (SEA) to the special conditions existing in the EEZ.
- Discussion platform

http://www.tu-berlin.de/fb7/ile/fg_lbp/index.htm

Simulation of ship collision with foundation types of wind energy constructions

TU Hamburg Harburg



This project deals with principle questions on calculation of collisions between ships and offshore wind energy converters. Numerical simulations, based on the non-linear finite element method for different situations, will be prepared.

www.tu-harburg.de/skf/forschung/windenergie.html

Noise emission and hearing abilities

DEWI, University of Hanover, ITAP

Noise in the water induced by offshore wind turbines can affect fish and marine mammals. Mathematical and physical models are developed to calculate the noise reflection of the structures and the propagation of the noise in the water. Measurements of the noise induced of onshore-wind turbines and offshore-wind turbines will be carried out. The background noise at two points in the North Sea and at one point in the Baltic Sea near the platforms will be measured. The result of research will show methods of measurements and calculations in a standard. Then it will be possible to make a prognosis of the noise induced of an offshore-wind turbine in the design phase.

http://www.cri.uni-hannover.de

Development of criteria to identify nature protection areas for birds

Schreiber Umweltplanung

The project addresses derivation of scientific criteria for selection of Special Protection Areas (SPA) according to Article 4 of the Birds Directive and proposed Sites of Community Interest (pSCI) under Article 4 of the Habitats Directive. To determine criteria for designating sites in the German EEZ, the directives themselves, appropriate judgements of the European Court of Justice and examples of good practice from other countries and others (e.g. NGOs) will be analysed. This includes a list of bird species, habitats and species of Annex II, which have to be protected under the Birds and Habitats Directive respectively.

Further investigations will deal with the definition of concentrations and how to draw boundaries, if there are no firm structures to be leaned on. All scientific results shall be checked for their legal evidence.

Measurement Platforms

- North Sea platform installed August 2003
  - 80m high mast
  - crane
  - radar
- Baltic Sea platform planned for 2004/2005
- Proposed platform near Sylt in co-operation with project development companies

Suggestions for use of these platforms for research, including integration with other countries programmes would be welcome.

www.fino-offshore.de

GRID Connection

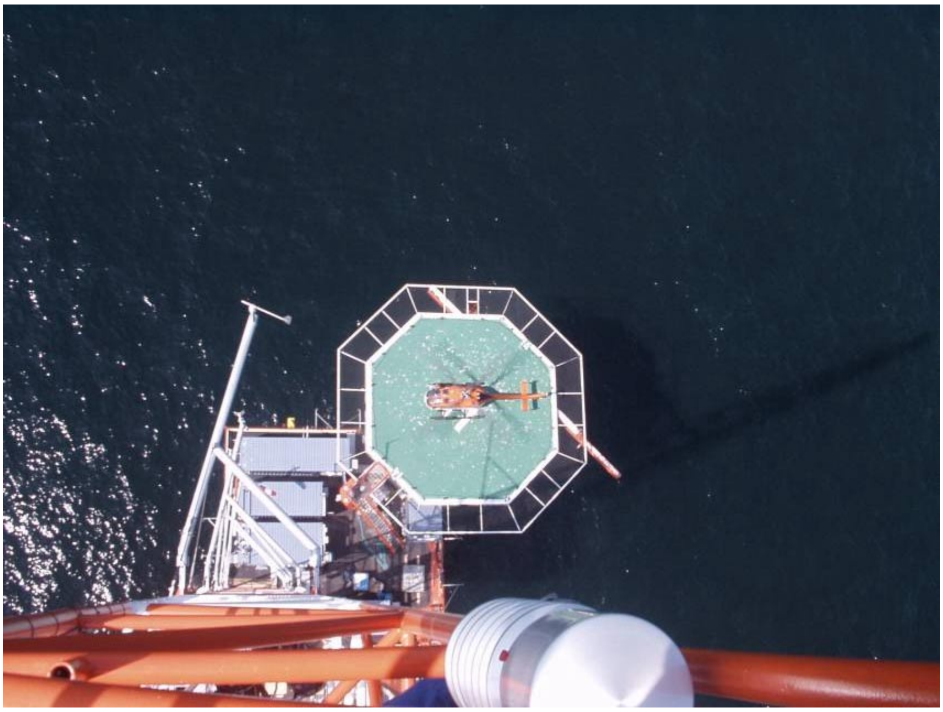
Schreiber Umweltplanung / Deutsche WindGuard

A general strategy is necessary for the grid connection of total offshore wind capacity and the reinforcement of the grid. Within the scope of the project an analysis of the effects on ecology by connecting offshore wind capacity to the grid and by the reinforcement of the grid has to be made. Technical solutions of grid connection and reinforcement will be analysed and measures to reduce effects on ecology will be proposed

Other research projects:

In addition to the ZIP projects there is:

- Research by BfN (Federal Agency for Nature Conservation)
- Research by UBA (Federal Environment Agency), including investigations to avoid and reduce possible impacts of wind energy parks on the marine environment in the offshore areas of North and Baltic Sea. Final report was recently published in German (but will be translated into English).



Outlook:

The German government plans a continuous research programme for offshore wind energy in the coming years. The budget will not be finalised until the end of 2003. These decisions will help to continue the ambitious research that was initiated and will contribute to fill in the existing gaps in knowledge about offshore wind energy and the marine environment.

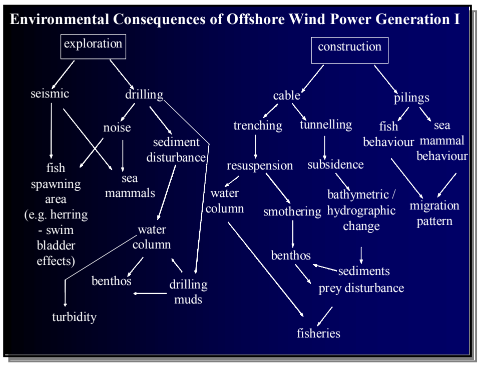
Compiled by:	More information:	Presented by Cornelia Viertl
- Cornelia Viertl: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety	www.bmu.de www.offshore-wind.de www.gigawind.de www.bine-info.de www.offshorewindenergy.org (COD-Project)	

11. Monitoring the Environmental Impacts of Offshore Wind Farms (1)

Construction phase

As the "horrendogram" opposite shows, we have a good *conceptual* knowledge of what wind farm construction does.

We are also starting to get background information about what actually happens during the construction phase. Practical experience in Danish waters indicates that destruction of habitats will amount to a very small area or percentage of the total construction area. Damaged vegetation and fauna will recover within few years.



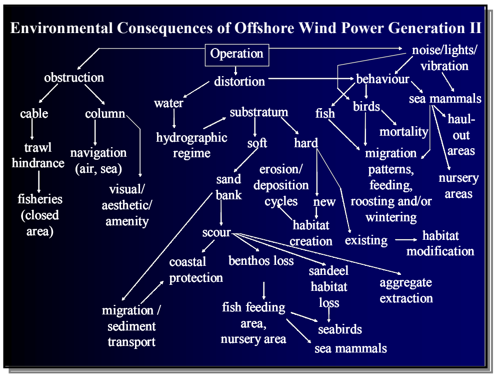
The key aspects of monitoring programmes for this phase are:

- Endangered or protected species
- Ecosystem key organisms
- The need to take account of potential fouling organisms in design of the survey

Operation phase

We also have a good *conceptual* knowledge of what happens during windfarm operation.

Although we have no practical experience so far, we know about the potential impacts:



Scour protection and towers will create hard substrata and thus act as artificial reefs

Production on these reefs will create organic material that will act as organic enrichment

Decision Tree to Assess the Effects of Offshore Wind Power – Exploration and Operation - Assumptions:

Separate
"what is nice to know"
from
"what is needed to know"

We can start by looking at the information that we do have to see how we make decisions about monitoring.

For instance, there is no need to be too concerned about water quality, nutrients, dispersal and chemical behaviour of additives, solubility, sequestration and re-liberation of contaminants, behaviour of pollutants in the organisms, micro-features of water surface, direct or secondary toxic effects.

We should, instead, concentrate on effects that we do need information on. This will include physical pollution and additives, effects on the coastal and offshore system rather than estuarine habitats and on bottom-up physical processes as a means to protecting the top-down biological responses (see Horrendogram).

We need to assess the impact of an activity in an area, including the near-field and far-field effects. We should also consider the impact of associated prohibition (e.g. beam trawling).

Aim: description, prediction, reduction

Level 1 Decisions to provide knowledge, information and data of:

Decision 1- Behaviour/characteristics of the open coastal system, especially the physical/chemical nature of system - hydrography, topography, bathymetry;

Decision 2 - Physical behaviour of particulate (re-suspended sediments) and physical additives (cabling, monopile) to system;

Decision 3 - Behaviour/characteristics of the activity in the environment - barrier to flow of materials and biota, disruption and processes

Decision 4 - Habitat at risk from modification or materials addition - water column, water-substratum interface, sediment, supralittoral, intertidal, circalittoral, infralittoral, shelf;

Decision 5 - Inert or biologically effective action (after modification in or of habitat);

Decision 6 - Biotic and non-biotic component(s) at risk - phytoplankton, zooplankton, pelagic nekton, demersal nekton, hyperbenthos, epifauna, infauna, macroalgae, sea mammals, seabirds;

Decision 7 - Structure & functioning of biological system - community response;

One of the problems in marine monitoring is the inherent variability of all of the above leading to a large 'signal to noise' ratio. This causes difficulties in predicting and quantifying of effects in order to answer scientific questions. It is also difficult to demonstrate any reduction or removal of effect in order to answer socio-economic or political questions.

How do we detect significant change (in statistical or ecological or social terms)?

Level 2 Monitoring Definition (what sort of monitoring do we need to do?)

Statutory Monitoring ⇒ is monitoring required and if so, who should do it;

Uses/users at risk/of interest ⇒ where is the demand for monitoring, why to do monitoring ⇒ matrix of impingement on different users/uses;

Detail of monitoring is required ⇒ subjective/qualitative/skilled eye *vs.* fully quantitative, statistically rigorous;

Components at risk ⇒ what to be monitored ⇒what methods to be used;

Spatial extent ⇒ area to be monitored ⇒ define station positions, strata to be sampled; station positions with regard to hydrographic characteristics;

Duration ⇒ temporal component, ⇒ length of campaign, window of opportunity;

Degree of change expected/tolerated ⇒ number of samples, degree of replication;

In other marine activities we often talk about the area of impact or “footprint of effect”. We are not yet in a position to do this for offshore wind farms.

Level 3 Types of Survey Required/Desired

- background surveillance
- condition monitoring
- compliance monitoring (reliant on standards)
- impact determination:
- exploratory (scanning, desk study)
- baseline (large coverage, define problem area)
- ongoing survey (statistically robust)
- BACI (Before-After-Control-Impact) PS (Paired Series)
- replication *vs.* pseudoreplication

Level 4 Associated Parameters/Integrated Monitoring

- physical monitoring
- chemical monitoring
- community biology (*)
- ecotoxicological/individual health
- socio-economic aspects

(* Component: (hard benthos, soft benthos, hyperbenthos, nekton, plankton, birds, mammals, etc.) singly or in combination)

Attributes for the diagnosis of ecosystem pathology:
⇒ 7 indicators for general application

- primary production
- nutrients (fate & effects)
- species diversity (abiotic areas)
- community instability (biotic composition)
- size and biomass spectrum
- disease/anomaly prevalence
- contaminant uptake and response

Level 5 Methods to be Used in Monitoring

- assess degree of potential change
- define component(s) of interest
- premise - the greater the actual or potential changes then the more detailed the methods to be used (and *vice versa*)

Extent of Impact

Temporal severity (longevity/duration):
- instantaneous
- short-lived (hours-weeks)
- intermediate (weeks-months)
- long-lived (years-decades)
- ‘infinite’ (centuries/millennia)

Spatial severity (area affected):
- local/district
- regional
- national (intra-boundary)
- international (transboundary)
- intercontinental
- global

5 spatial levels of study

- Microscale: composition and roughness of the foundations/pilings
- Mesoscale: material, size and arrangement of scour protection
- Macroscale: heterogenity within the park

- Megascale: wider scale heterogeneity
- Metascale: European integration of data and knowledge

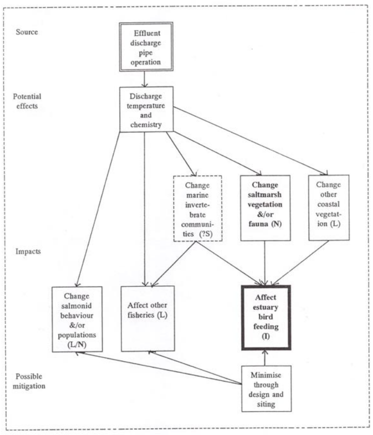
This also applies to temporal scale.

EIA – Quantification of change (spatial extent and temporal duration)

We have good background protocols for monitoring and determining impact assessment which could be applied to wind farm monitoring. The example in the table below show how information can be obtained, reduced to a series of blobs and used to convey information to the managers.

TABLE 1. IMPACT SCALES							
TYPE OF EFFECT		IMPORTANCE OF ECOLOGICAL ELEMENT#					
		I	N	R	D	L	Nil
NEGATIVE	Irreversible in long term	●●●●●●	●●●●●	●●●●	●●●	●●	0
	Reversible in long term	●●●●●	●●●●	●●●	●●	●	0
	Reversible in short term	●●●●	●●●	●●	●	0	0
NO KNOWN IMPACT		-	-	-	-	-	-
POSITIVE	Short-term benefit	□□□□	□□□	□□	□	0	0
	Long-term benefit	□□□□□	□□□□	□□□	□□	□	0

(International); N (National); R (Regional); D (District); L (Division/Parish); Nil (no known value)



Potential impact scenarios:
e.g. Effluent Dispersal Pipeline Operation (Solway estuary)

The table below (EIA – Objective Impact Quantification, e.g. EDP Solway Estuary) is an example of how you can work out the importance of a biological or physical element and then determine the likelyhood of a change to that element.

TABLE 4 EDP. POST-MITIGATION IMPACTS AT NEWBIE.											
Source of impact			Impact "target"			Nature of impact					Signif.
Element	Activity	Aspect	Comp-onent	Potential size of target	Intrinsic ecol. value	(-)ve irrev.	(-)ve long term	(-)ve short term	(+)ve long term	(+)ve short term	
EDP	Construction	Excavation	Mussel bed	0.5 ha	Nil	X					0
			Fish	small nos	L			X			0
			Birds (1)	1.0% UK	N			X			●●●
			Birds (2)	0.8% UK	R			X			●●
		Noise/activity	Birds (1)	1.0%UK	N			X			●●●
			Birds (2)	0.8% UK	R			X			●●
		Dust #	Marine inverts								
			Fish								
			Birds (1)								
			Birds (2)								

Birds (1): Bird community of affected area (Annan foreshore). Birds (2): Oystercatcher on Annan foreshore.

Impact of dust not considered in this example

Main Points

Once we have worked out how big a change we are trying to determine, then monitoring is easy

- co-ordinated sequence of biological and physical sampling – hypothesis based monitoring;
- stratified random sampling (SRS) ⇒ spatial extrapolation to whole area;

- detailed statistical analysis (univariate and multivariate) against control/reference sites;
- quantify site-specific natural factors (e.g. sediment type, wave action);
- acknowledge area-wide natural factors (e.g. temperature);
- true monitoring required rather than surveillance;
- survey designs for each component are available;
- determine the end points of the monitoring and the actions to be taken;
  - number of samples per site depending on site complexity (homogeneous sites require fewer samples);
  - use of power analysis to indicate degree of replication required (Premise - that the effect of interest will be detected if it is $\geq$ natural (or unexplained) variation);
  - separate different sources of variability.

Interannual Variability vs. Spatial Variability

Problem #1 - Reliance on historical or baseline reference may prevent detection of impacts due to interannual variability;

Problem #2 - interannual variability differs with habitat and with large scale climatic changes, e.g. NAO or even winter storms;

Problem #3 - BACI relies on valid temporal changes - if the biological community changes during the impact due to non-impact variables (e.g. storms) then this invalidates comparisons;

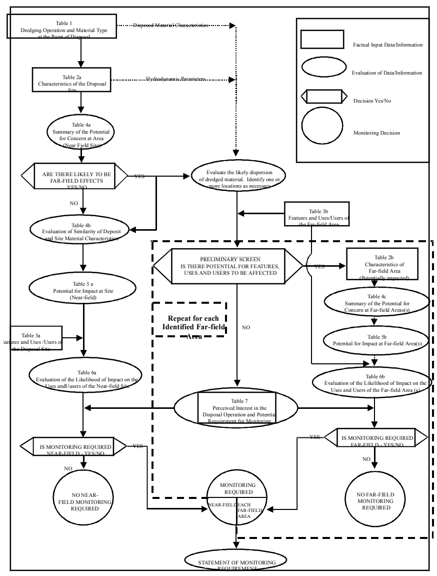
Solution – do not rely on historical data.

Aim: Detection of no statistical significant difference with reference sites

Problem #1 - no long-term pre-construction baseline data available for comparison;
Solution – do not rely on baseline, design it out of the protocol.

Problem #2 – exploration, construction and operation phases will each create different effects;
Solution – separate the different phases.

Problem #3 - no reference site will be in exact synchrony with the ‘ecological trajectory’ of an impacted site;
Solution - need adequate replication to average out potential asynchrony.



Procedure to determine monitoring requirements for the disposal of dredged material at sea – flowchart accompanied by structured tables to indicate the need for and type of monitoring
(CEFAS in press)

A similar approach could be used for wind farms.

Better understanding is urgently needed with regard to:

- Impact of structures on the tide and wave regime at the site and nearshore – tidal shadow affects, wave interference patterns – poorly understood?
- Geomorphological changes of the sandbank and nearshore – poorly understood?
- Re-mobilisation of potentially contaminated sediments into the water column – unimportant?
- Impact of Construction – cable laying, driving monopiles, resuspension due to propeller wash and "ducting" under the installation/support vessels
- Determine ecological footprints of individual monopiles and of wind farm
- Determine construction window in relation to seasonal cycles and potential for recovery
- Impact of potential changes in sediment type and mobility on the benthos (Ecosystem approach)
- Separate the coastal processes from the offshore processes
- Relative importance of structural and functional changes Resilience of the system – what activities are likely to cause an impact and what is the half-life of the impacts?
- How can the monitoring cope with uncertainty, e.g. sandbank mobility?
- Determine effects (-ve and +ve) on carrying capacity of the system
- Importance of habitat destruction vs. habitat creation?
- Separate the 'potential' effects from the 'likely' ones

Background Approaches (reduce wheel-reinventing!):

There is a large background of experience in Europe but this needs pulling together so that it can be built on. For example:

- UK Marine SAC Project for habitat sensitivity and features, e.g. Intertidal Sand and Mudflats & Subtidal Sands Banks (Elliott et al 1998);
- Structured approach to dredging and dredged material disposal monitoring (CEFAS in press);
- Various benthic methodologies (NMMP, ICES, etc.);
- Existing methods in other countries (D, DK, NL, UK);

Generic approaches should have priority over site-specific ones.

Other Considerations:

- Recognise the need to transfer information and knowledge from detailed technical measurements through to more general assessment and management
- Understand the physics of the system before understand the in-situ biology and sedimentology
- Separate the ecologically-important ecological changes from the socially-important ecological ones (i.e. the charismatic megafauna)
- Is there the demand/acceptance for hypothesis-driven, fully statistically rigorous monitoring?
- Create generic and site-specific indicators of cause and effect

Indicators

True monitoring (as opposed to surveillance) has an end-point in that you are trying to pick up an agreed amount change. That agreed amount of change is an indicator.

DPSIR Approach (Elliott, 2002)

Driving forces (human activities and economic sectors responsible for the pressures);
Pressures (particular stressors on the environment in the form of direct pressures such as emissions);
State (environmental variables (geo/physical/chemical/biological) which describe the characteristics and conditions of the coastal zone);
Impact (changes in the ecosystem, resources, human health);
Response (measurement of different policy options as a response to the environmental problems).

Challenge

We should be looking at positive as well as negative effects. For instance use of aerogenerator monopiles as artificial reefs – mitigation, compensation or problem source?

- Introduction/creation of new habitat
- Change (increase?) in species diversity
- Facilitate spread of fouling organisms and invasive species (biological pollution?)
- Recreation or production possibilities

Aerogenerator monopiles as creators of no-take zones and fish/shellfish refuges – mitigation, compensation or problem source?

- Prevention of a deleterious activity
- Creation of new habitat
- Knock-on effects in surrounding area
- Production possibilities

Conclusions

• conceptual basis of change?	• good
• practices/available knowledge/data?	• poor
• why/when monitor?	• getting there
• what/how to monitor?	• easy
• what change expected (qualitative)?	• OK
• what change expected (quantitative)?	• very poor
• Derive Quality Standards for Monitoring?	• realistic?
• Clarity of thought?	• poor

Compiled by:	More information:	Presented by Mike Elliott
- Mike Elliott: Institute of Estuarine and Coastal Studies, University of Hull, UK **- Piers Larcombe:** Centre for Environment, Fisheries and Aquaculture Science, UK - **Jens Kjerulf Petersen:** National Environmental Research Institute, Denmark		

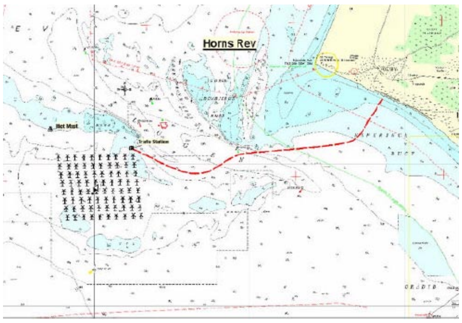
12. MONITORING THE ENVIRONMENTAL IMPACTS OF OFFSHORE WIND FARMS (2)

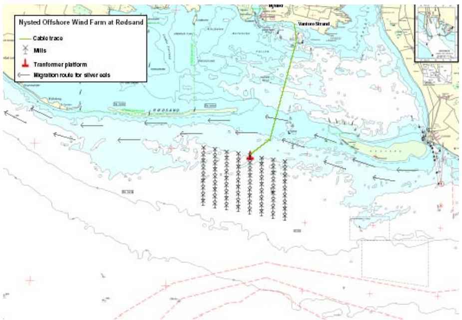
Wind energy in Denmark

The Danish wind energy programme started in 1999. The state provided 10 million Euros for five years to set up measurement and monitoring programmes to investigate the effect on marine ecosystems before, during and after the construction of five demonstration parks. Only two of these parks have been established to date.

Horns Rev
- 80 turbines
- 15-17 km offshore
- already producing electricity

Rødsand, Nysted
- 72 turbines
- just starting to produce electricity)





Offshore wind farms - we need to know:

- Potential areas
- Impact on hydrography/geomorphology
- Impacts on flora and fauna
- Assesment of cumulative impact
- Methods for studying impacts
- Handling of demands made on lighting, etc.

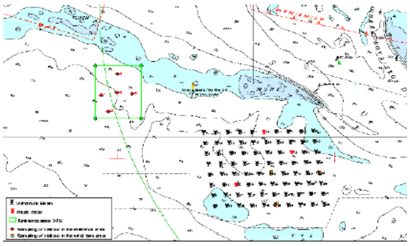
Potentially affected parts of the environment:

- Marine bottom Fauna and Flora
- Fish
- Mammals
  - Seals
  - Harbour Porpoise
- Birds
- Visual and socioeconomic impact

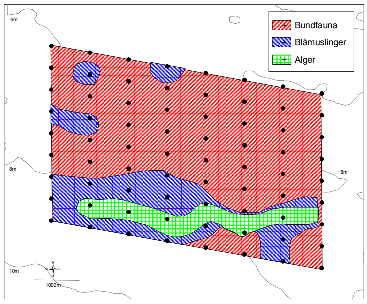
Projects

Subject	Baseline	Monitoring	Research project
Bird • Disturbance/Habitat loss • Risk of collision	HR & Nysted	HR	HR &Nysted Nysted
Mammals: • Seal • Porpoise	HR & Nysted	HR	Nysted
Fish	HR & Nysted	(HR)	Nysted
Benthic invertebrates & plants	HR & Nysted		
Hydrology / Geomorphology	HR & Nysted	Nysted	
Electric & magnetic fields			Nysted
Noise/Vibration	HR & Nysted	(HR)	
Theme project: • Introduktion of hardbottom habitat • Visual and socioeconomic impact of wind farm			HR & Nysted HR & Nysted

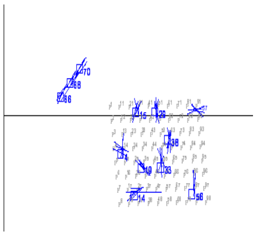
Horns Rev
Study locations for benthic communities



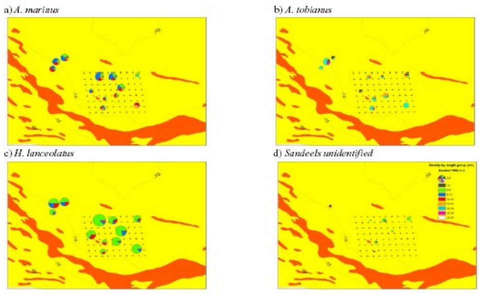
Nysted
Benthic communities



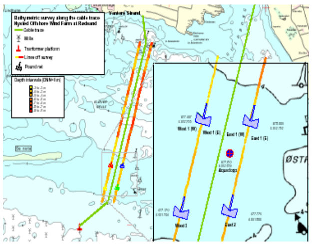
Horns Rev: Sampling of Fish



Average densities of sandeels

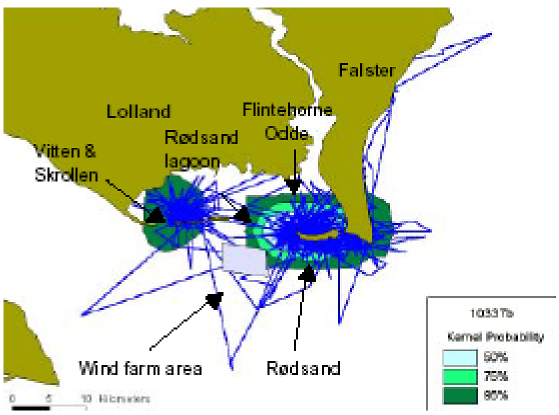


Nysted: Use of pound nets to determine whether electromagnetic fields affect migration routes of "Silver eel"

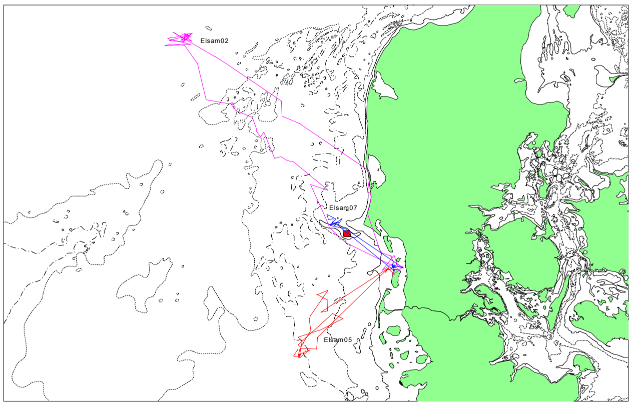


Nysted: Seal sanctuary

Subadult male harbour seal
Home range from 21 April to 22 June
Use of GPS and satellite tracking to determine movements

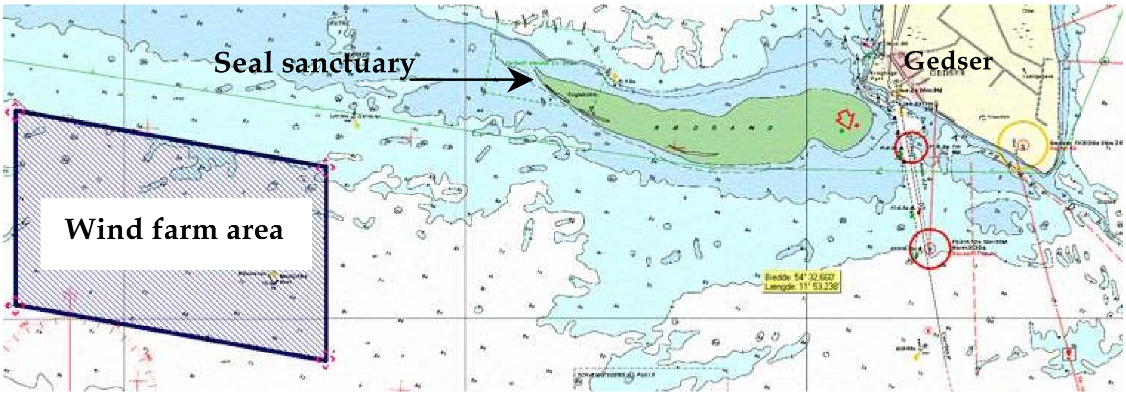


Horns Rev: Results - seals on 18, 15 and 10-days trip:

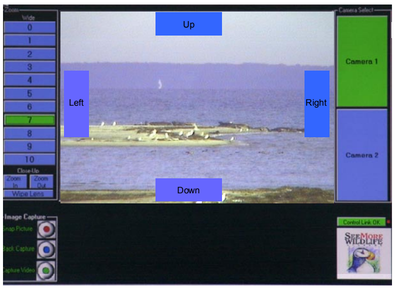


This shows that they did not use the park area very much but swam quickly to the middle of the North Sea to feed for about a week then returned to the beach until hunger forced them out to feed again. This was completely unexpected.

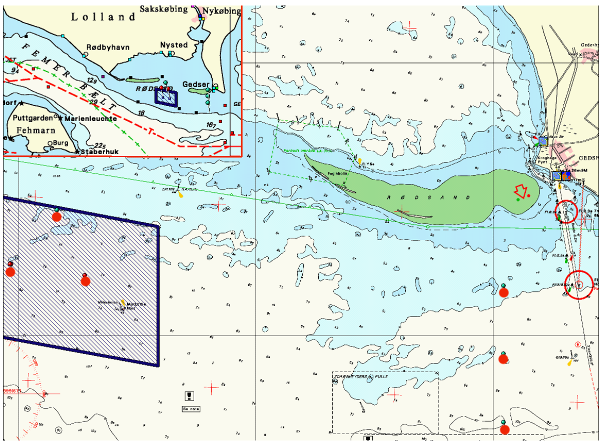
Nysted: The seal sanctuary



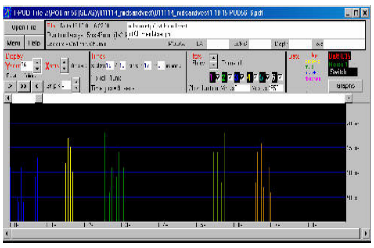
Use of video cameras to follow seals and determine how they react in the sanctuary to the wind farms. The indications are that the construction activities in the wind farm areas is not a major problem.



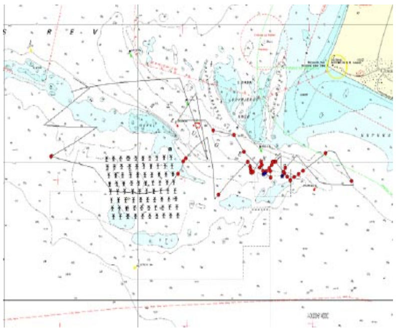
Nysted - Location of T-POD deployments for Harbour porpoises

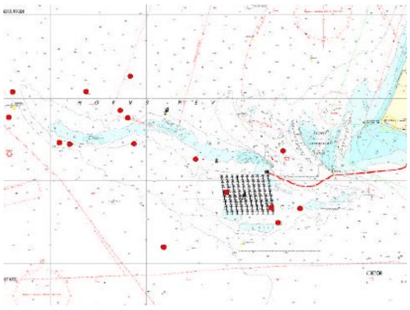


Nysted: snapshot from the T-PODS.exe



Horns Rev: Harbour porpoise survey record 21 April and sighting of calves

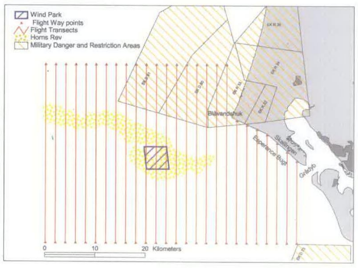




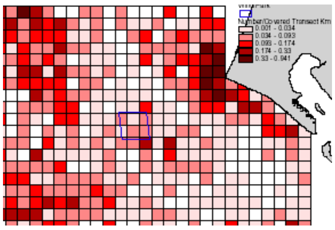
It seems that construction activities are not a major problem as, although they are deterred whilst 'noisy' work is being carried out in the area, they return within 24 hours.

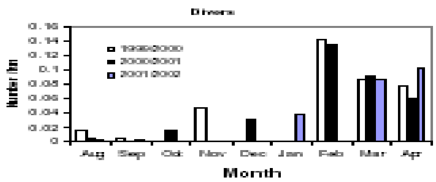
Arial bird surveys: Study area:

18 surveys during August 1999 –April 2002



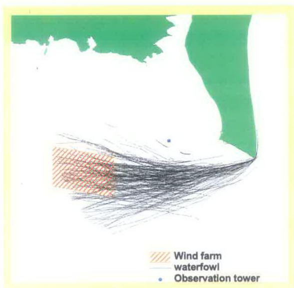
The relative number of divers





Species	Period		Total	WF	WF +2km	WF +4km
Divers	Baseline	1999/00	773	11	32	48
	Baseline	2000/01	504	10	32	45
	Construction	2001/02	322	1	2	12
Gannet	Baseline	1999/00	306	0	6	40
	Baseline	2000/01	136	0	1	5
	Construction	2001/02	12	0	0	0
Arctic/Common Tern	Baseline	1999/00	1,343	9	33	94
	Baseline	2000/01	217	0	3	7
	Construction	2001/02	5	0	0	0
Sandwich Tern	Baseline	1999/00	73	0	5	6
	Baseline	2000/01	298	0	2	2
	Construction	2001/02	54	0	0	1
Alcids	Baseline	1999/00	608	3	15	53
	Baseline	2000/01	334	7	11	33
	Construction	2001/02	207	0	0	0
Eider	Baseline	1999/00	3,331	1	1	1
	Baseline	2000/01	8,441	0	0	0
	Construction	2001/02	1,349	0	0	0
Common Scoter	Baseline	1999/00	41,158	4	9	55
	Baseline	2000/01	52,165	513	3,089	10,369
	Construction	2001/02	49,823	378	1,629	2,546

Radar is used to monitor flocks of migrating birds
Radar registration during autumn 2000



This shows registration by radar of the migration routes of bird across the wind farm areas. In this area we are improving the technique to detect and quantify collisions of birds.

Conclusions

So far the Danish experience is that effects of wind farms on mammals in the construction period (when piling and other activities frighten organisms to move away) are negligible. The range of impact on the habitats of staging birds and collision risk is not yet clear. In light of the trend for offshore wind farms there is a real need for methodologies to assess cumulative impacts and decide the extent of impact that is acceptable.

To ensure the quality of the Danish programmes an International Advisory Panel of Marine Experts has been established. The panel meets once or twice a year and prepares a statement after discussion with the regulatory authorities, developers and consultants. These are available on the website.

Priority for project on environmental impact of wind farms.

- The risk of substantial negative effects
- The ecological vulnerability of the specific sites
- The suitability of the specific sites for demonstrating specific effects
- The relevance of the effects for a decision about the extension of the specific areas

- The relevance of the effects for a decision about the overall extension of the offshore wind farms
- The importance of the effects in relation to the need of effort

Compiled by:	More information:	Presented by Anne Grethe Ragborg
- Anne Grethe Ragborg: Danish Forest and Nature Agency, Ministry of the Environment		

13. EIA & SEA at the European Level

There are three Directives that cover Environmental Impact Assessment (EIA) for specific projects, and one that covers Strategic Environmental Assessment (SEA) for plans and projects.

1985 Directive (85/337EEC)

Work began on the first EIA Directive in 1975, but took the Commission 10 years to resolve controversies so it was not adopted until 1985. Member States then had until July 1988 to implement it. The Directive set out the minimum information requirements for an environmental statement and had two lists of projects for which an EIA would be required (Annex I = always required and Annex II = required only if it is likely to have significant effects on the environment – this has been interpreted as the potential to have significant effects). Renewable energy did not feature strongly as a project type in this 1985 Directive. The nearest categories were "Industrial installation for the production of electricity" and "hydroelectric energy production". One of the provisions of the Directive was for a five year review of the Directive. This was scheduled to take to place 5 years after the adoption of the Directive, so there were only two years post-implementation experience on which to base the review.

1985/88 Directive five year review

The five-year review was published in1993. This concluded that there were a number of weaknesses in the EIA process:

- The EIA process is, in many cases, not starting early enough. There is a tendency for a decision to be made about what the project is going to be before the EIA is carried out. The EIA therefore does not have an opportunity to inform the design of the project or influence the decision between options;

- Adequate quality control systems for the EIA and of the EIA process as a whole are not always present. The EIA systems around the world that work best are the ones that have a good quality control process. The Dutch EIA quality control process is renowned as a model example;

- Mitigating measures of a wider nature are infrequently and inadequately integrated into the planning and design of projects. This is mainly a result of the EIA process not being starting early enough;

- Public consultation and participation, and availability of EIAs, tended to be weak. The role of the public was described as being marginal;

- The contribution of the EIA process to the eventual decision-making and the role of monitoring in project implementation are not as clear or as effective as they could be. Studies undertaken in the UK on that first Directive showed that, even where people had responsibility under the Directive to take account of the EIA, they were often giving little attention to them.

- Monitoring, in common with many other countries, was largely non-existent – there were very few examples to refer to where there was any extensive monitoring

The five year review resulted in a number of recommendations for improvements to the Directive. These included formal scoping, aformal quality control system, accreditation of EIA consultants and the preparation of EIA guidelines. Other proposals for capacity building, the strengthening of institutions and EIA training were also included.

1997 Directive (97/11/EC)

The 1997 Directive had to be implemented by 1999. Its purpose was to achieve a more consistent application of EIA across member states. This time, Annex II contained explicit reference to wind farms, so they require an EIS if they are likely to have effects on the environment. The Directive included provision of guidance on the screening of Annex II projects to determine whether or not an EIA was needed. This was to promote a more consistent approach to screening. Whether or not an EIA is required could depend on the country in which it was placed (e.g. the number of EIAS required per year in a country ranged from approximately 20 to 2000). There was also some enhancement of requirements related to scoping (but not formalised as proposed in the 5 year review), alternatives and public involvement.

Amending Directive 5 year review

A five year review of the amended Directive was published in 2003. It concluded that there was no evidence that further revision of the Directive was required. Although shortcomings exist (absence of quality control and scoping) these would be left to the Member States to address. In particular, they were encouraged to introduce some sort of formal review/quality control system. The review also found that there was insufficient understanding of what an EIA is and how it is meant to be used in the decision making process. This should be addressed by providing training on EIA for personnel in decision-making positions.

Directive 2003/35/EC

This Directive, which was passed in 2003, further amends the EIA Directive. It was required was required in response to the Aarhus Convention - on access to information, public participation in decision making and access to justice in environmental matters, which was passed in 1998. This is more prescriptive on public involvement and sets some performance requirements as to the effectiveness of the participation, although detailed methods are left to member states. It includes a requirement for “early and effective opportunities to participate” in the EIA system (i.e. when all options are open) but doesn’t specify what that means. Some environmental lawyers take it to mean that this should be at the scoping stage, although that is not specified in the Directive. There is also a requirement for “reasonable time frames…..” , although the term “reasonable” is not defined. Nevertheless, an EIA that interprets these clauses in a minimal fashion could be open to legal challenge.

Strategic Environmental Assessment Directive (2001/42/EC)

The fifth Environmental Action Programme (1993) indicated an intention to adopt SEA. However, as with the EIA Directive this measure was also controversial. The Directive was adopted in 2001 and has to be implemented by June 2004.

This Directive concerns assessment of the effects on the environment of certain plans and programmes, namely those that are prepared and/or adopted by an authority and are required by legislation, regulation, etc. SEA is the application of the principles of EIA applied at the strategic level. However, the detail of environmental information and the accuracy of predictions that can be made are different at these higher levels of decision-making. A strict EIA type model therefore doesn’t necessarily translate and may not fit with the decision-making process at this level. Some problems were encountered with the SEA for offshore wind farms in the UK.

Plans subject to SEA are identified by the sector (which includes energy) and that they set out a framework for development of consent. The other thing that triggers an SEA will be the Habitats Directive so a development bordering on an SPA, for example, would require an SEA. The plans are subject to screening so not every plan requires an SEA unless it is likely to have significant effects on the environment. The Directive states that the SEA should be undertaken during preparation of the plan. The Directive requires a report to be produced at the end and this must be subject to public consultation. Transboundary consultations are required to determine if it is likely to affect the environment of another

Member State. Monitoring of the significant environmental effects of the plan is required. This contrast with the lack of a similar requirement in the EIA Directive, where monitoring of individual projects would be easier. Member states are required to inform the Commission of the quality control measures they have put in place for SEA reports (this is also not in EIA Directive). The first review of the Directive will be in 2006.

As the Directive does not clearly define what is meant by a plan or project, there may be opportunities for challenges. EIA, in particular, is an issue that members of the public have identified as an opportunity to challenge or oppose developments. Developers should therefore be interested in the details of an SEA and the requirements of the Directive as they may find their developments delayed or prevented should the SEA be challenged by members of the public. Defining exactly what a plan or programme is may therefore be an issue that the workshop could pick up on.

Compiled by:

More information:

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14. HOW THE OSPAR CONVENTION APPLIES TO RENEWABLE ENERGY

What is OSPAR?

The OSPAR (Oslo/Paris) Convention (1992) was set up to protect the marine environment of the North East Atlantic. It has 15 Member States in the North East Atlantic catchments:

Belgium	Denmark	Finland
France	Germany	Iceland
Ireland	Luxembourg	The Netherlands
Norway	Portugal	Spain
Sweden	Switzerland	The United Kingdom

and the European Community. It is administered by the OSPAR Commission, which is based in London, UK.

The OSPAR Convention contains a general obligation on Member States to take all possible steps to prevent and eliminate pollution and to protect the North East Atlantic against the adverse effects of human activities. This covers a number of aspects. One is the obligation to apply the precautionary principle, the "polluter pays" principle, Best Available Techniques (BAT) and Best Environmental Practice (BEP). Contracting parties may also go further than this and to establish more stringent conditions. There is a reporting obligation where Member States have to report to the Commission on how they are implementing the Convention. NGOs are allowed to participate and there are rights of public access to information.

Application of OSPAR to non-polluting activities

Originally, OSPAR only covered polluting activities. However, with the adoption of Annex V, the Convention now has authority to deal with adverse effects of all human activities, including prevention and, where practicable, restoration. This does not include fisheries management, but the Commission is permitted to bring any problems to the attention of the relevant International competent body. There is also a preference to ask IMO to take action on shipping

Appendix 3 of the Convention contains criteria for identifying Annex V human activities. These include the extent, intensity and duration of the activity, the actual and potential adverse effects of the human activity on specific species, communities, habitats or ecological processes and the irreversibility or durability of these effects.

The OSPAR Commission has been adopting six different strategies:

1. Hazardous Substances Strategy
2. Radioactive Substances Strategy
3. Eutrophication Strategy
4. Offshore Oil and Gas Industry Strategy
5. Protection of Marine Biodiversity and Habitats Strategy
6. Joint Environmental Assessment and Monitoring Programme

The biodiversity strategy has a threefold approach:

- Threatened or declining species & habitats
- Marine protected areas
- Impacts of human activities

The last of these is particularly relevant to this workshop. A general problem for the OSPAR Commission is how do we integrate all of these activities together?

OSPAR's working methods

OSPAR works by first identifying the impact of each human activity on the marine environment. It then assesses what is already being done in each country by sending a questionnaire to all contracting parties. The results are reviewed to establish whether collective OSPAR further action is needed and a background document is produced. According to the outcome of this background document, it adopts OSPAR measures

Human activities were chosen for investigation under the Biodiversity Strategy:

Currently under study:

- Cables and pipelines
- Dredging
- Minerals exploration
- Non-native species
- Offshore oil and gas installations
- Tourism

Some type of agreement already reached:

- Sand and gravel extraction - *agreement reached, reporting to be improved*
- Land reclamation - *nothing needed at present*
- Offshore wind-energy parks - *agreement reached but more work to be done*

Progress on offshore wind farms

A database of existing and authorised offshore wind farms was established by OSPAR in 2003. This is available on the OSPAR website and will be updated annually.

Guidance has been produced on a common approach for dealing with applications for offshore wind farms (2003-16). This was adopted by OSPAR in 2003. It was discussed by the Biodiversity Committee where contracting parties inform each other about the common requirements that they are looking at in dealing with applications.

Denmark and Germany produced the first draft of a background document on the problems and benefits associated with offshore wind farms. This document was also provided. The workshop was tasked with considering ways that that this could be improved, especially the section that looks at best ways to develop BAT and BEP and guidance on how to apply it for a particular location.

How do we integrate all of these elements?

We know there are limits in our scientific knowledge. We also know that there are a number of critical processes for maintaining the structure and the functioning of ecosystems. Interactions occur, both within the food webs ("multi-species approach") and also with the background. Chemical, physical and biological environments are consistent with a high level of protection.

The sea is one environment but action currently taken on a sectoral basis:

- UN Convention on the Law of the Sea established sectoral machinery
- National structures take a sectoral approach
- Management of human activities is sectoral

European Marine Strategy

The EU, HELCOM and OSPAR have accepted the concept of a marine strategy based on an ecosystem approach. HELCOM and OSPAR have adopted an "over-arching statement" on the eco-system approach.

Enter the ecosystem approach!

Summary:

- OSPAR is being applied to non-polluting human activities affecting the sea
- It is looking at offshore wind-energy parks

- OSPAR have adopted initial measures – and are asking the workshop to contribute to the OSPAR background documents
- The context for future work will be within the framework of the European Marine Strategy

OSPAR Commission
for the Protection of the Marine Environment of the North East Atlantic

Compiled by:	Websites:	Presented by Amparo Agrait
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WORKSHOP SESSIONS

Chair:

Lindsay Murray
Centre for Environment, Fisheries and Aquaculture Science

Day 1
Presenting format for the days activities.
Brainstorming sessions.
Fixed discussion groups.
Wrap up session.

Day 2
Recap of the previous days work.
Presenting the format for the days activities.
Continue in discussion groups.
Presentation by discussion group Chairs on outputs.
Summary, conclusions and recommendations session.

Discussion Group 1: Physical Processes

Faciltator: **Ceri James** British Geological Survey		Rapporteur **Piers Larcombe** Centre for Environment, Fisheries and Aquaculture Science

Members	**Country**	**Organisation**
Beth Greenaway	UK	DEFRA – Science Directorate
Bill Cooper	UK	ABPmer
Geoff Bowles	UK	MCEU (DEFRA)
Jon Rees	UK	CEFAS
Justin Ridgewell	UK	Environment Agency
Mike Brook	UK	DTI
Peter Hayes	UK	FRS

The physical process working group identified the main physical issues in relation to the development of renewable energy in the marine environment. The group discussed main issues, overall importance, and weaknesses. The group used this information as a base and worked on the four points to consider in relation to physical processes:

- Environmental assessment
- Monitoring
- Research
- Data Exchange/ Networks

Below is a summary of comments from the group's discussion.

1. Environmental Assessment

The group saw the need to develop EIA guidance documents to improve ecosystem understanding. It was agreed there is a general need to improve understanding of interactions. The group suggested two documents:

- One for the developers and financiers, to explain the likely logical linkages, and timescales.
- Another which deals with consequent details, for the planners, engineers and consultants,. i.e. similar nature to the dredging guidance document, but rather broader in scope (e.g. taking regional aspects and joining up of information).

The group was concerned about the timeframe to deliver guidance documents given the continuous development of renewable energy, particularly in the UK. The group discussed the development of a checklist style document or flow diagram but did not have sufficient time to further explore. The group highlighted that such documents are applicable for all marine developments and also need to be designed to test the effectiveness of such documents.

The group also felt that the OSPAR guidance they were asked to consider was a good starting point but required a greater depth and lacked reference and discussion on physical processes. The group suggested that the reports needed to include lessons from the experience of UK and other countries. This should also include non-contracting parties.

Regional

"IV. Environmental Impact Assessment (EIA)

9. Contracting Parties should agree on characteristics or thresholds which determine whether a project is to be subject to an Environmental Impact Assessment (EIA) – e.g. a *specific number of turbines. The applicant should be required to investigate and assess the area of the planned project in accordance with agreed standards of EIA. Where projects have not been informed through a Strategic Environmental Assessment or other relevant scientific knowledge, gathering environmental data for an EIA could take at least two years. "*

The current practice in the UK is the development of an EIA.

In terms of EIA and SEA assessments the group felt that there should be feedback between these two documents. The EIA that are being developed now need to feedback into future SEAs and vice versa. The level of EIAs and SEAs should be produced on regional, national and European scale. They should address all marine issues, not just windfarms or other renewable energy options in isolation. They are applicable in terms of all users and constructions within the marine environment. The UK Marine Stewardship report reflects this approach and encourages the integration of sectors to ensure there is more informed decision making.

Spatial planning was also discussed. Currently, there is little spatial planning going on (apart from the SEA), and the SEA is generally insufficient to effectively reduce efforts made to examine issues under the EIA. The group questioned whether there was testing in place on whether the process is working and whether the process is delivering sustainable marine development.

2. Monitoring and Mitigation

The group considered their UK experience and queried what questions are being asked and answered by the monitoring process, and why.

It was questioned how much duplication of effort exists across Europe and it was considered that collaboration is required at a range of levels.

There was a distinction proposed between 'real' monitoring and surveillance and a number of questions posed. Is what we do hypothesis-driven? How does the 'monitoring' take natural variation into account? How do we test for uncertainties?

Regarding UK windfarms, Round 1 'monitoring' was done at the same time as the development were as baseline monitoring ideally should occur before the development, especially in order to inform the decision-makers about the marine science in time for Round 2.

Collaboration is required both at a national and international level in terms of monitoring because some topics may be performed by a relatively small group of specialist groups and a layer of duplication can be removed. Feedback is required from current developments whether there was an effect, whether there was no effect or whether there was an effect that had not been anticipated.

The group discussed the progress of reviewing the monitoring information. Monitoring groups set up to examine information would be useful to ensure there are feedback loops into future developments and that stakeholders get feedback from the monitoring data. The latter reducing repeat questions. A monitoring network would assist a method of disseminating results and as a method of informing stakeholders, regulators and developers.

There is a need for mitigation strategies. Their content needs to address the appropriate level of mitigation and include conditions that might require the ultimate mitigation the removal of the development.

3. Research

Research gaps:

Background Physical Knowledge

- Ground conditions and geology
- What are the sediment pathways and the driving processes in the area? i.e. wrt the location of regional sediment transport pathway.
- Bedforms and bathymetry – rates of change, and change over various timescales (diurnal, daily, monthly, annual, decadal, century).

Data gathering

- Detailed flow data in shallow waters (→ sediment transport prediction)
- Issues of physical 'thresholds' on a range of scales (e.g. initiation of sediment transport, stability of regional sediment transport pathways, and esp. the stability of sandbanks, wrt the controls). → concepts of system 'resilience'.
- Turbulence effects generated by underwater turbines, undulators etc.? i.e. irregular mobile objects, including cumulative effects. .g. wave diffraction, scale effects etc – 10 rows of turbines etc… what effects are possible? Tap into international knowledge? Wind flow around buildings etc? (Wind farm monopiles are relatively simple, being cylindrical).

Modelling

- New generation of sediment transport models. The present sediment dynamic models are not adequate. Need t be able to cope with multimodal sediments, shallow water depths, large relative changes in water depths (e.g. → changes in flow regime), wave breaking, wind-driven currents, and interactions with the benthos.
- Scale effects and the cumulative nature of disturbance (multiple rows of turbines, cumulative effects of a number of wind farms close to each other, device size, shape, footprint etc).

Tools

- Issues of 'Significance' and the 'Scale' of impacts. How to measure **significance**? Analogues? Natural change? (How much are we guessing? Perhaps focus on the significant effects? But what is significant? The circular argument continues!).
- Objects etc as positive features. Includes fabric/textured mats for mitigating scour etc are they useful?
- Improving techniques to predict and remove impacts.
- Hydrodynamic and sedimentological "prediction of change of large-scale current dynamics".

<u>4. Data Exchange / Networking</u>

How should we provide for data exchange?

The group stressed that is it essential to understand what research is currently being done and that one option is a European and OSPAR network for the collation of research. There should also be networks for different groups, administrators, policy, environmental advisors, planners, NGOS, biologists etc but it is important that these networks not be developed or managed in isolation of one another.

The group highlighted several issues regarding sharing information with stakeholders.

1) Access to information on the web is not always feasible and a broad range of methods are needed for data gathering and consultation.

2) Quality assurance of data is essential. The first step is to this is good metadata.
3) The issue discussed establishing set standards for EIAs or promoting well produced applications or technical documents. Although these applications and supporting documents are generally public information, there are questions regarding copyright, liability and clarity of the reports authors' purpose in writing.

Final discussions included consideration of an appropriate organisation to manage data or networks of research. Some of the required criteria required were links to OSPAR, Europe and UK national contacts. It was thought that exchanged needed to be:

- international, relevant to offshore users
- linked with other data sources
- publicly available and accessible
- free of commercial aspect
- inclusive of metadata standards (wrt Europe Arrhus)

Discussion Group 2: Nature Conservation & Biology

Faciltator:		Rapporteur
Mike Elliott Institute of Estuarine and Coastal Studies		**Victoria Copely** English Nature

Members	Country	Organisation
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Sarah Wood	UK	CCW
Sytske van den Akker	Netherlands	Seas at Risk Federation
Tony Fox	Denmark	NERI
Torleif Malm	Sweden	Institute of Botany

The brainstorming sessions identified a long and complex list of ideas and issues from the national, European and OSPAR experiences of the various group members. In order to focus discussions to rationalise and prioritise the list a series of questions were set:

The fixed group discussions considered that a List of the Mitigation Practices that may be available for offshore renewable energy developments was needed to assist developers, regulators and other stakeholders to appreciate scope and scale. Mitigation and best practice should be better defined to ensure a common understanding. Section 4 of the OSPAR problems and benefits paper could be a useful starting point to develop guidelines on best practice. However, this would need the right people to be involved; should relate to other existing best practice; should provide a decision support system (flow chart of decision steps); should be an organic document that can be reviewed and amended if necessary in light of new experience (comparison of predictions with actual outcomes as more wind farms are built); use of demonstration sites.

The value of monitoring should be reviewed in respect of its economic value; temporal and spatial levels; biological detail; role of expert judgment; link to other uses (non-wind farm); special / charismatic species versus important for structure and function. Better sampling techniques are required (e.g. non-destructive) for fish, birds etc particularly for Annex II species. Better access tools are required e.g. the horrendogram to define **all** potential problems as a first quick checklist; the Table 1 approach. Guidance is also needed on the benefits of offshore renewables (particularly in the marine environment) and how to maximize these.

The group agreed by that Table 1 of the OSPAR problems and benefits paper should be a guide to inform but not used instead of the EIA scooping process. Splitting the Table into likely impacts from the different stages of development (survey, construction, operation, decommissioning) would increase the Tables usefulness. Some system to prioritise / score the receptors could be investigated. The Table should be expanded to allow for expert judgement and indicate the quality of the decision (i.e. based on experience or expert judgement, prioritisation of spatial and temporal effects). Should include where impacts are regionally or locally specific. Column for mitigation and/or BEP required for each impact. May be better to have different tables for different technologies, i.e. wind, tide, waves rather than a general list. Where appropriate reference should be made to (statistical) sampling and monitoring methods.

Better use should be made of international guidance (where of national relevance) including techniques and databases.

Broad-scale information required to inform site selection. This would require a robust SEA programmes (who should lead?). Site characterisation methods do exist and should be utilised and developed.

Improved linkages across OSPAR to exchange and collaborate on research are required. Better funding mechanisms are required to allow and encourage collaborative work. Effort required to relate other experimental research that are also applicable to offshore renewables, e.g. Swedish work on artificial reefs. Research synergies should be investigated and applied, i.e.

- between disciplines, e.g. physical processes and biology
- between developments/technologies, e.g. nature conservation and fisheries
- with aquaculture opportunities
- with tourism opportunities

Data exchange should be facilitated, e.g. COD (European level) but also between Europe and OSPAR. We need to overcome commercial constraints, e.g. a COWRIE type approach for Round 2 in the UK (although other initiatives necessary). Establish national and OSPAR databases (coordinated approaches), change to common (set) standards (a meta-database would be the first step).

Energy targets needs to question net benefit in respect of the consequences of building or not building wind farms, depends on scale location etc.

From these discussions the points raised in the brainstorming sessions of highest priority were identified and the 'top' seven were:

1 Prioritisation/relative scales

Significance of effects

Criteria/thresholds

2 Ecosystem approach

bigger picture – other uses

physical processes before biological especially other renewables

Cumulative effects

3 Sampling methods

fitness for purpose

4 Use of monitoring data

feedback into decision making

5 Data quality, exchange, availability, metadata

6 Predictability of response

biological risk assessment

modelling

use case histories

7 Mitigation

minimise effects / define what constitutes best practice

or compensation? Or alteration

Conclusions:

Is there sufficient guidance on environmental assessment at both the national and international level? If not, what is needed?

There is at present insufficient guidance on environmental assessment for offshore renewables. The OSPAR problems and benefits document is a good starting point, however, Table 1 needs to be expanded to ensure complete coverage of all potential impacts and their importance. Use of a multiple-cause diagram approach will help to define all the potential problems for use as a checklist. This list in the 'new' Table 1 can be expanded to incorporate qualitative judgement, temporal and spatial aspects, order of priority, geographical context, mitigation and BEP. Consideration of impacts needs to look at each aspect of the development (exploration, construction, operation, decommissioning) as well as the whole as the nature and importance of the impacts will be different. This guidance must be developed at the international level (although this development must be sympathetic to national needs).

Is there sufficient guidance on environmental monitoring and mitigation? If not, what is needed?

No there isn't but most of the information exists somewhere! This needs to be built into the Table as guidance. There is a strong need for proper hypothesis based monitoring – defining the right questions and applying adequate methodologies to tackle these. As the problems are not yet fully understood this is a current weakness in the decision making framework. After much discussion it was clear that mitigation means different things to different people. The potential habitat creation aspects of offshore developments are outside the common view of mitigation. The regulators are not making a value judgement on whether this is good but acknowledge that it will occur. It should be built into the design what is the 'best' sort of habitat to have, which will come from data collected in the EIA so that the habitat created suits all other activities and features – holistic environmental management.

What are the gaps (Annex 1 Section 1 of the OSPAR Problems & Benefits paper) and what are the priorities for filling these gaps? Who is responsible? How should this be progressed? There is a serious need to formally identify research synergies.

We need to determine the resilience of areas, i.e. half-lives of effect, the way systems bounce back after an impact etc. The use of impact scales can bring a more scientific approach to defining the problem in terms of both temporal and spatial aspects, the significance of these and their likely effects can constitute generic guidance.

A detailed approach on the physical and ecological footprint is necessary. Once we know and understand the physical footprint we have a better chance of getting the biological one.

What are the behavioural responses of various organisms? Needs the development of biological risk assessment tools, predictive models that should be linked with the physical models. All models must be fit for purpose and properly calibrated and validated. We are looking at physical and biological impacts and how they inter-relate.

Developing cost effective monitoring strategies – although a lot of survey techniques are available to generate data there is a deficit of experimental approaches to look at the processes. Lessons can be learnt from the Swedish example. We need to make the most of monitoring data and build up case histories.

Other ideas that need further investigation are quantitative indicators of change, the ecosystem approach and assessment of cumulative impacts.

We need to draw on (research) synergies between disciplines to relate physical with biological, aerial with aquatic, energy production with fish production, wind with oil and gas etc.

How should data exchange/access be facilitated (this includes developers, regulators and other stakeholders)?

Needs a central point. Data exchange groups such as COD and COWRIE are a start but need advertising to all interested parties. Better synergies/communications are required between OSPAR and Europe (e.g. COD and OSPAR strategies should be developed and work together to a common end). Data exchange must be at an international level. OSPAR has already set up databases for levels of persistent pollutants so with the necessary drivers a precedent exists.

The workshop has highlighted that most of us don't know what information exists or is being collected (outside our disciplines and countries) – as such it is difficult for us to work out what we don't know (identify data gaps). To right this wrong is a very high priority.

DISCUSSION GROUP 3: FISHERIES AND OTHER USERS

Faciltator: **Stuart Rogers** Centre for Environment, Fisheries and Aquaculture Science		Rapporteur **Stacey Faire** Centre for Environment, Fisheries and Aquaculture Science

Members	**Country**	**Organisation**
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Dick Rycroft	UK	CEFAS
Frank Neumann	Belgium	The Institute for Infrastructure, Environment and Innovation
Gareth Lewis	UK	BWEA (AMEC Ltd)
John Maslin	UK	DTI
Ken Collins	UK	Southampton Oceanography Centre
Maggie Hill	UK	CCW
Nick Cantwell	Ireland	Maritime Safety Directorate
Paul Leonard	UK	DEFRA – Science Directorate
Ralf Wasserthal	Germany	Federal Maritime and Hydrographic Agency
Saskia van Gool	Netherlands	Ministry of Transport, Public Works and Water Management
Steffen Nielsen	Denmark	Danish Energy Agency

The first part of this workshop session was aimed at identifying all the users of UK coastal waters that might coincide with offshore renewable development. All the workshop participants had an opportunity to identify these users in the revolving workshop session. Discussion focussed on whether the list should describe users or uses, and quickly highlighted the large number of activities in the marine environment, their interactions, and their associated pressures on marine resources.

By the end of the first session there was an extensive list of users, grouped according to broad user type. There was also an attempt to prioritise the major user groups so that subsequent discussion could focus on the most important / frequent issues likely to arise in renewable energy development.

Detailed Users Table

Prioritisation of the users list (Table 1) was difficult as participants had an interest in all aspects of users in the marine environment, and prioritised differently. In addition, our development of the users list reflected that the marine resource industries are often viewed by sector, rather than by impact or activity type. However, the group concluded that shipping and fisheries were the reoccurring and dominant users when considering offshore renewable energy development, and these were given top priority. Shipping was given a high priority based more on the issues of safety, while fisheries was important because of their potential displacement = from an area allocated to renewable energy.

Main users: Shipping and Fisheries

The group then spent some time on the two main issues highlighted as part of the workshop process. The discussion of shipping revolved mainly around safety aspects but touched on exclusion zones and multiple use impacts. Fisheries discussions focused on how to increase awareness of renewable energy with stakeholders, and how to value small boat inshore fisheries compared to proposed areas for development of offshore renewable energy. The following recommendations came from these discussions:

Table 1. Main users of the UK marine environment.

<table>
<tr><th>Main Users</th><th colspan="2">Aspects to consider</th></tr>
<tr><td>Shipping</td><td colspan="2">IMO Regulations
Cross Traffic Impacts (maintenance and recreational)
Sea Bed surveys
Anchorage</td></tr>
<tr><td>Fisheries</td><td colspan="2">Commercial Boat activity
Wild Harvest Culture (aquaculture/mariculture)</td></tr>
<tr><td>Maritime Cultural Heritage (includes) Personal Recreation</td><td colspan="2">Marine archaeology
Protected areas
Seascapes
War graves (wrecks/planes)
Yachting
Scuba/Free Diving
Boating
Fishing
Bird/Mammal Watching</td></tr>
<tr><td>Other Structures</td><td>Navigation Buoys
Pipelines
Cables
Intakes/Outfalls
Wrecks
Other Renewable Energy Structures (underwater)
OIL & Gas Wells & Platforms
Artificial Reefs</td><td>Coastal defence structures
Land Reclamation
Land/Cable
Research sites
Scientific Areas
Demonstration sites
Protected habitats</td></tr>
<tr><td>Extraction</td><td colspan="2">Aggregate Extraction
Capital and maintenance dredging
Minerals exploration</td></tr>
<tr><td>Disposal</td><td colspan="2">Dredged disposal – capital & maintenance
Military bullets & ammunition</td></tr>
<tr><td>Tourism</td><td colspan="2">Economic gain/impact
Potential attraction sites
Potential associated education centres
Sea and land based implications
Impacts on existing tourism attractions</td></tr>
<tr><td>Air Traffic</td><td colspan="2">Civil & Military
Impacts on communications
Microwaves
MOD cables
Defence radar</td></tr>
<tr><td>Emergency Services</td><td colspan="2">Impacts on Emergency Services
Life Boats accessing other sites or accidents
Oil spills from collisions</td></tr>
<tr><td>Ministry of Defence</td><td colspan="2">Submarine
Military operations
Cables</td></tr>
</table>

Recommendations in relation to shipping

- Common approach required to exclusion zones for shipping, not currently consistent (to address cross traffic of recreational and maintenance vessels)
- Need to share risk model that is accepted (mitigation applied by IMO)
- Encourage the use of IMO standards for traffic separation schemes and encourage a common approach
- Need integrated contingency plans, these are currently sectoral based but could do with being brought together and compared.
- There are MCA guidelines for wind farms which are helpful (see useful information)
- Encourage industry to develop a European standard for collision risk models. German research has already started to work on this aspect.
- Facilitate links between OSPAR and other EU countries and Trinity House (UK) which is responsible for navigation structures such as lighthouses, buoyage etc.. They are hosting a Collision Risk Management workshop that will include assessment of the Navigational Impact of Offshore Wind Farms.
- International Shipping Federation is an organisation that works well - http://www.marisec.org/isf/. Could be useful for industry to use for consultation.
- Facilitate links between UK Maritime Coastguard Agency and European Counterparts / OSPAR.
- UK Maritime Coast Guard Agency has drafted guidance: Steps Taken To Address Navigational Safety in the Consent Regime for Establishment of Wind Farms off The UK Coast - 8 July 2003. www.mcga.gov.uk/c4mca/mcga-regs/windfarm

Recommendations in relation to fishing activity

- Encourage the use of vessel satellite monitoring for small vessels
- Develop a common approach to establishing economic value of small vessel fisheries. Some existing protocols are available (P. Leonard publications).
- Compensation is a topic for discussion between developers and fishers
- Increased awareness of fishers and the need to encourage new technologies.
- The need for monitoring was key throughout discussions and to ensure that all the data are statistically robust. The group discussed the COD (concerted action) project led by the Denmark.

Common Themes

The group discussed how the development of offshore renewable energy had highlighted the multiple use of marine resources and the lack of spatial planning to support new development, or to protect existing resources and user groups. This was summed up by one of the participant's as: "Complex management within a multiple use marine environment". Several common themes emerged from the discussions. The three key aspects were managing multiple use of marine resources, marine spatial planning and habitat mapping. Throughout these common themes there was constant emphasis on the need to improve data exchange, develop consistent approaches and increase awareness of other stakeholders.

Multiple Use of Marine Resources

The group discussed the marine users and highlighted the pressure on marine resources. It was felt that renewable energy should not be developed at the expense of other users of the marine environment. This point confirmed the obvious conclusion that renewable energy development cannot be assessed in isolation from other users and activities.

The countries represented in the group highlighted that current practice is to exclude other users from offshore wind farm locations, but no consistent arrangements had been made in the UK for the phase 1 wind farms. It was thought that complete exclusion of other users was not the most efficient use of marine resources and that there should be the potential for multiple use. This need for these exclusion zones was based on safety. However, there is no common understanding of what is needed for renewable energy structures. The helicopter pads used to support the offshore oil and gas industry need a 5 or 6 km radius for access and also flight paths, but there are few other examples where no construction is permitted near an activity.

The following questions were raised:

- Are exclusion zones the best way forward? Is this an interim measure until multiple use can be further explored?
- Can we establish a European standard until further information is available?
- Can the renewable energy industry manage multiple use? Risk, liabilities etc

Suggestions of multiple use include mixing types of renewable energy (i.e. wind and tide energy), artificial reef development, encouraging alternative fishing methods perhaps involving shellfish, combining developments with disposal sites, permitting recreation and developing on disused aggregate sites. Although there will be site specific considerations, the general feeling was that a common approach to managing renewable energy locations is necessary.

Nature does not mimic regulatory or administrative boundaries. The group discussed future renewable energy development that will have cross boundary impacts. Discussion centered on how we can work together to ensure that requests for additional research are shared within Europe, and that consultation and integrated decision-making is applied. A collective and practical approach would assist decision-makers to integrate requests for information or research and provide developers with focused research, monitoring and licence conditions.

Habitat Mapping & Spatial Planning

These topics were discussed in light of the difficulties with identifying the extent of seabed resources (physical and biological), and having available a system of integrated spatial planning to manage them effectively. This key issue was discussed for activities such as aggregate extraction, fisheries, and marine constructions. The group concluded that in order to be strategic with development, decision-makers need to focus understanding on marine habitats to underpin effective marine spatial planning. The following questions were raised:

- Are there European standards for mapping that we should be sharing now?
- We need to develop a method of mapping that supports spatial planning. The current practice should not be just looking for the gaps between existing activities in order to plan for new activities.

Key points to come from these discussions included:

- The table of user groups could be expanded or add to the OSPAR list or be developed into a checklist for regulators and developers when scoping for an EIA
- Encourage OSPAR to be more inclusive of additional agencies or NGO's.
- Encourage information sharing between UK cables sub committees and European counterparts.

In summary, the group highlighted the different approaches across European to understanding other marine users. Common issues arose with lack of habitat mapping to underpin strategic planning and how to appropriately manage multiple use activities. Networking seems to be the only current method of sharing information. We need much more thorough co-ordination of information and better processes to make data available more widely. Apart from OSPAR, there is no European marine agency or industry initiative to ensure that current research is widely available and that duplication of effort is removed.

More resource needs to be allocated to developing tools for practical cumulative impact assessment. This could also include monitoring users and their integration with various marine sites. However it was discussed that monitoring has to be focussed, affordable and based on priorities. The group had useful discussions regarding exclusion zones and safety aspects of shipping, and there needs to be effective integration of these shipping aspects into the strategic development of sites.

Discussion Group 4: Environmental Decision Making (EIA and SEA Requirements)

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Within the group a number of key issues were identified relating to the problems with the current status of environmental decision making in relation to offshore renewable energy in the marine environment. These are listed below,

1. Lack of specific guidance for decision-makers (what is required, what are the problems, who is involved).
2. Decision support tools are required – such as Expert Systems.
3. How we assess cumulative impacts offshore? Problems were also identified with the consistency of the approach applied by various countries/ consultants etc.
4. There is a requirement for contracting parties to gain access to relevant data, both nationally and internationally, which could be provided by web-links, forums etc.

Each of these 'themes' was repeated throughout the day, both in the fixed working group and revolving working groups. The key issues pertaining to each of these themes are fully explored below.

- How do we actually assess environmental impacts and how well defined are the methods of assessment?
- A suggestion was made that OSPAR should re-word the content of *section 4* of the working document to enable this document to be more of a guidance document than a list of BEP and BAT goals.
- The title of *section 4* should be renamed as 'Aspects to be considered when developing BEP and BAT' inline with the suggestion made above.
- Can OSPAR collaborate a *catalogue of methods* that can be drawn upon by contracting parties? These methodologies could be more appropriate than actual guidance as they would allow contracting parties to implement actions within their own legislative framework.

- Can there be detailed guidance with a specific measurables and aims. This would be preferential to the standard methodologies currently provided by OSPAR.
- Can we produce any UK Guidance for monitoring of sites once construction has been undertaken? Do we have sufficient knowledge of this field ?
- Any guidance or criteria would have to be reviewed as knowledge increases, research improves and should be pitched at a national level.
- Can experience be drawn from other marine activities where we do have more experience, such as disposal and aggregate extraction? There may be some similar effects and conditions which can be drawn upon and this would provide an overall contribution to sustainable development.
- As an extension of the above, can we reduce the 'sectoral' approach and move towards a marine spatial planning approach?
- Defining the long-term impacts of wind farms can be problematic, as we have little experience to draw upon and little data on the effects of structures of this kind.
- There are also problems translating possible environmental impacts into the practical decision making process. For example how do we begin to weight a reduction in CO_2 emission to the loss of prime sand eel habitat ? This would relate to the scale of the impact.
- How can we share data and information internationally to provide support networks and share experience?
- Can data portals or websites be created to aid environmental decision making (hosted by CEFAS or ICES for example).
- How do we finance the research which supports environmental decision making and should this be self funding?
- How do we identify and address transboundary issues?
- How can the decision maker translate hypothesised effects from the baseline studies into observed actual effects?
- There is a real lack of definition of the spatial context of effects (should we be considering biogeographic regions, by seas etc)
- Defining criteria for wind farms can be problematic due to site specific issues, differing national legislation etc. Could there ever be generic criteria and guidance relating to offshore renewable energy?
- How can mitigation be integrated into the decision making process as we have little or no experience of these types of constructions?
- It is problematic to define levels of risk and uncertainty at present due to the lack of knowledge on the issues involved with offshore renewable energy.
- How can we integrate the possible positive effects (i.e. habitat creation, enhanced biodiversity) of offshore renewables into the decision making process?
- It would also be useful to know who owns and controls the current information on offshore projects to decide how this information could be moderated or shared to inform environmental decision making.
- How can we balance the factors relating to development, environmental impacts, the precautionary principle and the changes in priorities and issues relating to renewable energy ?
- Can we overcome barriers such as the comparability of data and language barriers to help researchers and decision makers improve knowledge and experience?
- There needs to be clearer understanding of the links between SEA and EIA and how this may aid or impede the decision making process.
- At present there is the preclusion of large scale cumulative impact studies (perhaps similar to that completed for the Eastern English Channel, REA) for offshore wind farms and other renewables. This is caused by the timescale of the environmental decision making process, particularly in the UK. Can studies be undertaken which address offshore renewables on a 'regional' scale?

- Should more emphasis be placed on ecosystems, ignoring administrative boundaries and allowing a more robust ecosystem approach?

In summary the working group on environmental decision making concluded the following points;

1. Recommendations should be made to OSPAR regarding the production of guidance, which may be in the form of the revised Draft Background Document on Problems and Benefits Associated with the Development of Offshore Wind Farms for baseline and monitoring surveys.
2. The group recommends that at a national level, contracting parties should develop frameworks for Cumulative Effects Assessment (CEA). This could feed into an international approach at a later date.
3. A catalogue of methodologies should be devised to aid the Environmental Decision making process, which draws on international experience and lessons learnt.
4. A website should be produced with links to sources of information on such matters as decision making processes and legislative frameworks etc. to allow for data exchange and comparison internationally (comparisons made to the COD project – www.offshorewindenergy.org).
5. There are many problems in providing robust monitoring advice for wind farms and a website should be produced which allows links to methodologies.
6. As a deliverable of the workshop it would be useful to have bulletin board or other such medium to facilitate continual idea exchange.
7. It would be useful for a list of delegates to be produced to include interests, field of expertise etc. alongside contact details and addresses. This would aid delegates in sourcing information.

CONCLUSIONS & RECOMMENDATIONS

The aim of the workshop was to examine the problems associated with the development of offshore wind farms and discuss, *inter alia*, the best way to develop BAT, BEP or guidance on location and construction of offshore energy, as appropriate.

Although focused around the current problems of licensing wind farm construction, the workshop also aimed to address generic issues that would equally apply to other forms of renewable energy in the marine environment (i.e. wave and tidal). This would help to put the regulators and industry in a state of readiness when other forms of renewable energy require consent.

THE NEED FOR ACTION

Renewable energy is a new marine industry developing to meet both national and international obligations and targets. The most advanced renewable energy source is offshore wind farms, but new tidal turbines and other experimental renewable energy technologies are being explored. Practitioners are committed to learn from others' experiences, establish guidance, avoid duplication and coordinate research. New applications for larger developments are being received and processed by regulators now so action cannot be delayed.

PRIORITIES FOR ACTION

The workshop delegates raised issues that require action at international, national, regional, and local levels. The workshop recommendations have been designed to capture the delegates' efforts and provide practical solutions that can be brought forward. They highlight actions that will require coordinating and funding. The workshop stimulated discussion and although not providing definitive actions for all its objectives provided the base from which all of these can be progressed. We should therefore collectively ensure that the impetus captured at the workshop is not lost and work together to develop a consistent framework.

Recommendation: Current Experience

Networking with other practitioners is an essential method of sharing information. The workshop was the first attempt to identify and bring together experts in the environmental assessment of offshore renewable energy in the marine environment. The workshop delegates requested a formal record of delegate's professional interests, current research and/or regulatory experience and additional contacts that may wish to be included in correspondence.

Action

- The workshop report includes a list of delegates and records the workshop groups that they participated in.
- The workshop report includes a delegate questionnaire to identify additional information.
- The questionnaire will be collated by CEFAS and with approval, will be circulated to delegates.
- While this is being actioned in the absence of any formal mechanism the delegates list will assist with sourcing and transfer of information.

Recommendation: Current Experience

The workshop highlighted only a fraction of the current research projects and decision making practice that European practitioners are applying on a day to day basis. The workshop delegates requested that practitioners learn from collective experiences and produce a definitive list of impacts and their importance.

Action

- Identify funding to host a second workshop to draw together collective experiences. Defra has provided funding for this workshop.
- Identify the participants for the workshop.
- Organising the date, finalise attendance and coordinate the workshop and draw together the findings.

Second Workshop Aims include:

- Expand the table in the OSPAR document to provide more detail on the issues raised (from Annex 2).
- Capture European experience (both positive and negative) and provide specific comments about the likely significance of each of the issues. This should differentiate between the generic issues likely to be significant in most cases from those that might only be significant at certain sites.
- Attempt to rank the issues by significance.
- Provide pointers (websites and paper documents) to methodologies useful for baseline surveys and monitoring of the issues. These are likely to have been developed for other purposes but will be relevant to wind farms.
- List the on-going research and identify issues where understanding is adequate and where there are important gaps in understanding.

Recommendation: Habitat Mapping

Delegates raised the need to manage marine resources based on scientific information. Decision-makers need to focus understanding on marine habitats to underpin effective spatial planning. An OSPAR/ European consistent method of mapping habitat to support spatial planning and effective decision making is required. This is a cross sector issue for marine resource management.

Action

- The issue of a lack of consistent habitat mapping should be highlighted as a barrier to sustainable marine development and continually raised at the OSPAR and national levels.

Recommendation: Spatial Planning

Spatial planning is a tool to manage multiple uses and users of marine resources. UK has undertaken an Strategic Environmental Assessment (SEA) which is start but is generally insufficient to effectively identify suitable locations or improve the process of examining issues at the EIA level or address complex multiple use conflicts. Broad-scale information is needed to inform site selection, which in turn requires robust SEA.

Action

- The issue of a lack of consistent spatial planning mapping should be highlighted as a barrier to sustainable marine development and continually raised at the OSPAR and national levels.
- To move the issue forward, interested delegates could identify current practice and disseminate this information to national representatives in order to formulate a collective approach and also to address resource issues within their own organisations.
- Offshore renewable energy should not be developed at the expense of other users of the marine environment. From initial discussions with delegates it is apparent that management of an areas multiple uses in relation to offshore wind farms is not consistent. The use of exclusion zones is the default option when there is lack of other management options. There is a need to identify countries' approaches and ensure consistency within Europe and across sectors.

Recommendations: Cumulative Impacts

Habitat mapping, spatial planning and cumulative impacts are all connected issues and apply across sectors and national boundaries.

Action

- These issues are high-level action points that need their profile raised to progress sustainable marine development.
- Guidance on assessment of transboundary issues/impacts is needed.
- The workshop recommends that at a national level, contracting parties should develop frameworks for Cumulative Effects Assessment (CEA). Continual communication with European practitioners would ensure a consistent approach. This could feed into an international approach at a later date.

Recommendations: SEA & EIA Guidance

Delegates highlighted the need to strike a balance between meeting renewable energy commitments whilst ensuring that sufficient time and resources are allowed for the assessment of marine environmental impacts. Putting the right amount of resources and effort into EIA and SEA now will ultimately reduce costs and problems for the developers once construction starts.

Any guidance documents produced, whether nationally or by OSPAR, must be detailed and have specific measurables and aims. All guidance or criteria would have to be reviewed on a regular basis as knowledge increases and research improves.

Action

- There is a need for the production of guidance, which may be in the form of the revised Draft Background Document on Problems and Benefits Associated with the Development of Offshore Wind Farms, for baseline and monitoring surveys.
- Best practice guidance should be developed at the European/OSPAR level, drawing on national experience. A review of what guidance exists (national and international) would be a useful first step and it is essential that the relevant people are consulted.
- A consistent approach to EIA and SEA is required. Reviewing and revising SEA documents to include additional information from EIA and operational experiences will capture additional data for future decision making. Built into this process should be methods to confirm that EIA and SEA processes are effective tools for sustainable development.

Recommendations: Monitoring & Mitigation standards

Construction and disturbance are not new activities within the marine environment. There are opportunities to learn from impacts from other marine industries. This is necessary as renewable energy is a new marine industry and subsequently there are few actual results of monitoring available. Delegates highlighted the need to gather practical experience on pre, during and post-construction monitoring.

Action

- Experience and examples should be drawn from other marine activities (e.g. telecommunications, aggregate extraction, sea disposal etc). There needs to be a lead organisation to produce guidance in consultation/collaboration to ensure a consistent manner. Some of the required criteria required were links to OSPAR, Europe and national contacts.

- Delegates encouraged organisations to learn from one another's practical experiences. It is recommended that results from monitoring of initial developments are fed back into future planning rounds. There is a need to establish countries' experiences (e.g. Denmark, Sweden etc) of post-construction monitoring to work towards developing national guidance. The first stage is to identify monitoring that has specific sound results.

- A list of appropriate mitigation practices available for offshore renewable energy developments would be useful to developers, regulators and other stakeholders in appreciating scope and scale. Mitigation practices could be used in developments to produce mitigation strategies that include the life cycle of the structure. The strategies should not be inconsistent with national and international standards.

- Translate and incorporate actual environmental impacts into the practical decision making process. Develop a framework that can be used to score balances between reduction in CO_2 emission and for example, and loss of prime sandeel habitat.

- It is recommended that a monitoring network be established to collect and disseminate results.

- Mitigation and best practice should be clearly defined to ensure a common OSPAR/Europe wide understanding.

- There should be a European collaborative approach to methods for monitoring. The recommendation is to approach industry, or identify and resource organisations to support the coordination of current methods to ensure robust science is applied across Europe in order to assist scientific advisors and developers.

Recommendation: Networking & Data Exchange

The workshop was the first formal gathering of various scientific experts and policy and practitioners involved with environmental assessment of offshore renewable energy in the marine environment. It was the first step to make connections between European colleagues to compare approaches and discuss differences.

Action

- Use, with delegates permission, emails to establish an email group to share information.
- A more proactive involvement of member states is required to share experiences. Delegates need to continue to identify colleagues and create opportunities to meet other practitioners in order to share information.
- Identify one organisation to establish a web platform for exchanging information across disciplines and between developments and technologies.
- Approach OSPAR regarding access to web site for NGO and other national organisations that have limited access.

Recommendation: Future Research

At present all countries are progressing research based on their own experiences. Delegates highlighted benefits from coordinating research. Two key benefits were, to avoid duplication of effort and allocate scientific resources efficiently.

Action

- There should be a lead organisation that sets up a working group and maintains a list of all research works underway. It should facilitate such projects, ensuring that potential collaborators are brought together and that research is strategic at an international level.

- Better funding mechanisms are required to allow and encourage collaborative research and the exchange of data throughout OSPAR. Effort is also required to relate research needs to other disciplines in order to avoid duplication. Consider how research that supports environmental decision making could be funded through licence fees or estate fees.

- Research synergies should be investigated and applied, i.e.
  - Between disciplines
  - Between developments/technologies
  - with aquaculture opportunities
  - with tourism opportunities

- The offshore renewables industry should take the lead in developing an international / European standard for collision risk models. Germany has already started work in this area.

- A common approach is required to establish the economic value of fisheries, particularly those worked by small vessels.

- Fisheries monitoring data must be statistically robust.

- A new generation of sediment transport models is required, as those currently available are unable to answer the questions being asked of them. Models need to cope with multi-modal sediments, shallow water depths, changes in flow regime, waves, wind driven currents, interactions with benthos etc. Fit for purpose.

- Scale, layout and cumulative nature of disturbance (multiple rows of turbines, cumulative effects of a number of wind farms / other developments close together. The size and shape of the footprint.

- Renewable energy areas, trial multiple use sites, i.e. wind, wave, current all in same location, artificial reefs, shellfish cultivation, alternative fishing methods etc. Include all the construction / engineering synergies and constraints.

- Physical ‘thresholds’ e.g. suspended sediment concentrations, initiation of sediment transport, stability of regional sediment transport pathways. Investigate the use of appropriate indicator species and/or ‘thresholds’ of biological impact. – system ‘resilience’. How to measure significance – link with ‘natural’ change.

Associated issue:

The volume of data, data ownership, liability, copyright, language, linkages to other data sources, whether publicly available and metadata standards are all issues needing further discussion (with regard to Aarhus Convention, national data strategies). COD, COWRIE – wider advertising.

Recommendations: Benefits and Problems Paper

The OSPAR guidance document (Ref No. 2003-16) provides a reasonable starting point. The delegates had an opportunity to directly feed into the draft document at the workshop and by consultation. The following comments were recorded.

Actions

- Better use of international guidance, techniques and databases (where appropriate)
- Logic not joined up
- No consideration of high energy environments with regard to tides, waves
- Too little geology
- Too little physical processes
- No prioritisation
- No link between geology – hydrodynamics – sediment dynamics – biology
- No consideration of natural change
- Scour pits – significance?
- Table 1 – use as a guide to inform but not instead of EIA scoping process
- Table 1 – split into likely impacts from different stages of development (survey, construction, operation, decommissioning)
- Table 1 – investigate a system to prioritise / score the receptors
- Table 1 – expand to allow for expert judgement (but qualify quality of the decision)
- Table 1 – distinguish between regionally and locally specific impacts
- Table 1 – include column for mitigation/BEP
- Table 1 – different tables for different technologies (i.e. wind, wave, tidal)

  Section 4 of the OSPAR problems and benefits paper should be reworded so that it becomes guidance rather than a list of BEP and BAT goals. A different title for this section would be required, such as 'Aspects to be considered in developing BEP and BAT for renewable energy'.

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APPENDIX 2 – GLOSSARY

ABP MER	Associated British Ports – Marine Environment Research	UK
ADCP	Acoustic Doppler Current Profiler	
BACI	Before-After-Control-Impact	
BAT	Best Available Techniques	
BDC	OSPAR Biodiversity Committee	
BEOFINO	Project investigating the environmental effects of wind farms	Germany
BEP	Best Environmental Practice	
BfN	Federal Office for Nature Conservation	Germany
BGS	British Geological survey	UK
BWEA	British Wind Energy Association	UK
CCW	Countryside Council for Wales	UK
CEC	Crown Estates Commissioners	UK
CEC	Crown Estates Commissioners	UK
CEFAS	Centre for Environment, Fisheries and Aquaculture Science	UK
COD	Concerted action for wind energy deployment	
COWRIE	Collaborative Offshore Wind Research into Environment	UK
D	Deutschland	Germany
Defra	Department for Environment, Food and Rural Affairs	UK
DEWI	German Wind Energy Institute	Germany
DfT	Department for Transport	UK
DK	Denmark	Denmark
DPSIR	Driving forces/Pressures/State/Impact/Response	
DTI	Department of Trade and Industry	UK
EA	Environment Agency	UK
EDP	Effluent Dispersal Pipeline	
EEZ	Exclusive Economic Zone	
EEZ	Exclusive Economic Zone	
EIA	Environmental Impact Assessment	
EIS	Environmental Impact Statement	
EN	English Nature	UK
ESM2	EcoSense Monitor 2 (Data Logger)	
ETSU	Energy Technology Support Unit	
EU	European Union	
FEPA	Food and Environment Protection Act	UK
FRS	Fisheries Research Services	UK
GPS	Geographic Positioning System	
GV	Government View	UK
HELCOM	Helsinki Commission – governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area 1992	
ICES	International Committee for Exploration of the Sea	
IECS	Institute of Estuarine and Coastal Studies	UK
IEMA	Institute of Environmental Management and Assessment	UK
ITAP	Institute for Technical and Applied Physics	Germany
JNCC	Joint Nature Conservation Committee	UK
MCEU	Marine Consents and Environment Unit	UK
MEP	Monitoring and Evaluation Programme	Netherlands
MHW	Mean High Water	
MHWS	Mean High Water Springs	
MINOS	Foundation for the Assessment of Offshore Wind farms project on Marine Warm-blooded Animals in the North & Baltic Seas	Germany
MLVC	Marine Licence Vetting Committee	Ireland
MLW	Mean Low Water	
MNR	Marine Nature Reserve	
MoD	Ministry of Defence	UK
MUMM	Management Unit of the North Sea Mathematical Models	
MW	MegaWatts	
NERI	National Environmental Research Institute	Denmark
NGO	Non-Governmental Organisation	
NIOZ	Netherlands Institut voor Onderzoek der Zee	Netherlands
NL	Netherlands	Netherlands
NMMP	National Marine Monitoring Programme	
NMZ	Nautical Mile Zone	
OBS	Optical Back Scatter	
OSPAR	Oslo-Paris Convention/Commission	

OWF	Offshore Wind Farm	
PS	Paired Series	
pSCI	proposed Site of Community Interest	
R&D	Research and Development	
RES	Renewable Energy Systems Ltd	UK
RSPB	Royal Society for the Protection Birds	UK
SAC	Special Area of Conservation	
SEA	Strategic Environmental Assessment	
SFC	Sea Fisheries Committee	UK
SFI	Sea Fisheries Inspectorate	UK
SNH	Scottish Natural Heritage	UK
SOC	Southampton Oceanography Centre	UK
SPA	Special Protected Area	
SRS	Stratified Random Sampling	
SSSI	Site of Special Scientific Interest	
T-POD	dedicated cetacean echo-location device	
TU	Technical University of Berlin	Germany
UBA	Federal Environmental Agency	Germany
UK	United Kingdom	UK
UKCS	UK Continental Shelf	UK
ZIP	Zukunfts-InvestitionsProgramme	Germany

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www.bmu.de

Deutche Energy-Agentur (Dena)
www.offshore-wind.de

Structure, Design and Environmental Aspects of Ofshore Wind Energy Converters
www.gigawind.de

The website on offshore wind energy in Europe. Includes COD (Concerted Action for wind energy Deployment) Project

www.offshorewindenergy.org

Marine Consents and Environment Unit (UK)
www.mceu.gov.uk

Department of Trade and Industry, Energy Group (UK)
www.dti.gov.uk/energy

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APPENDIX 4– BACKGROUND PAPERS

OSPAR CONVENTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT OF THE NORTH-EAST ATLANTIC

OSPAR WORKSHOP ON THE ENVIRONMENTAL ASSESSSMENT OF RENEWABLE ENERGY IN TH MARINE ENVIRONMENT

MALDON: 17 – 18 SEPTEMBER 2003

Revised Draft Background Document on Problems and Benefits Associated with the Development of Offshore Wind Farms,
including recommendations on how to develop a description of best available techniques for the location, construction, operation and removal of offshore wind energy farms with a view to facilitating their development and to protect the marine environment

Presented by Denmark and Germany

Background

1. Discussions and agreements at the Meeting of the Biodiversity Committee (BDC) in January 2003 were as follows:
   - **Following agreements at BDC 2001, BDC examined a draft background document, prepared by Denmark with the assistance of Germany, on problems and benefits associated with the development of offshore windmill parks (BDC 03/4/2). The document identified gaps of knowledge and research needs on the topic and made an overview of potential impacts associated with the development of offshore wind-farms on the marine biota and environment. The report also included recommendations on how to develop a description of best available techniques and best environmental practise for offshore wind-farms.**
   - **Germany pointed out that although they generally supported the document, they were not in a position to fully endorse Annex 2 to the document (BDC 03/4/2) as it stood. Germany highlighted the interest in the list of potential benefits of wind-farms included in the document, such as the reduction of CO2 greenhouse gas, the use of a sustainable energy source, the economic benefits and the potential basis for future hydrogen production by electrolysis of water as well as for refuges for fish.**
   - **Contracting Parties welcomed document BDC 03/4/2 as a useful outline for further work on the impacts of wind-farms and, after discussion, <u>agreed</u>:**
     - **a. that, in the light of the comments received, Denmark and Germany should further develop BDC 03/4/2 as a background document on problems and benefits associated with the development of offshore wind-farms for its discussion at the workshop intended to be hosted by the UK (see indent c);**
     - **b. for this purpose, to invite Contracting Parties to send by 1 June 2003 to Denmark and Germany their comments on BDC 03/4/2;**
     - c. to welcome the intention of the UK to host a workshop on problems and benefits associated with the development of offshore wind-farms. This workshop should become an OSPAR Workshop subject to the adoption by OSPAR 2003 of terms of reference, to be circulated by the UK after the meeting. The workshop should discuss, *inter alia*, the best way to develop BAT, BEP or Guidance on location of offshore wind-farms as appropriate;

2. At the Meeting of the OSPAR Commission (OSPAR) in June 2003 it was „noted that Denmark and Germany would further develop a draft background document on problems and benefits associated with the development of offshore wind-farms for its discussion at the workshop on

this topic intended to be hosted by the UK. The UK would circulate to BDC heads of delegation by the end of July 2003 terms of reference for the workshop for adoption in a written procedure, so that it could be accepted as an OSPAR workshop."

3. Denmark and Germany received comments from Sweden, Belgium (no further comments), the Netherlands (no further comments) and from Germany. The original document BDC 93/4/2 was revised taking into account the above-mentioned comments (see enclosed Annex 1 and 2).

Action requested

4. The participants to the OSPAR Workshop are invited to discuss the enclosed revised document with the aim to further develop the background document.

The use of offshore wind energy is a rather new activity in the marine environment and therefore, a lot of knowledge gaps on potential impacts and the scale of such impacts on the marine environment still exist. Up to date rather few ecological studies concerning offshore wind farms (OWF) have been carried out. Only a small number of OWFs have already been erected. With the exception of one (Horns Rev) all current OWFs are located rather close to shore (e.g. Tuno Knob in Denmark, Utgrunden in Sweden, Blyth in the UK). The development of a number of OWFs - in greater distance from the coast and in deeper water - is underway. The research and monitoring that will accompany the construction and operational phases of these new projects should provide valuable information on the potential scale of impacts and for the assessment and the avoidance or minimisation of negative environmental impacts for future projects. In particular, impacts on birds, benthos, fish and mammals may occur during the construction, operational and removal phase. Due to its physical presence, a wind farm may provide a hazard to shipping. Accidental collision between vessels and the wind turbines may result in release of oil and chemicals and subsequently in an environmental contamination. In addition, the lightening of wind farms may have impacts on the landscape An overview of potential impacts is given in Table 1.

1 Knowledge Gaps and Future Research Needs

Gaps in scientific knowledge and future research needs include:

- more data on distribution and abundance of species, to establish densities and locations at which populations occur throughout the year, for example data on the location of reproduction and foraging sites of marine mammals and on bird-habitat relationships to predict sensitive areas
- bird migration data, such as site-specific information of migratory routes and species-specific flight altitudes, including local movements
- generic studies on behavioural responses of different species to wind energy plants to establish species specific sensitivities
- data on hearing sensitivities (e.g. audiograms) of marine mammals and fish to predict possible effects of underwater sound emission
- generic sensitivities of different species based on life history traits, population dynamics, ecology and abundance
- more data on possible impacts of OWFs and associated power cables on marine species and habitats, such as effects of introducing metal substrate, noise (including measurements of underwater emissions already installed related to the type of foundation used), electromagnetic emissions, increases in sediment temperature and possible changes in marine community structure, shadow effects resulting from the movement of rotor blades
- hydrodynamic models to predict local and large-scale changes in sediment dynamics
- methodology to assess cumulative impacts of OWFs on migratory birds and the marine flora and fauna, particularly impacts on migratory species
- methodology for measuring impacts of OWFs, for example how to monitor bird collision rates or long-term effects such as possible reduction of biological fitness of animals due to stress from maintenance traffic or habitat loss
- measures to minimise the environmental impact of wind energy plants, such as bird collisions (for example through layout design and appearance of OWFs) or sound emissions during the building phase (using bubble curtains)
- how to construct wind turbines in order to minimise the damage to ships in case of collision
- development of new techniques with reduced sound emissions for the installation of windmill foundations

2 Overview of Potential Impacts of Offshore Wind Farms on the Marine

Biota and Environment

Table 1:

	Cause	Potential impact
Birds	**- turbines, mainly rotor blades** **- light emission**	- bird collision - attraction of birds due to illumination by navigational lights and subsequent increase in the risk of collision
	- wind farm as a whole	- temporary or permanent habitat loss - fragmentation of feeding, breeding and roosting areas, as well as migratory routes due to barrier effect - change of food species availability
	- boat traffic during construction and maintenance	- stress and reduction of biological fitness
	- electric cable to shore - increase of temperature in sediments during operation	- increased risk for botulism in coastal areas (eulittoral) resulting in an increased death rate for wading birds and water birds
Bats	- turbines, manly rotor blades	- collision and barrier effects
Marine Mammals	- shadow from rotor blades - emission of sound and vibration into the water body	- habitat loss due to avoidance - fragmentation of migratory routes and of sites for foraging and reproduction
	- boat traffic during construction and maintenance	- impairment of behaviour, stress
	- electric cables (see below)	- disturbance of small- and large-scale orientation
Fish	- electric cable within the wind farm and to shore – artificial electromagnetic fields emitted during operation, in particularly from monopolar direct current cables	- disturbance of small- and large-scale orientation (especially migratory species) - impediment of foraging activity
	- emission of sound and vibration into the water body	- habitat loss as fish may leave area - disturbance of behaviour and stress
	- clouding and sedimentation during construction	- damage to fish eggs
	- introduction of hard substrate	- alteration of food species availability and abundance, which in turn may alter community composition and abundance of fish
Zoobenthos	- local destruction and sediment plumes during the construction/removal of foun-dations - permanent covering of the seafloor	- temporary and permanent habitat loss
	- introduction of artificial hard substrate - changes in hydrodynamics	- alteration in the benthic community composition - indirect habitat loss through small-scale changes in sediment structure around the turbine and changes of large-scale sediment dynamics
	- electric cable within the wind farm and to shore - increase of temperature in sediments during operation	- alteration in the endobenthic community including colonisation by alien species - increased degradation of the organic content resulting in a release of heavy metals (depending on the total organic matter content and metal content of the sediment)

Macrophytes	- local destruction and sediment plumes during the construction of foundations - permanent covering of the seafloor	- temporary and permanent habitat loss
	- change of current dynamics and sediment conditions - introduction of artificial hard substrate	- habitat loss - alteration in the plant community composition
Sediment	- change of large-scale current dynamics	- change of sediment dynamics, for example slowing down of natural erosion and sedimentation processes
Landscape	- tall structures, visible from afar	- intrusion on the typically flat and featureless sea and "industrialisation" of this natural landscape
Navigation	- danger of collisions between vessels and wind turbines	- pollution through oil spills or chemical spills
Emergency operations	- obstacles due to the presence of static structures	- impact on emergency operations

3 Potential Benefits

Potential benefits associated with the development of offshore wind energy include:

- Reduction of greenhouse gas carbon dioxide

  The concentrations of man-made greenhouse gases such as carbon dioxide (CO_2) have increased in the atmosphere. According to the Intergovernmental Panel on Climate Change (IPCC), the emissions of greenhouse gases due to human activities continue to alter the atmosphere in ways that are expected to affect the climate. The global average surface temperature has increased over the 20th century by 0.6°C and is projected to increase by 1.4 to 5.8°C over the period 1990 to 2100. According to IPCC , expected effects of climate change for Europe inter alia in coastal areas are as follows: the risk of flooding, erosion, and wetland loss will increase substantially with implications for, human settlement, industry, tourism, agriculture, and coastal natural habitats[1]. Furthermore increasing run-off of fresh water to the coastal areas will cause changes in salinity and nutrient state with consequences for the marine biodiversity.[2]

  One important cause for this increase of greenhouse gases is the incineration of fossil fuels (oil, gas, coal) whereby carbon dioxide (CO_2) will inevitable be released . In order to reduce the emission of greenhouse gases, primarily CO_2, international measures (The United Nations Conference on Environment and Development 1992 in Rio; 1997 Kyoto Protocol of the United Nations Framework Convention on Climate Change) were agreed. According to Directive 2001/77/EC of 27 September 2001, the increased use of electricity produced from renewable energy sources (i.e. non-fossil energy sources like wind, solar, hydrothermal, hydropower) constitutes an important part of the packages of measures needed for compliance with the Kyoto Protocol.

  According the 2002 Delhi Declaration actions are required at all levels, with a sense of urgency, to substantially increase the global share of renewable energy sources with the objective of increasing their contribution to the total energy supply. Offshore wind power is expected to contribute a significant proportion of this renewable energy. According to a study published by the European Wind Energy Association/Greenpeace[3], in Northern Europe alone more than 20 000 MW of capacity is planned off the coast of European countries.

- Use of a sustainable, pollution-free energy source

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[1] Intergovernmental Panel on Climate Change – IPCC Third Assessment Report – Climate Change 2001; http:/www.ipcc.ch;

[2] Climate Change Research, Danish Climate Centre, 2001. http://www.dmi.dk/f+u/ and http://www.dmu.dk/1_Om_DMU/2_afdelinger/3_am/4_Expertise/5_Research/6_climatechange/default_en.asp

[3] Wind Force 12 – A Blueprint to Achieve 12% of the World's Electricity from Wind Power by 2020

- Use of wind as a free and inexhaustible energy source (wind speeds are considerably higher at sea compared to land; most of the marine sites are expected to deliver 40% more energy than good shoreline sites[2)]
- Economic benefits
    - Creation and safeguarding of jobs, e.g. manufacturing of wind turbines, construction, operation, maintenance and removal of turbines, research and monitoring
    - potential to develop tourism (boat trips to the wind farm)
    - potential for EU companies for a world wide export market (technical transfer)
- Potential basis for future hydrogen production by electrolysis of water
- Potential to act as refuges for fish (if no fisheries are allowed within the wind farm area)

4 Recommendations on how to develop a description of Best Available Techniques (BAT) and Best Environmental Practise (BEP) for OWFs

When developing BAT/BEPs for the location, construction and removal, inter alia the following aspects should be taken into account:

Location

- potential conflicts with other past, existing or planned uses/non-uses in the area e.g.
    - nature conservation areas including Special Protection Areas or candidate Special Areas of Conservation
    - marine archaeology
    - marine traffic (shipping routes) including safety zones
    - leisure-time activities (e.g. sailing)
    - air traffic
    - fisheries
    - military uses
    - pipelines
    - cables
    - sediment extraction
    - oil and gas activities
    - dumping sites for dredged material
    - past dumping sites for munitions
- wind speeds
- characteristics of the sea bed (foundations/piles; internal cabling; scouring; turbidity)
    - ➢ geological (e.g. sonar, seismic) and geo-technical (e.g. drilling, cone penetration tests) ground investigations: the scope of the ground investigations performed should be such that all ground property data relevant to planning are available well before the beginning of turbine installation.
- water depth (foundation)
- wave heights (foundation)
- natural ice conditions (foundation)
- distance from shore (impact on landscape; costs for cabling to shore)

Construction

- seabed type/sediments
- foundation type
- installation methods (e.g. use of bubble curtains to reduce noise; laying of cables)
- scour protection
- appropriate seasons (time windows) in order to avoid/minimise potential environmental impacts (taking into account human safety aspects)

Operation

- minimisation of disturbances on the local nature and environment, e.g. minimisation of noise
- safety zones around OWFs
- safety distances to shipping routes
- lightening of OWFs (shipping and aviation)

- cable type (e.g. flat type bipolar direct current cable)
  - In order to prevent adverse impacts on marine species sensitive to electromagnetic fields, wind farm power cables with the lowest electromagnetic field emissions should be employed.
- development of emergency response plans, e.g to handle oil spills resulting from a collision between a vessel and a wind turbine
- inspection of scouring e.g. with side scan sonar, multibeam.
- waste concept
- mitigation - if possible - in case of essential impact on nature and environment

Removal [**and disposal**]

- In general, the removal phase of wind turbines (including foundations) may have similar impacts as the construction phase.
- Techniques which minimise impacts on the environment (e.g. benthos, fish) including re-suspension of the sediment should be applied for the removal.
  In general, foundations of wind energy installations (WEAs) are designed to have a life span of up to 50 years and could be used for two generations of wind turbines. As a lot of oil/gas installations will be removed and disposed of on land in the next decades, it is expected that the removal techniques will evolve and much technical expertise will be gained.
- When decommissioning of WEAs (end of operational life-time use or premature termination of the project), the WEAs (including foundation) and cables should be removed completely and disposed off (recycling) on land. In order to avoid hindrances for e. g. fisheries, the piles should at least be cut-off far enough beneath the sea bottom to ensure that the remaining parts will not be exposed by natural sediment dynamics.

Annex 2

Possible Impacts of Offshore Wind Farms on the Marine Environment during Construction, Operation and Removal

I: Potential impacts during construction, operation and removal

1. Destruction or disturbance of the local sea bottom area
2. Sediment re-suspension and increased turbidity
3. Noise and vibrations from the turbines
4. Electromagnetic fields
5. The physical presence of the turbines
6. Disturbance due to construction/removal activities and to maintenance operations
7. Introduction of hard substrate

The different types of impact listed above are described below. Some of the impacts may occur during more than one or even all three phases, viz. construction, operation and removal phase.

I.1 DESTRUCTION OR DISTURBANCE OF THE LOCAL SEA BOTTOM

The construction of the wind turbine and transformer platform foundations may require sea bottom preparation (e.g. levelling). Sea floor preparation may cause destruction or disturbance of the local sea bottom .

The sea-cables interconnecting the wind turbines and connecting the wind farm to land will generally be laid beneath the surface of the sea bottom or if rocky sediments occur, the cables may need to be laid on the sediment surface. For the installation of sea cables small trenches may be cut into the sediment by a water jet/plough or may be dug. Cables laid on the sediment surface need to be covered, e.g. by rocks so that they are protected from physical damage or do not create an obstacle (e.g. to fishing gear). Trenching and digging floor will cause destruction or disturbance of local sea bottom within the wind farms or along the cable routes to shore.

It is expected that the removal of cables will result in a similar disturbance of local sea bottom areas.

I.2 SEDIMENT RE-SUSPENSION AND INCREASED TURBIDITY

Both sea bottom preparation and cable laying activities during the construction phase will result in temporary sediment re-suspension and thus in increased turbidity of the water, which may change sediment characteristics. The extent of sediment re-suspension will depend on the methods used, the steps taken to avoid sediment re-suspension and the sediment type and the hydrographic conditions in the area at the time of such activities.

The increase of the turbidity will depend on the amount of sediment re-suspended , the sediment grain size and the local hydrographic conditions at the time of the sediment re-suspension. Sedimentation is slower for sediment with a small grain size and thus, there is a higher and longer lasting turbidity when the grain size of the sediment is small.

Like in the construction phase, there will be a temporary sediment re-suspension and thus an increased turbidity in the removal phase of foundations and cables.

With regard to re-suspension and turbidity it should be taken into account that pending on the local natural conditions in the marine environment, a natural re-suspension and (re)-sedimentation takes place.

I.3 NOISE AND VIBRATIONS

Noise is coming from different sources during the construction, the operation and the removal phase. During construction noise will be emitted e.g. from shipping operations, pile driving, sea floor preparation for foundations, laying of cables. The noise generated by these sources, except mono-pile driving, will primarily be of low frequencies. If mono-piles are used as foundations for the turbines, pile driving will be used to construct them and this is likely to cause high noise levels.

When operating the wind turbines and the transformer noise will be emitted to air and through the tower and foundation to water. Measurements of noise from a wind turbine show that the airborne noise has a negligible contribution to the underwater noise level. So, the noise measured underwater from the wind turbines is transmitted through the tower and the foundation of the wind turbine.

During operation, the underwater noise from the offshore wind turbines is not higher than the ambient noise level in the frequency range above approximately 1 kHz. In the frequency range below approximately 1 kHz, the underwater noise emitted from the offshore wind turbines is higher than the ambient noise level (Ødegaard & Danneskiold-Samsøe, 2000).

When operating, the turbines will transmit vibrations to the surroundings and this might have an impact on the benthic fauna, fish and marine mammals in the vicinity of the foundations. So far, this type of impact has not been investigated thoroughly and the knowledge on the subject is very limited.

Also the removal phase will result in the emission of noise, e.g. removal of foundations, boat traffic.

I.4 ELECTROMAGNETIC FIELDS

Generally, electromagnetic fields are created within cables when an electric current is running through the cable. The magnitude of the magnetic field around a cable is, inter alia, depending on the type of the cable empoyed. Different power cable types with different properties exist, e.g.

- monopolar and bipolar direct current cables

A direct current cable will contain a constant unidirectional current and induce a magnetic field with fixed poles. Monopolar direct current cables can emit an electromagnetic field strength many times above that of the natural geomagnetic field strength, e.g. for the “Baltic Cable” the electromagnetic field strength in 1 m distance to the cable has been calculated to be more than six times higher than the natural geomagnetic field strength. Unlike monopolar direct current cables, bipolar direct current cables have two parallel conductors with opposite current direction. The less distance there is between these two conductor cables the less the expected electromagnetic field emission, as the opposing field emissions will cancel each other. This compensatory effect is particularly strong in a so-called flat type bipolar direct current cables. For this cable type the electromagnetic field emission in one meter distance from the buried cable has been calculated to be much lower than the natural geomagnetic field strength in the North Sea. A recently developed new type of coaxial cable – which is still being tested – is expected to have electromagnetic emissions close to Zero.

- alternating current cables (three phases in one cable or as three single cables)

Alternating current cables do not generate the same constant electromagnetic field as direct current cables because of the alternating and pulsating current. If the three phases are bundled in one cable, there is a strong compensatory effect which will minimise the electromagnetic field. The electromagnetic field surrounding such cables at a distance of about one meter is calculated to be much lower than the natural geomagnetic field strength in the North Sea. Therefore such alternating current cables are not expected to influence the marine fauna to the same degree (if at all) as a conventional direct current cable.

The knowledge of the impact of electromagnetic fields on marine animals is limited.

I.5 PHYSICAL PRESENCE OF THE WIND TURBINES

The wind turbines are large structures that may change the physical characteristics of the area markedly. This may have an impact on some species, causing them to minimise their use of the area or completely abandon the area.

The physical structure of the foundations might also attract certain species, which may use them as resting-place or protection against predation.

I.6 DISTURBANCES

Disturbances as a result of the wind farm may occur during the construction, the operation and the removal phase. During the construction phase, boats, machinery and people operating in the wind farm area, might disturb the marine fauna living in the area. Similar impacts may occur during the removal phase

During the operational phase, boats and people entering the wind farm area to carry out maintenance work, might disturb the marine fauna occurring in the area.

I.7 INTRODUCTION OF HARD SUBSTRATE HABITATS

As a secondary element of establishing offshore wind farms, the foundations and the rocks placed to prevent scouring at their bases will introduce new hard substrate surfaces. The foundations and the scour protection may form a new type of sub-littoral habitat, which may be colonised by a variety of marine species. Likewise the covering of power cables which need to be laid on the sea floor may introduce unnatural or additional hard substrate.

The hard substrate may increase the opportunities for epifauna to settle and it may provide a substrate, which is more attractive to hard substrate communities than the previous 'pre-wind farm seabed. In turn, the naturally occurring species, i.e. the soft substrate community, which may have been present previously in the area will be out competed and displaced.'. The establishment of epifauna and flora on the hard substrates may increase the food available to fish, which in turn could lead to an increase in the food available to marine mammals and birds.

The possible effects of introducing hard substrate cannot be established until the foundations have been in place for some time.

II: Potential impacts on affected parts of the environment

The potential impacts of offshore wind farms described above are of various importance to the different parts of the environment in and around the offshore wind farms. In the following the possible impacts of an offshore wind farm on the different parts of the environment are described in general.

II.1 HYDROGRAPHY / GEOMORPHOLOGY

The construction and operation of an offshore wind farm can potentially have an impact on the hydrography and the geomorphology in the wind farm area and in the areas surrounding the wind farm. An offshore wind farm may change the water flow and thereby the transport of material and the sediment properties in the area.

The resistance from the foundations may influence the current and wave conditions in the wind farm area and this may influence the rate of erosion and deposition of sediment in the area.

The potential impacts on local hydrography may also affect the coastal morphology in the area, due to changes in current conditions and erosion and deposition of material.

II.2 BENTHIC FAUNA AND FLORA

The introduction of hard substrate into the marine environment will allow the settlement of sedentary epibiota and a fouling community will develop that will evolve over time. In temperate areas of Europe communities developing on new hard substrata are considered to take about 5 years to reach a state similar to mature communities on natural rock.

The precise nature of the community depends on, amongst other things, availability of larvae to settle, the physical complexity of the habitat and the time of year the substrata are deployed. In addition, mobile fauna will enter the community both from the plankton and through migration, their inclusion will depend on the suitability of the habitat available. The overall complexity/diversity of the final community will depend on the habitat complexity available assuming that other parameters such as food availability, predation and physical disturbance are not the dominant force influencing the community development.

The sea bottom preparation for foundations and cable laying activities during the construction phase will cause destruction and disturbance of the local benthic fauna and flora. Sea bottom preparation will cause both increased sediment re-suspension in an area around the activity and increased turbidity of the water. Increased turbidity can cause clogging and destruction of the feeding organs of the benthic organisms. Furthermore, increased sedimentation of suspended material can cause shading of the benthic vegetation. As the suspended material settles on the sea bottom the increased sedimentation may cause smothering of the benthic flora and fauna. Similar potential impacts are expected during the removal phase.

In the operational phase, changes in the pattern of erosion and deposition of sediment around the individual foundations might affect the benthic fauna. Changes in the sedimentary environment can make it less attractive to some species and perhaps more attractive to other species, and thereby change the species composition of the benthic fauna and flora.

II.3 FISH

The windmills might affect the fish fauna in an area permanently by introducing new or additional hard substrate on which epibenthos can settle, by changing sediment characteristics, by introducing electric cables that might possibly interfere with fish migration and by the noise and vibrations generated by the mills during their operation. However, it is also possible that the fish become habituated to the noise from the wind turbines. Additional impacts may be generated during the construction phase.

Changes in the water quality and the food resources caused by the construction and/or operation of the wind farm may affect the fish population in the area.

Changes in the sedimentary environment may also affect the fish. Sandeels and sprats are very dependent on the availability of suitable sediment, and are particular sensitive to changes in the content of silt and fine sand.

The physical structure of the foundations and the scour protection may attract some fish species, e.g. because the physical structure provides protection against predation or because it provides protection against the prevalent current and thus saves the fish energy.

II.4 MARINE MAMMALS

The construction and operation of the offshore wind farm can potentially affect the marine mammals in the area in a number of ways. The marine mammals can be affected by the noise and disturbances caused by the construction work. The construction work might affect the food sources and thus, make the area less attractive to the marine mammals during the construction. Also during the removal phase marine mammals may be disturbed due to the working activities.

As a result of establishing an offshore wind farm, the habitat might change, making it less attractive to marine mammals which might abandon the area e.g. because it is no longer suitable as foraging or breeding area.

The electromagnetic fields generated around the cables interconnecting the wind turbines and connecting the wind farm to land, may affect and disturb the marine mammals and cause them to avoid the area. See Section I.4 above.

II.4.1 SEALS

The common seal (*Phoca vitulina*) and the harbour seal (*Halichoerus grypus*) are both included in Annex II of the EC-Habitat Directive, which aims to maintain a favourable conservation status of natural habitat and species of wild fauna and flora of community interest.

The most significant impacts on seals are expected to come from the physical presence of the wind turbines, the noise from ships and construction and removal work, as well as the temporary or permanent loss of habitats near offshore wind farms. Seals use sound to communicate and perhaps for hunting both on the surface and under water. The seals ability to communicate can be affected by the noise generated by the construction work and the operation of the wind turbines, and cause them to leave the wind farm area.

II.4.2 HARBOUR PORPOISES

The harbour porpoise (*Phocena phocena*) is also included in Annex II of the EC-Habitats Directives and listed as “vulnerable” in the “Red List of Globally Threatened Animals and Plants” by the International Union for the Conservation of Nature (IUCN).

The breeding period of harbour porpoises begins by late June and ends by late August. Ovulation and conception typically take place by late July and early August. The calves begin suckling immediately after birth and are fed by their mother until March the following year and possibly longer (Sørensen & Kinze, 1994).

Harbour porpoises feed on schooling fishes such as herring and sprat. Porpoises are expected to follow the migrations of these species. The construction, removal and/or operation of the wind farm might affect the distribution of food resources for the harbour porpoises.

Where pile driving is used for establishing the foundations there is a high risk of hearing damage to the harbour porpoises in the vicinity of pile driving. The emitted energy within such a series of short signals is most certainly high enough to seriously impair the hearing of harbour porpoises and seals in the surrounding area. The signals will have the potential to physically damage the animals tissues in the close vicinity (depending on the received peak pressure) or to impair the animals auditory sensitivity (i.e. hearing) over a medium range around the ramming site. The repetitive nature of this sound production is thereby increasing the potential negative effects as the threshold for impairing the auditory sensitivity is lowered accordingly.

Since, the harbour porpoise is not by nature a stationary animal, but is believed to move around within a large sea area, it must be expected that harbour porpoises will leave areas in which construction activities are taking place. Also the noise emitted during the removal phase may disturb the harbour porpoise.

Also the noise generated by the operation of the turbines may affect the harbour porpoises and this may cause the animals to abandon the wind farm area completely. Depending on the importance of the wind farm area as feeding or breeding area for the harbour porpoises, this may have an impact on the harbour porpoise population in the area.

II.5 BIRDS

Wind farms might affect birds by increasing mortality rates through collisions, by disturbance of birds in their resting and feeding habitat, or by altering the amount of resting and feeding habitat. Large wind farms may also produce a barrier effect, deflecting bird movements away from their intended tracks.

Particularly migrating birds on the East Atlantic flyway and waterfowl staging, moulting and wintering in waters for shorter or longer periods during migration are vulnerable to impacts from wind farms.

The potential impacts can be divided into two subjects of expected impact, namely disturbance and collision risk.

II.5.1. DISTURBANCE:

The noise and disturbances during the construction and removal phase can affect the birds and cause them to abandon the area, resulting in a temporary loss of habitat area.

Birds are likely to be displaced from foraging habitat by the disturbance caused by wind farms in operation. They may habituate to such disturbance over time, and it is even possible in some cases that once such habituation occurs, some species might benefit from increased amounts, or concentrations, of food in the vicinity of individual turbines or wind farms. Thus short term and medium term effects of wind farm development might differ, or effects may differ between species. Particularly sensitive bird species might never habituate to wind farms and be permanently displaced from the area or continually disturbed from these areas by maintenance activities such as helicopter flights.

It is suggested that birds resting or foraging on or in the water will maintain a minimum distance from the wind farm, which will affect their ability to exploit the habitat for foraging and/or resting (NERI, 2000). The aspect of habitat loss is mainly relevant for the waterfowl species.

II.5.2 COLLISION RISK

There is the risk that birds will collide with the wind turbines in operation. This can affect wintering and staging species, which over-fly the wind farm area every day over longer periods. Furthermore, it can affect a population of migrating birds, where a smaller or larger number of individuals over-fly the wind farm area once or twice a year. A rather limited knowledge exists on the risk of birds colliding with wind turbines.

Collision rates are extremely difficult to predict since it is not possible to extrapolate with any confidence from experience with terrestrial wind farms to what will happen at marine wind farms. The high natural survival rates of seabirds and sea ducks, together with their low recruitment rates, make them vulnerable at a population level to even small increases in mortality rates of fully-grown birds. Therefore, it is not possible to be certain that the wind farms will have only trivial impacts on seabird populations.

II.6 VISUAL AND SOCIO-ECONOMIC IMPACT

Offshore wind farms can potentially have a major impact on the landscape and the local community. An offshore wind farm with several wind turbines will most likely change the landscape considerably particularly in the dark because of lightning. This will affect both the local communities (if wind farm is visible from the coast) in the area and the people visiting the area.

The impact on tourism and on the local community can be either negative or positive. A negative impact will occur if the tourists stay away from the area, the rental of holiday cottages is reduced and the general use of the area for recreational activities such as yachting, angling, diving etc. is reduced due to the presence of the offshore wind farm.

A positive impact will occur if the offshore wind farm becomes an attraction for tourists. .

The noise emitted from the wind turbines during operation can potentially be a nuisance to the people on land. According to the modelling of the noise emitted by an offshore wind farm, the wind turbines will be heard at a distance of 1 km at the most.

ANNEX 7
(Ref. § A-4.20)

OSPAR CONVENTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT OF THE NORTH-EAST ATLANTIC
MEETING OF THE OSPAR COMMISSION (OSPAR)
BREMEN: 23-27 JUNE 2003

Guidance on a Common Approach for Dealing with Applications for the Construction and Operation of Offshore Wind-Farms

(Reference Number: 2003-16)

Introduction

1. The Quality Status Report 2000 for the North-East Atlantic refers to a conclusion by the Intergovernmental Panel on Climate Change (IPCC) that increases in greenhouse gases are contributing to global warming. It notes that such changes may lead to major climate-system changes with resulting impacts on the ocean and its biota. In response to global warming, OSPAR Contracting Parties have signed and ratified, approved or acceded to the Kyoto Protocol to the United Nations Framework Convention on Climate Change, thereby committing themselves to reduce by 2008 – 2012 overall emissions of greenhouse gases to 5% below the 1990 emission levels.

2. In this context, the use of energy from renewable resources plays an important role. Wind energy can contribute considerably to the national goals of CO_2 reduction and seems indispensable in this respect due to its potential to avoid substantial amounts of CO_2 emissions every year. As a consequence, the use of wind energy is expanding in Europe, which includes making use of offshore wind-energy potential. While, on the one hand, avoiding CO_2 emissions by means of the use of wind turbines is welcome, the construction of wind-farms at sea requires consideration and mitigation of the impacts that such installations may have on the marine environment. This document, therefore, aims to provide guidance on a common approach by the OSPAR Contracting Parties when dealing with applications for the construction and operation of offshore wind-farms.

3. The guidance is divided into sections dealing with:

A. Aspects of Licensing Procedures for Offshore Wind-farms

B. Main requirements to be fulfilled by an Offshore Wind-farm

C. Minimum criteria to be considered in environmental impact assessments (EIA)

D. Guidance on how to define areas suitable or unsuitable for the location of wind-farms.

A – Aspects of Licensing Procedures for Offshore Wind-farms

4. Contracting Parties should include the following items in their licensing procedures for offshore wind-farms:

I. Involvement of other authorities

5. The approval authority should forward the application documents to the full range of authorities which, by reason of their specific responsibilities, are likely to be concerned by the project (e.g. local authorities, authorities which are responsible for the safety of navigation, nature conservation, cables and pipelines, military, fisheries, submarine exploitation of the seabed) and should ask them for their comments within a reasonable time frame.

II. Involvement of the public/stakeholders

6. The approval authority should make the application documents available for public consultation for a reasonable period of time and should ensure that this fact is published in regional and national newspapers. The public should be given the opportunity to comment in writing on the planned project within a reasonable time frame, including the public affected or likely to be affected by, or having an interest in, the planned project and relevant non-governmental organisations, such as those promoting environmental protection, commercial or recreational shipping, fishing or energy from renewable sources. In this context, the "public" includes any one or more natural or legal persons and, in accordance with national legislation or practice, their associations, organisations or groups.

III. Involvement of the authorities of a neighbour state

7. Where the approval authority considers that the implementation of a project is likely to have significant effects on the environment of the territory of another state (including the maritime areas under the jurisdiction of that state), the latter should be notified of the project. The potentially affected state should respond to the approval authority acknowledging receipt of the notification and indicate whether it intends to participate in the procedure. If the potentially affected state desires to participate in the procedure or in transboundary consultations, the approval authority should forward the application documents to the competent authority in that state and ask for its comments within a reasonable period of time.

8. When no notification has taken place, but a neighbouring state considers that it would be affected by the project, the approval authority should forward the application documents to that neighbouring state if it so requests.

IV. Environmental Impact Assessment (EIA)

9. Contracting Parties should agree on characteristics or thresholds which determine whether a project is to be subject to an Environmental Impact Assessment (EIA) – e.g. a specific number of turbines. The applicant should be required to investigate and assess the area of the planned project in accordance with agreed standards of EIA. Where projects have not been informed through a Strategic Environmental Assessment or other relevant scientific knowledge, gathering environmental data for an EIA could take at least two years.

B – Main requirements to be fulfilled by an Offshore Wind-farm

I. No endangerment and obstruction of shipping and aviation

10. The safety of shipping and aviation should not be compromised by windfarms and the impact of windfarms on the efficiency of shipping and aviation should be minimised. Therefore the approval authority should develop requirements to be met by, and measures to be applied to, the project, such as regulations for requiring lights on the wind-farm, safety distances to shipping routes, safety zones around the farm etc., that are appropriate to reduce the risk of possible ship collisions with wind turbines as well as the risk of other possible damage.

II. No hazards to marine environment

11. The erection and operation of wind turbines should not endanger the quality of the water and air or the conservation of the species using the area as their habitat. Disturbances of sedimentary or hydrodynamic processes which have a significant impact should be prevented.

12. The threat of marine pollution which might be caused by any hazardous substances originating from wind turbines should be prevented. The risk of the release of pollutants caused by the collision of a ship with a wind turbine should be reduced to an acceptable minimum. Provision, therefore, has to be made to prevent collisions and for minimising the impact of pollutants on the sea and the coastline.

III No hazards to bird migration

13. The construction and operation of a wind-farm should not endanger bird migration. Birds may be affected by loss of habitat, e.g. in connection with resting and foraging, in areas where wind-farms have been constructed. They may also be killed or injured by collision with the installations. Wind-farms may be a barrier for birds on their long-distance migrations or on their flight from feeding grounds to sleeping or breeding grounds. The EIA provides the basis to evaluate the impact of the specific project on bird migration. The impact on the population level of a species of the specific wind-farm as well as the impact on the number of birds and the characteristics of the species should be investigated and considered.

IV Other interests/uses of the sea to be considered

14. Other interests or uses of the sea which are likely to be affected by the project (e.g. tourism, military activities, commercial fishery, landscape conservation) should be considered in the procedure.

C – Minimum criteria to be considered in environmental impact assessments (EIA)

I Objectives

15. The objective of an Environmental Impact Assessment is to give the approval authority a basis of information for estimating the consequences that a project might have for the environment, which have to be considered in granting an approval. It should assist the promoter to define the construction that is to be preferred and inform the public in order to facilitate their participation in the decision-making process. The environmental features that may be affected are flora (sea grass, macroalgae) and fauna (fish, benthos, birds and mammals), water, soil (seabed, sediment and associated features such as sandbanks), landscape, human-beings and cultural heritage. Therefore the applicant should investigate the area in order to:

a. determine and assess the spatial distribution of such features, their temporal variability (where applicable) and their condition ("baseline survey");

b. describe the effects that the construction, operation and eventual decommissioning of the wind turbines, including scour protection, might have on these features;

c. survey the actual utilisation/exploitation of the area and any conflicts that may arise;

d. assess the sensitivity of the natural resources of the area;

e. assess any cumulative effects and any impact interactions a project might have with other projects, whether wind-farms or other types of construction, that have been, or will definitely be, carried out in the near future.

16. If an assessment is due under the Birds Directive (79/409/EEC) and the Habitat Directive (92/43/EEC), this should be included in the EIA.

II. Potential adverse impacts

17. As far as concerns possible impacts of offshore wind-farms on the marine environment, various risks during the construction and operation phases are relevant, e.g. bird collision, loss of habitat, disturbance of benthos, fish and sea mammals. An overview of potential impacts is being further developed by the OSPAR Biodiversity Committee. The EIA should consider mitigation measures that will prevent, reduce or compensate possible adverse impacts.

III. Precautionary approach

18. In order to enable prediction of effects and to avoid large-scale substantial impacts, the results of monitoring should provide a rapid feedback if effects are detected.

IV. Landscape and risk analysis

19. A visualisation of the impact of the wind-farm on the landscape should be prepared for projects planned within a range visible from the coast (e.g. by computer simulation or photomontage). Such a visualisation should only be demanded to the extent that the economic burden on the applicant is reasonable.

20. A state-of-the-art risk analysis assessing the probability of a ship collision with a wind-farm, both with and without accidental pollution (worst case scenario), should be carried out and presented in the framework of the baseline surveys preceding the pilot phase. This would only be necessary where, due to specific conditions (e.g. navigable water depth), there may be a risk of such an accident.

V. Monitoring area

21. The "monitoring area" comprises the planning or construction area, including the cable route, and the reference area. The individual environmental features that may be affected require different areas in terms of size and location. Reference areas will be used for comparison, where applicable, to document the development of the environmental features that may be affected without the impact of wind turbines. The reference areas should as far as possible be located outside the planning area and their natural ambient conditions should correspond to those in the planning area.

D – Guidance on how to define areas suitable or unsuitable for the location of wind-farms

I. Definition

22. A general definition for areas suitable for the location of wind farms could read:

"an area which could be identified as a location where the construction of an offshore wind-farm would not conflict substantially with other interests and where existing data on marine environment as well as the results of a baseline survey or other environmental monitoring programmes verify that wind turbines would only have negligible adverse impacts on environmental features."

II. Interests to be considered

23. The following interests should be considered in the first place in order to find suitable areas for the location of wind-farms:

1.Nature conservation

Ecologically valuable areas or designated conservation sites should not be designated as a suitable area for installing a wind-farm, though a single project might be admitted if it is consistent with the objectives of a designated site or protected species or the general provisions of the legislation under which they are identified or where advanced monitoring programmes verify that wind turbines have no adverse impacts on the marine environment.

Existing indicators for conservation areas are:

a. components of the OSPAR Network of Marine Protected Areas (MPAs) under the OSPAR Convention;

b. Special Protection Areas (SPAs) under the Birds Directive (97/409/EEC) and candidate Special Areas of Conservation (cSACs) under the Habitat Directive (92/43/EEC);

c. Habitats and species protected under the Ramsar, Bonn or Berne Conventions;

d. Important Bird Areas (BirdLife Conservation series).

Matters to be considered by Contracting Parties in relation to nature conservation:

e. Contracting Parties are encouraged to develop and implement marine research and monitoring programs;

f. Collected data and information on marine nature should be exchanged between Contracting Parties;

g. Baseline data and monitoring requirements should probably be more stringent in nature conservation areas than elsewhere;

h. Conditions may need to be attached to any consent which may restrict working practices and therefore increase costs. For example tidal, daily or seasonal restrictions;

i. Compensation measures may be required to compensate for lost habitats.

2.Safety and efficiency of shipping

In order to reduce the risk of pollution, designated shipping routes and main traffic routes should generally be kept free from any obstacles. Suitable areas for wind-farms should consequently be designated with sufficient distance from these routes. The main traffic generally takes place on the shortest connection between certain ports of loading and discharge. The density of the local area traffic should also be considered. Areas that pose in themselves a certain risk to shipping, due to their natural or artificial conditions (e.g. narrow straits), should not be selected as a suitable area for the location of a wind-farm.

3. Safety of aviation

The installation of wind-farms should not compromise the safety of aviation.

4.Other uses/exploitations

Other uses of the sea, such as sand and gravel extraction, pipelines, cables, military activities, fisheries and shell-fisheries and the landscape (tourism) should be taken into account. Possible conflicts and cumulative effects should be anticipated.

Particular issues which may need to be considered include:

Fishery/shell fishery

a. The level of the importance for fishery/shellfishery would be indicative of any difficulties that may arise.

b. Again this may lead to stringent baseline requirements and monitoring.

c. Consenting restrictions may restrict working practices and increase costs.

Changes in hydrodynamics and sedimentary processes

d. Areas of coastline known to suffer increased rates of erosion are particularly vulnerable to any changes to processes along the coast. Such changes may have direct consequences to any flood defence strategies.

e. Stringent baseline requirements and monitoring will be required which will include validation and calibration of any models used.

f. The distance from the shoreline may need to be altered as may the shape of the wind-farm in order to try to mitigate any predicted impacts.

g. If the site is located within a sedimentary system such as sandbanks this feature may itself require preserving.

Any of the above could ultimately lead to a consent being declined or the requirement for the wind-farm and/or its cable route location to be changed. However, it is more likely that these issues will cause an application to incur increased costs caused by baseline data collection, modelling, mitigation including changes to working practices and restrictions and monitoring costs.

5. Effective use of energy source

The area should be suitable in respect of its potential as an effective energy source. Therefore the speed and number of days of wind shall be considered.

III. Procedure

24. As a first stage, all interests which might be affected by the construction of an offshore wind-farm should be ascertained.

25. As a second stage, all authorities and stakeholders whose interest or area of responsibility might be concerned (i.e. authorities responsible for nature conservation, safety of shipping, military, cables, pipelines, submarine exploitation of the seabed etc) should be asked to examine existing data and to indicate areas where conflicts with their interests are not expected.

26. As a third stage, areas where no conflicts, or the least conflicts, are expected should be identified.

27. As the last stage, these areas should be surveyed in respect of marine species and other environmental features. This baseline survey will decide whether an area will generally be suitable for the installation of a wind-farm.

IV. Further Planning and Guidance Instruments for Application Processes for Offshore Wind-farms

To allow for early and efficient guidance for applications for wind-farms in offshore areas, planning instruments such as Strategic Environmental Assessment (SEA)[4] and spatial planning should be introduced.

[4] For Contracting Parties which are Member States of the European Union, Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment will be relevant.

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