INTERNATIONAL ENERGY AGENCY

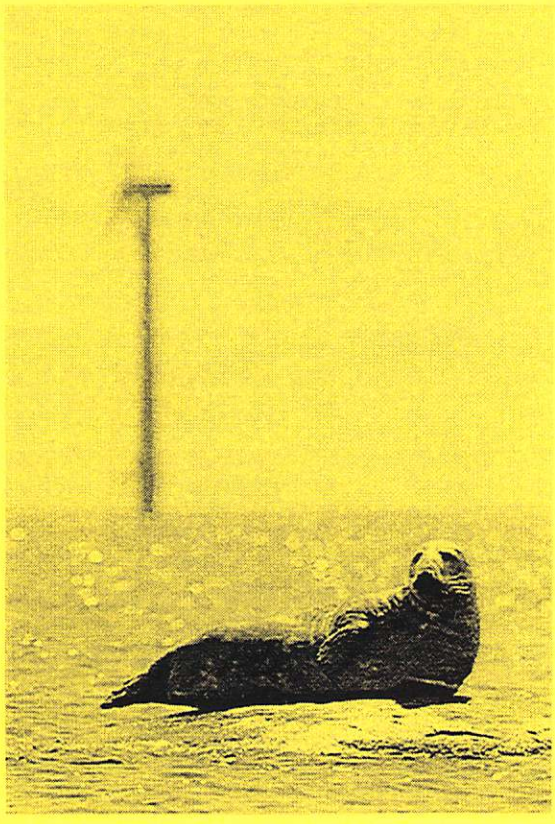
Implementing Agreement for Co-operation in the Research and Development of Wind Turbine Systems
ANNEX XI

40th IEA Topical Expert Meeting

Environmental issues of offshore wind farms

Husum, Germany, September 2002

Organised by: Forschungszentrum Julich



FOI
SWEDISH DEFENCE RESEARCH AGENCY

Scientific Co-ordination:

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FOI, Aeronautics Division - FFA, 172 90 Stockholm, Sweden

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RESEARCH AGENCY

IEA R&D WIND ANNEX XI
The Operating Agent

November 14 2002

To: Members of the Executive Committee, IEA R&D Wind, Annex XI

Dear Colleague,

Please find attached a copy of the proceedings from the following Topical Expert Meeting:

40 Environmental issues of offshore wind farms

At the end of the document there is a summary of the meeting. If you need more copies, contact Inez Engström on E-mail, ie@foi.se.

The next meeting deals with wind forecasting techniques and will be held in Sweden December 3 and 4. For more details see:
http://www.windenergy.foi.se/IEA_Annex_XI/Invitations.html.

Best regards

Sven-Erik T.

Sven-Erik Thor

Attachments: Proceeding

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Environmental issues of offshore wind farms

ANNEX XI
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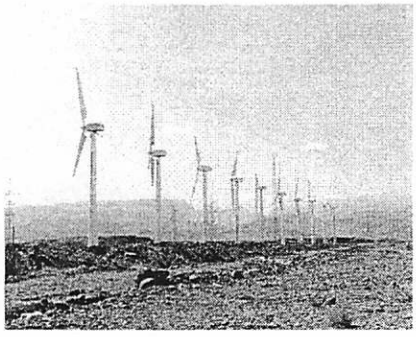

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The objective of this Task is to promote wind turbine technology through cooperative activities and information exchange on R&D topics of common interest. These cooperative activities have been part of the Agreement since 1978.

The task includes two subtasks. The objective of the first subtask is to develop recommended practices for wind turbine testing and evaluation by assembling an Experts Group for each topic needing recommended practices. For example, in 1999 the Experts Group on wind speed measurements published the document titled "Wind Speed Measurement and Use of Cup Anemometry".

The objective of the second subtask is to conduct joint actions in research areas identified by the IEA R&D Wind Executive Committee. The Executive Committee designates Joint Actions in research areas of current interest, that requires an exchange of information. So far, Joint Actions have been initiated in *Aerodynamics of Wind Turbines, Wind Turbine Fatigue, Wind Characteristics, and Offshore Wind Systems.* Symposia and conferences have been held on designated topics in each of these areas.

In addition to Joint Action symposia, Topical Expert Meetings are arranged once or twice a year on topics decided by the IEA R&D Wind Executive Committee.

Since these activities were initiated in 1978, 32 volumes of proceedings from Expert Meetings, 13 volumes of proceedings from the symposia on Aerodynamics of Wind Turbines, 5 from the symposia on Wind Turbine Fatigue, and two from the symposia on Wind Characteristics have been published. In the series of Recommended Practices 11 documents were published and five of these have revised editions.

The Annex was extended in 1999 until 2001. In January 2000, Sven-Erik Thor of FFA, Sweden, replaced the Technical University of Denmark as operating agent.

Four meetings took place in 1999. At the 32d Expert Meeting on *Wind Energy under Cold Climate Conditions* in Helsinki, Finland, 13 participants from 7 countries made eleven presentations. At the 2nd Symposium on *Wind Characteristics* at RISØ National Laboratory in Denmark, twelve papers were presented by 11 participants from 5 countries. At the 5th Symposium on *Wind Turbine Fatigue* at DTU Delft in the Netherlands, 14 participants from 4 countries gave 10 presentations. Finally, the 13th Symposium on *Aerodynamics of Wind Turbines* at FFA in Stockholm, Sweden, had 19 participants from 6 countries that presented 15 papers.

All documents produced under Task XI and published by the Operating Agent are available from the Operating Agent, and from representatives of countries participating in Task XI.

The Operating Agent of Annex XI also acts as the official IEA observer on Technical Committee No. 88, Wind Turbine Generator Systems, of the International Electrotechnical Commission (IEC TC88). The IEC is an international body that generates international standards in cooperation with ISO. The emerging standards often take the IEA Recommended Practices as precursors.

IEA TOPICAL EXPERT MEETING ON
Environmental Issues of Offshore Wind Farms

INTRODUCTORY NOTE

Ruud de Bruijne (Novem), the Netherlands
Elke Bruns, Technische Universität Berlin, Germany
Henning Grastrup, Techwise, Denmark

BACKGROUND

The IEA R&D Wind ExCo meeting in Magdeburg on the 19-th of April 2002 decided to hold a topical expert meeting of IEA R&D Wind on Environmental aspects of offshore wind energy and to maximise synergy with the COD project.

COD stands for Concerted action for Offshore wind energy Deployment and will be funded by the European Commission.

The objective of COD is to speed up the responsible deployment of offshore wind energy in the EC by early identification and possibly removing non-technical barriers: legal, administrative, policy, environmental and infrastructure issues, by co-ordination between energy agencies of 7 North/Baltic seas countries (NL, DK, UK, DE, SE, PO, and IRE) representing >90% of the technical Offshore potential in the EU. COD will interact with NGO's such as EWEA, Seas-at-Risk, through a Steering Board. The information will be fed into governmental decision-makers. Innovative is the non-technical transnational co-ordination so early in the development of a renewable energy resource. The participants involved ensure high-profile project dissemination, creating a focal point for information, better understanding and more harmonised European processes for deployment, environmental impact analysis and permission procedures for Offshore Wind Energy Farms, and improved EC industry competitiveness.

In recent years many countries in Europe have announced plans for installation of wind farms off shore. A survey published in the German Wind Kraft Journal 3/2001 lists more than 10 000 MW of planned installations.

In Sweden, Denmark, the Netherlands and the UK first wind farms have been installed off shore and in these as well as other European countries many more will follow in the next few years.

Placing wind farms off shore solves some of the challenges encountered when siting wind farms on shore like visual influence on the landscape, annoyance to inhabitants from noise and flickering light, conflicts with other planning interests etc. etc.

Other challenges remain - like influence on birds – and new are added like influence on marine life, hydrography and marine traffic.

While there are now 20 years of experience in assessing and meeting environmental challenges associated with land based wind installations little is known of the effects of off shore wind installations.

The planning and consenting procedure for each off shore wind farm installed so far has been on a case-by-case basis as have the demands for environmental surveys prior to installation and monitoring programs during construction and operation.

OBJECTIVES

It is proposed to hold an expert meeting to establish an overview of the existing knowledge and experience of the environmental impact, procedures and activities in connection with existing and planned off shore wind farms.

The result of the workshop will be:
- important input for the COD project
- input to define a possible IEA future role in this field

The topics for the meeting take as guidelines the issues that were identified as high priority by the government representatives on the second day of the COD kick-off meeting on April 16, 2002 in Amsterdam.

Environmental issues:

1. Public acceptance/ competing uses (e.g. fishing industry)
2. Preparation and licensing procedure: how to integrate environmental aspects into the licensing process.
   - Environmental Impact Assessment (EIA)
   - Strategic EIA
   - Spatial Planning (e.g. visual impact)
3. Identification of protection areas (flora-fauna-habitat, important bird areas, national protection areas)
   - Criteria for identification
   - Relevance in licensing procedures
4. Parts of the marine ecosystem to be assessed (i. e by EIA, Strategic EIA)
   - Fauna, esp. birds, fish, sea mammals, benthic organisms
   - Soil / sediment structure
5. Impact analysis and prognosis:
   - Caused by the running of plants: electromagnetic fields , acoustic impacts, vibrations
   - Caused by construction
   - Avoidance of impacts (i.e. technical measures)

The aim of the meeting will be to make an inventory of the already existing and available information on environmental aspects offshore wind energy.

Participants are encouraged to present the information as overviews of their and/or national work and include bibliographies.

This is will be important input for the COD project (work package 4).

The full description of work package 4 of the COD project is:
Objectives
- Collection of information on activities (projects) of participating countries, including at least birds, benthic flora and fauna, sub-sea noise, visual intrusion, and coastal impacts
- Collection of information on legal, policy and administrative issues of participating countries,
- Composition of a coherent overview with white spots
- Regular Updating

Description of work / tasks:
T4.1 Selection of the sort of information to be collected, including at least experience with monitoring of first Offshore wind energy projects
T4.2 Definition of the formats in which the information should be presented
T4.3 Collection of the selected information in the required format
T4.4 Selection of the most user friendly format to present the information for both the benchmark
(WP5) and the dissemination (WP7)
T4.5 Editing of a 'living' information package
T4.6 Continued collection of information concerning changes in the issues, programmes and activities
T4.7 Distribution of information package to other (non-participating) EU member states
Deliverables:
D4.1 Coherent format for data presentation on non-technical issues/activities month 3
D4.2 A common information base for environmental issues and activities month 9
D4.3 Updates in common information base month 12, 24, 32
Milestones and criteria:
M4.1 Coherent format for presentation month 3
M4.2 Information base operational month 9, 15, 27
M4.3 Information delivered to WP 5 month 12, 18, 30
Interrelation with other work packages:
WP5: The information collected in WP3 will form the basis for the benchmark of the EU and national programmes
WP6: The information collected in WP3 will be the main source for the database for the web site and for the other means of information dissemination

The Expert Meeting will concentrate on the collection of information on current and planned activities.

Expected output.

The output of the IEA workshop will be this inventory and recommendations to the COD project on how to proceed within the work package.

Participants.

The national members will invite the participants for the meeting, preferably participants with access to monitoring results, involved with environmental impact studies etc. and/or associated with the COD project.

This introductory note was written by Ruud de Bruijne (Novem, COD project leader) and Elke Bruns (Technische Universität Berlin co-ordinator of the COD work package 4). Also some input was used from Henning Grastrup, Techwise Denmark.

IEA R&D Wind ExCo
Topical Expert Meeting
„Environmental Issues of Offshore Wind Farms“

Dipl.-Ing. Elke Bruns
Technical University of Berlin
Department of Environmental Planning and Environmental Impact Assessment
(Chair: Prof. Dr. J. Köppel)

COD - Concerted Action on Offshore Wind Energy Deployment

Submitted within the EESD-Energy-Programme in the 5th Framework Programme

Proposed and co-ordinated by NOVEM (NL)

Participants: 7 North Sea and Baltic Sea countries: NL, SE, DE, UK, DK, IRE, PO, (BE)

Network / Platform for sharing knowledge on **non-technical** issues (legal, administative, policy, environmental and infrastructural issues)

Objectives of the COD project

- Speeding up a responsible deployment
- Identification and removing of non-technical barriers
- Trans-national coordination at a very early stage of the technical innovation process
- Harmonising european processes for deployment, environmental impact analysis and permission procedures (methods, key issues..)

TU Berlin Köppel, Bruns, Peters

COD - Working packages

WP 1 Network management
WP 2 Coordination with other networks
WP 3 Collection of information on legal, administrative and policy issues in home countries
WP 4 Collection of information on environmental issues
WP 5 Benchmark of environmental, legal, policy and administrative procedures
WP 6 Formulation of guidelines for offshore Wind Energy Deployment
WP 7 Dissemination of information in home country

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WP 4: Collection of information on environmental issues in participating countries

Objectives:

- Collection of information on activities of participating countries (birds, benthic flora and fauna, sub-sea noise, visual intrusion, coastal impacts)
- Collection of information on legal, policy and administrative issues
- Composition of a coherent overview
- Regular Updating

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Results / deliverables of WP 4

- Coherent data format for the presentation of non technical issues
- Feeding the data base and making it operational
- Delivering of information to WP 5 „benchmarking“ and WP 6 „guideline“

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Scope of environmental key issues

- Impact analysis and prediction
  - Manufacture and Transportation
  - Installation
  - Operation
  - Decommissioning
  - Methods of prediction

Scope of environmental key issues

- Effects on the marine ecosystem
  - Seabirds, migratory birds, fish, sea mammals, benthic organisms
  - Sediment
  - Diffraction of waves

Scope of environmental key issues

- Instruments of environmental planning
  - Strategic EIA
  - EIA
  - Habitats Assessment
  - Spatial Planning

Scope of environmental key issues

- Public acceptance and competing uses
  - Fishery
  - Public Transportation
  - Recreational Use
  - MilitaryUse
  - Aggregate Extraction

Scope of environmental key issues

- Identification of protection areas
  - Habitats Directive: Special Areas of Conservation (SAC)
  - Birds Directive: Special Protected Areas (SPA)
  - National protection areas
- Status of identification to be considered

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Discussion

- Environmental key issues (physical, biological, human issues)
- Availability of data and current state of scientific knowledge on each knowledge
- Current research programmes (incl. monitoring)
- Environmental issues / biological data in context with designation of protected areas / suitable areas
- Practical use of an EC-wide database

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Objectives of the meeting

Inventory and recommendations how to proceed
Support of data transfer to COD Project

- National overview of current research activities
- State of demonstratory projects / monitoring
- Scope of environmental „key issues“
  - identification of impacts
  - effects on the marine ecosystem; sensitivity

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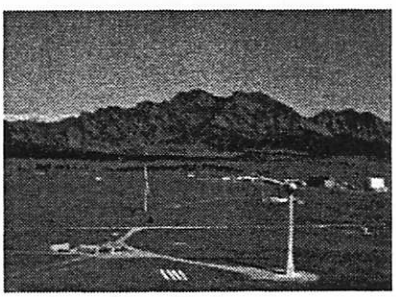
25 Years of Research Excellence 1977-2002

Presentation to:
Topical Expert Meeting On
Environmental Issues of Offshore Wind Farms



Jim Green, Senior Project Leader
National Wind Technology Center
September 23-24, 2002

Operated for the U.S. Department of Energy by Midwest Research Institute • Battelle • Bechtel

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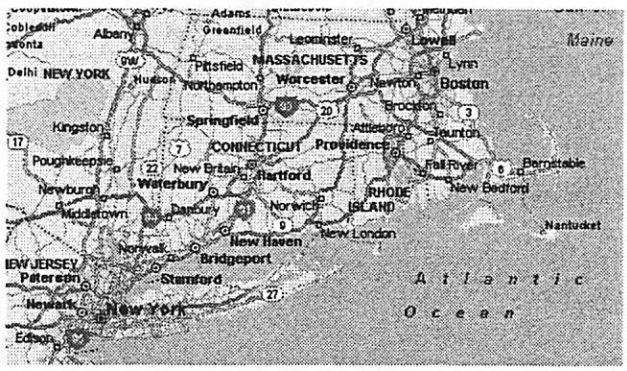
Siting of Offshore Power Plants?

- OTEC
  - Federal Law: Ocean Thermal Energy Conversion (OTEC) Act of 1980
  - Licensing Regulations issued by the US Dept. of Commerce (NOAA)
- Wind Farms
  - No similar guiding legislation for offshore wind
  - Permitting is being addressed under existing laws and regulations through the US Army Corps of Engineers

25 Years of Research Excellence 1977-2002

Cape Wind Project

- Proposed 425 MW offshore wind farm in Nantucket Sound
- www.capewind.org



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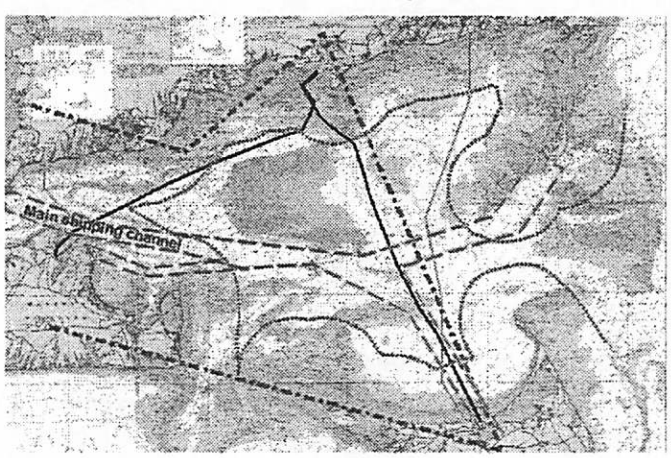
Cape Wind Project Map

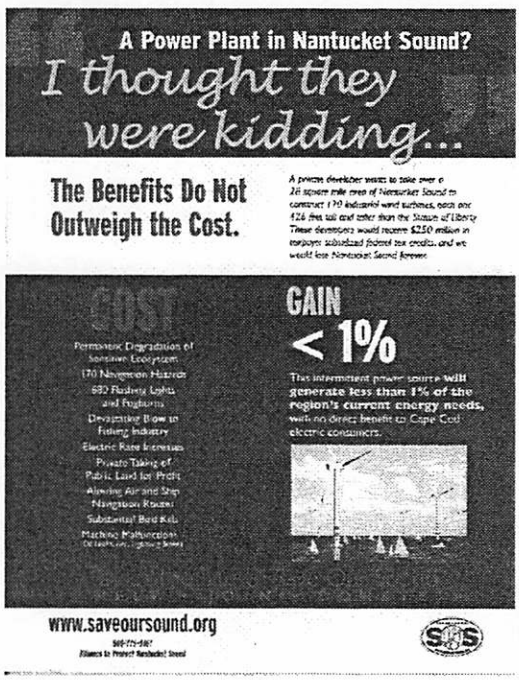


Wind Park Site
3 Mile Shoreline Boundary
Shipping Channels
Airline Flight Lanes
Ferry Routes
Existing Electric Cables

25 Years of Research Excellence 1977-2002

Cape Wind Project
Proposed Monitoring Station

- An environmental monitoring tower has been permitted by the US government (… and a law suite filed to block its installation)
  - Wind speed (cup and ultrasonic anemometers)
  - Wind direction
  - Air temperature
  - Barometric pressure
  - Wave height
  - Tides
  - Sea water temperature
  - Current velocity



The Opposition is Active

- Visual impact
- Industrial intrusion
- Economic damage
- Potential avian mortality

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State/Utility Collaboration

- Anemometer at 17 m on a navigation light
- Proposing a monitoring tower for a small island in Nantucket Sound, have a permit, awaiting funding
  - Wind speed: 10, 25, and 40 m
  - SODAR for short-term sampling of higher-level wind speeds
  - Wind direction
  - Air temperature, 2 heights
  - Acoustic Doppler current profiler: waves, currents, tides

Karlskrona offshore wind farm

Environmental Impact Assessment

Dr. Annika Andersson, Vattenfall Utveckling AB

VATTENFALL

Objectives

To get a permit to

- To build five wind mills offshore in Kalmarsund.
- Connect wind mills to transmission lines via a cable which is placed on sea bottom and on land.

Use the farm for evaluation and to gain experience.

VATTENFALL

Procedure

At initial stage three locations were defined for the wind farm.

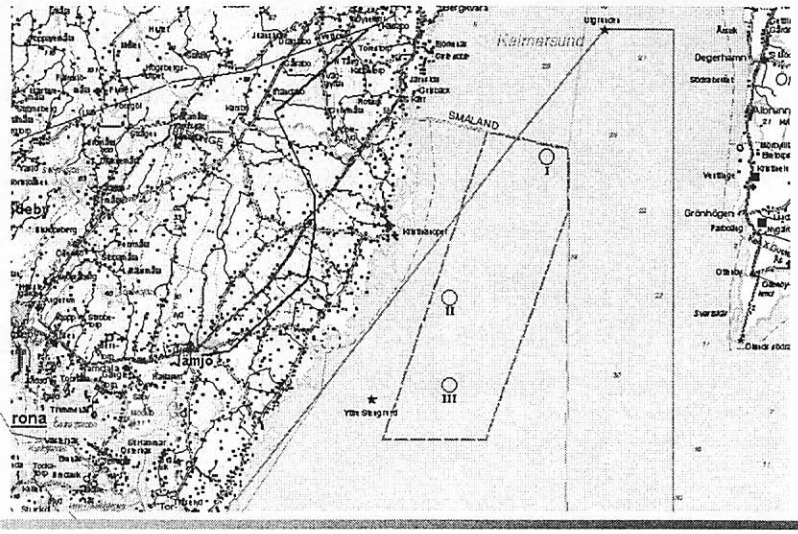
Eight locations for the cable to connect from sea to land were examined.

An extensive consultation with public, authorities and non-governmental organisations.

An acceptance questionnaire was sent to local public.

Military defence said no to two of the locations. Then only one was left.

Map of chosen area



Technique

Best available technique when permit is ready.

Plan is to use 3.5 MW turbines.

AC or DC cable will be decided when permit is ready.

Foundation – monopiles.

Environmental impacts – in proposal

Health and security

Noise, shadowing, reflexes, communication, aircraft, navigation, military defence, magnetic field.

Environment

Landscape, culture landscape, flora and fauna (birds and fishes).

Waste

Resources

Fishery, nature, culture, recreation, energy, military defence.

Fishes

National Board of Fisheries in Sweden

Pointed out three major impacts (2000)

- Noise (underwater and vibrations)
- Magnetic fields
- Changes in local environment.

Noise

In general, fishes perceive noise with low frequencies very well.

More studies are needed in this field?

Magnetic fields

Migration of silver eels has been studied related to the Baltic cable (HVDC).

Might affect the migration but in a minor extent. The eels could still migrate over the cable.

Other migrating fishes? Difference between AC and DC? Studies are needed?

Local environment

Might cause

- Increase the access to food.
- Increase the predation.
- Colonisations of new species due to new environment (like a reef).
- Loss of environment for some species.

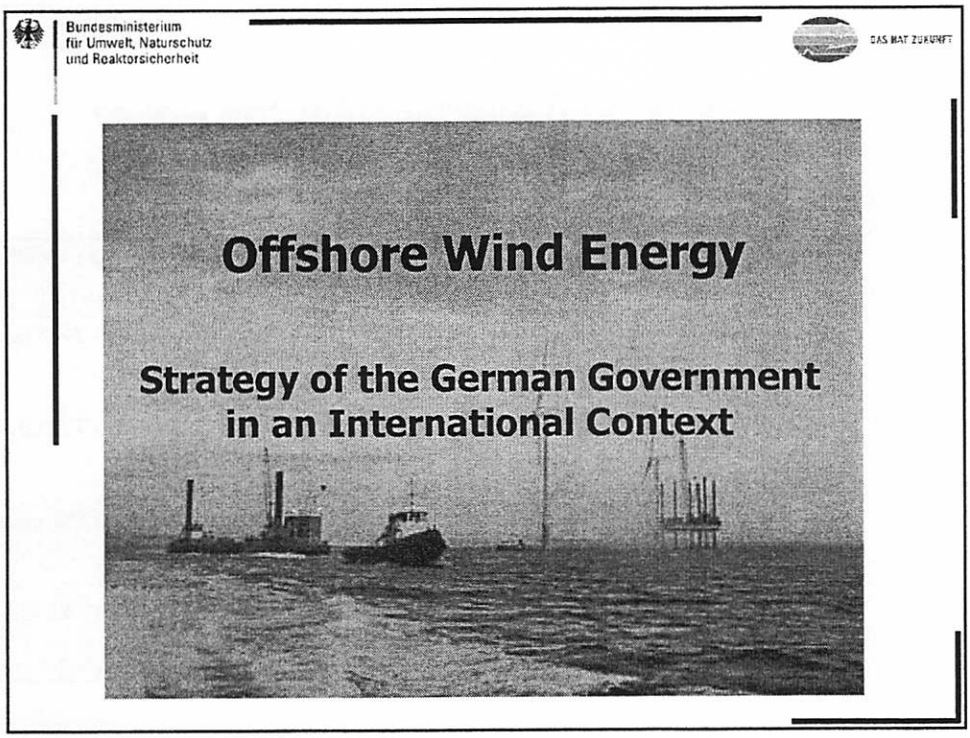
More studies in these areas ?

Finally

In order to evaluate environmental impacts from offshore wind farms, studies and investigations according to monitoring programmes are performed in Sweden.

Vattenfall follows these studies very carefully to be able to take the results into account when building our own wind mills.

www.vattenfall.se/karlskronavind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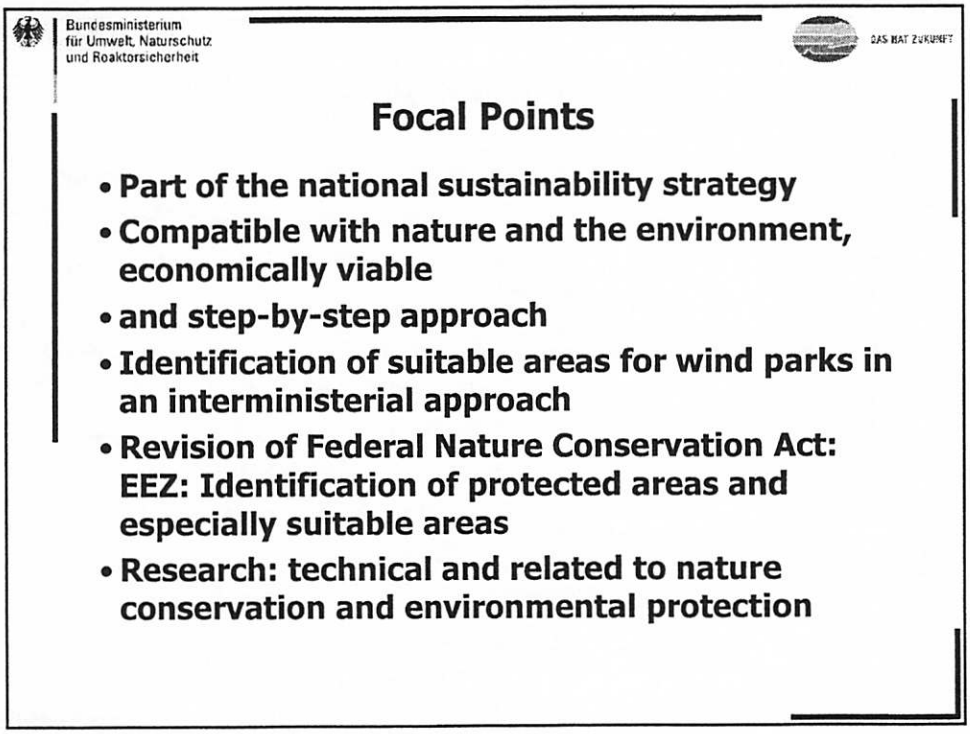
Offshore Wind Energy
Strategy of the German Government
in an International Context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Focal Points
• Part of the national sustainability strategy
• Compatible with nature and the environment, economically viable
• and step-by-step approach
• Identification of suitable areas for wind parks in an interministerial approach
• Revision of Federal Nature Conservation Act: EEZ: Identification of protected areas and especially suitable areas
• Research: technical and related to nature conservation and environmental protection

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Step-by-step Approach for the Use of Offshore Wind Energy

Phases	Period	Potential Capacity	Potential Power Yield
1. Preparation Phase	2001-2003	-- MW	-- TWh p.a.
2. Initial Phase (First Construction Phase)	2003/4- 2006	At least 500 MW	ca. 1,5 TWh p.a.
3. First Expansion Phase	2007-2010	2.000-3.000 MW	ca. 7 - 10 TWh p.a.
4. Additional Expansion Phases	2011-2030	20.000-25.000 MW	ca. 70 - 85 TWh p.a.

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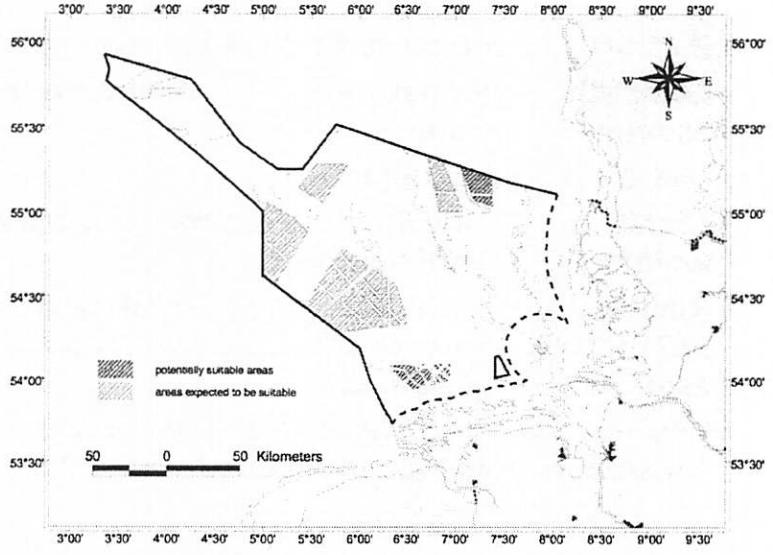
North Sea: Areas expected to be suitable for the use of wind energy in the EEZ as at 23 January 2002



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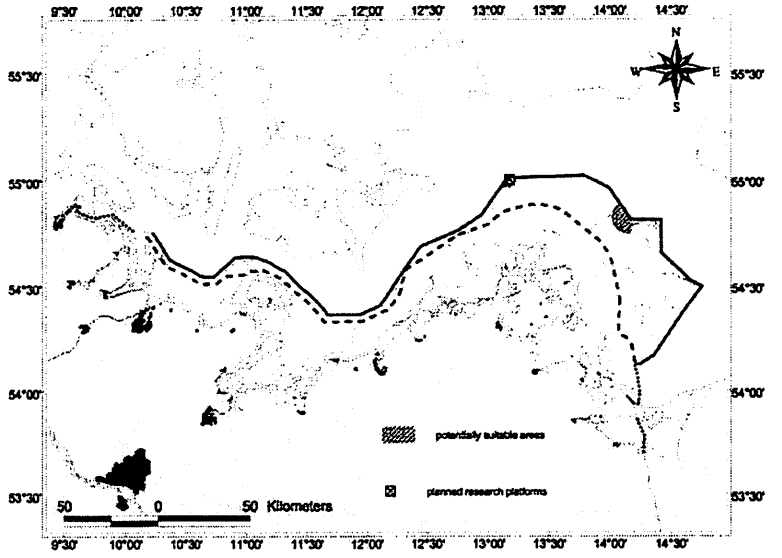
Baltic Sea: Potentially suitable areas for the use of offshore wind energy in the EEZ as at 23 January 2002



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Conclusions

- **Dynamic development of offshore wind energy in Germany expected**
- **Amendments to the Federal Nature Conservation Act and the Offshore Installations Ordinance laid the basis for legal and planning security**
- **Ambitious research project initiated**
- **Export increasingly important for German companies, also in the offshore sector**
- **Many things left to be done:**
  harmonisation of licencing
  grid connection

  to be solved in the near future!

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Article 2 a
Environmental Impact Assessment

For projects which require a licence under Article 2 and at the same time are projects as defined in Article 3 of the Environmental Impact Assessment Act, **an environmental impact assessment shall be carried out pursuant to this Act.** In the application of the provisions of the Administrative Procedures Act in accordance with Article 9 (1) second sentence of the Environmental Impact Assessment Act, the licencing authority shall take the place of the municipality. The public shall be informed of the **documents being presented for public inspection** pursuant to Article 6 of the Environmental Impact Assessment Act by means of an official announcement in the licencing authority's journal of legal notices and by publication in two supraregional daily newspapers.

Stand: April 2002

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Article 3
Refusal of the Licence

Issuance of the licence shall be refused if the safety and smoothness of traffic is disrupted or the marine environment is endangered and these negative effects cannot be prevented or compensated for by imposition of a time limit, condition or additional requirement. Particular grounds for a refusal shall be deemed to exist in cases where

- operation and effect of navigational installations and marks or,
- the use of shipping lanes or airspace, or navigation

would be disrupted;

- pollution of the marine environment as defined in Article 1 (1) No. 4 of the United Nations Convention on the Law of the Sea of 10 December 1982 (BGBl. 1994 II p. 1798) is to be feared, **or if bird migration is endangered.**

The licence shall not be refused if no grounds for refusal within the meaning of the first sentence above exist.

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Article 3 a
Particularly Suitable Areas for Wind Farms

- The Federal Ministry of Transport, Building and Housing shall specify, in agreement with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, with the participation of other Federal Ministries concerned, the participation of the public and after consultation with the *Länder*, **areas particularly suitable for wind farms.** (...) Identification of a particularly suitable area shall only be permissible if no grounds for refusal pursuant to Article 3 and no protected area designations in accordance with Article 38 of the Federal Nature Conservation Act oppose the choice of locations for wind farms in the areas concerned. Particularly suitable areas shall be specified and updated according to **the latest experience and scientific knowledge** available, especially with a view to be designated under Article 38 of the Federal Nature Conservation Act (...)

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Article 3 a
(Continued)

(2) In the licencing procedure, the identification of a particularly suitable area pursuant to paragraph (1) above shall have the effect of an **expert opinion** with regard to the choice of location for installations. The requirements concerning the environmental impact assessment for projects pursuant to Article 2a shall remain unaffected.

Wind Power off shore in Denmark

- The off shore programme
- Environmental monitoring programme

Lars Bo Hansen

Ministry of the Environment
Danish Forest and Nature Agency

Energy 21
The Danish Action Plan for Energy
(from 1996)

Main Targets in Energy 21

- 20% reduction of CO_2 - emissions from 1988 to 2005
- 50% reduction of CO_2 - emissions before 2030
- 12 - 14 % of renewable energy in 2005 (100 PJ)
- 35% of renewable energy by 2030 (235 PJ)

Targets for Wind Power

- 1500 MW wind power in 2005 (200 MW off-shore)
- 5500 MW wind power in 2030 (4000 MW off-shore)
  40-50% of electricity consumption

Energy 21
The Danish Government's Action Plan for Energy

Why wind power off shore

- Limited potential on shore
- Large potential off shore
- Better wind conditions
- Better conditions for large scale
- Less conflict of interests

Mapping of interests in the Danish waters (1995)

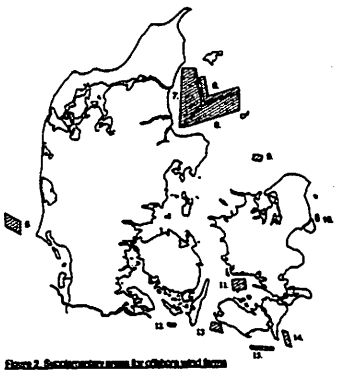
- **Prohibitive interests:**
  - **Maritime protection / Traffic**
  - **Bird protection areas and other protected areas**
  - **Areas of archaeological importance**
  - **Oil and gas pipelines and existing cables**
  - **Areas with raw materials**
  - **Military practice areas**
- **Relative interests**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

Recommendations for selecting future offshore sites

- **Wind farms should be concentrated in a few large areas in order to minimise the visual impact**
- **Large scale wind farms should be placed at least 7 km from coast, preferably 12 km, the distance depending the specific site**
- **Development should be concentrated in order to make optimal use of grid connections**
- **Areas should contain as few other interests as possible**
- **min. 6 meter and max. 15 meter water depth**

Areas for off shore wind farms

potential to 12500 (28000) MW



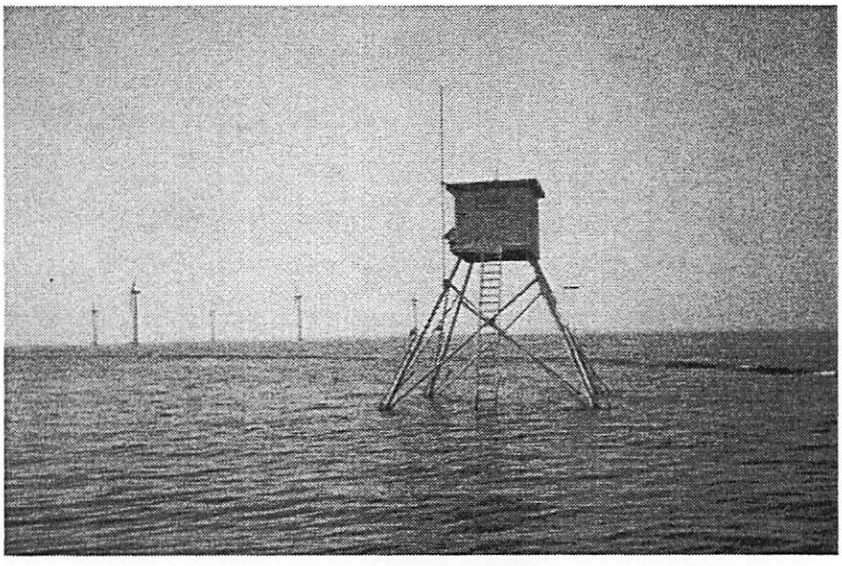
1997 Action Plan for offshore wind farms

by the Offshore Windfarm Working Group of the
Electricity Companies, the National Forest and Nature Agency and the Danish Energy Agency

Conclusions:

- Potential in the Danish waters to realise min. 4000 MW.
- Acceptable economy. Economy for first phase comparable to land based turbines on medium good placements
- Technology available - turbine size and grid connections
- Environmental impact limited
- Need for large scale demonstration projects

Bird investigation tower at Tunø



5 Large Scale Demonstration Farms

- **Agreement between Government and Electricity sector September 1997**
- **5 Demonstration offshore wind farms, each at 150 MW to be built from 2002 to 2008**
- **The wind farms are to investigate economical, technical and environmental matters**
  - **and to speed up offshore development**
  - **and open up the selected areas for future wind farms**
- **Projects financed by the electricity sector**
- **2.1 mio. tons of CO2 saved extra per year**
- ***Now: Only 2 projects and a new government decision in November 2002***

Off shore projects in Danmark

- Vindeby (1989:11 x 0,45 MW)
- Tunø Knob (1995: 10 x 0,5 MW)
- Middelgrund (2000: 20 x 2 MW)

+ Horns Rev (2002: 80 x 2 MW)

- Samsø (2002: 10 x 2,3 MW)

+ Nysted/Rødsand (2002/3 :72 *2,1 MW)

- Frederikshavn (approved: 4 x 1,5 MW)
- Rønland (approved: 5 -12 x 2 MW)
- Grenå (plan for few)

+ [Læsø, Omø Stålgrund & Gedser Government revision of the plan for 3 more parks at 150 MW)]

Monitoring programme

- **More than the EIAs that showed no significant negative impact**
- **Monitoring before, during after the establishment of the wind farms:**
  - A programme with diversity in subjects and sites
  - Relevance of effects for further extension
  - The ecological vulnerability and risk of negative effects at the sites
- **Environmental Committee and a Green Committee (public interests).**
- **Appointment of an advisory panel of experts on marine biology**

Monitoring programme (by 2002 but dynamic)

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

HR = Horns Rev, NY/RDS = Nysted/Rødsand.

Danish Offshore Demonstration Wind Farms

Nysted Offshore Wind Farm

(= Rødsand Offshore Wind Farm)

Environmental Impact Assessment and Environmental Studies

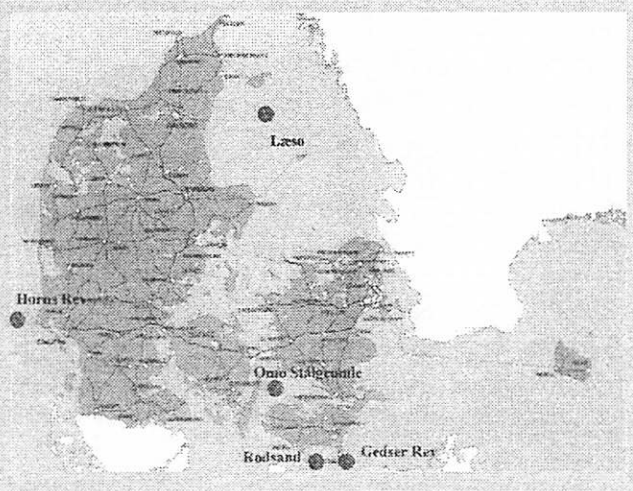
Pernille Holm Skyt
Environmental Planner

SEAS Wind Energy Centre

SEAS Wind Energy Centre

NystedHavmøllepark

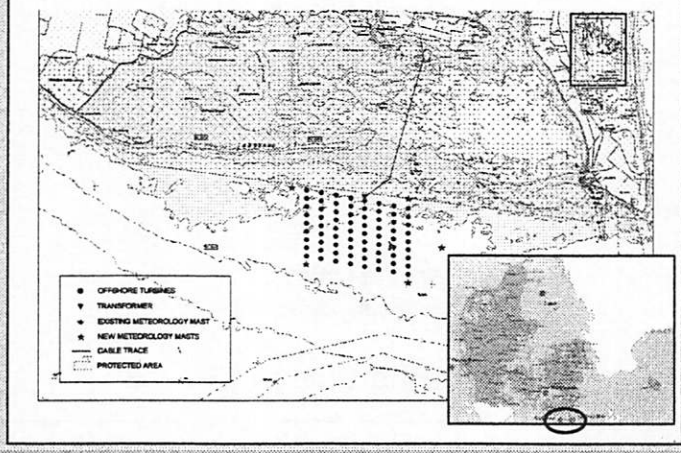
Offshore Demonstration Wind Farms in Denmark



SEAS Wind Energy Centre

NystedHavmøllepark

Location of Nysted Offshore Wind Farm



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NystedHavmøllepark

Environmental Impact Assessment

- Identification of possible environmental impacts
- Environmental Impact Assessment
  - *During construction of the wind farm*
  - *During operating the wind farm*
- Environmental studies
  - *Baseline studies*
  - *Studies during the construction*
  - *Studies during the operation*

SEAS Wind Energy Centre

NystedHavmøllepark

Environmental Impact Assessment

- Visual impact
- Morphology
- Bottom fauna and flora
- Fish and fishery
- Underwater noise
- Birds
- Porpoise
- Seals
- Risk assessment: ship collision

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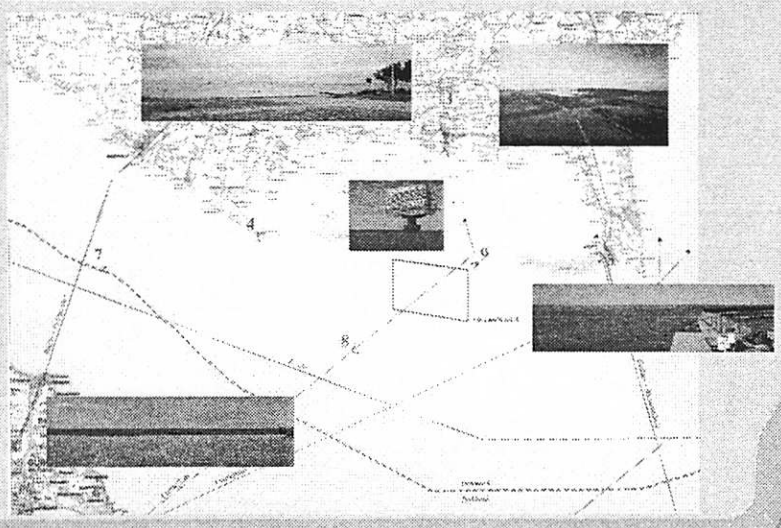
Nysted Havmøllepark

Visual impact: Visualisations



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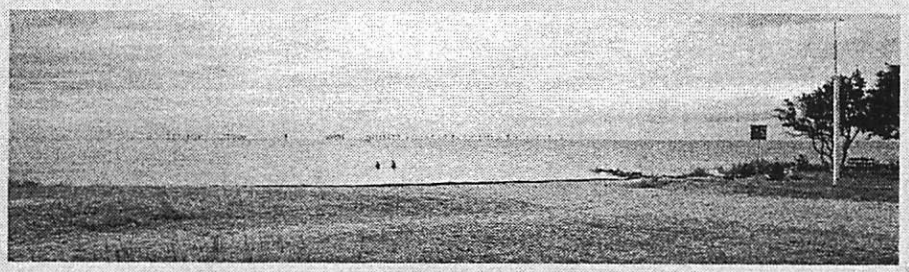
Nysted Havmøllepark

Visualisation: From Nysted - Skansen



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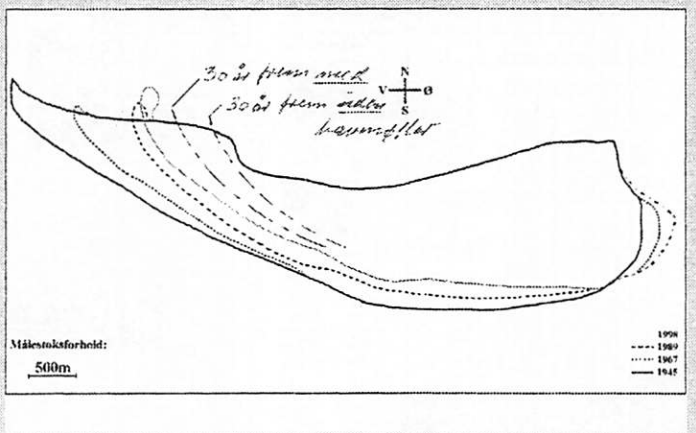
NystedHavmøllepark

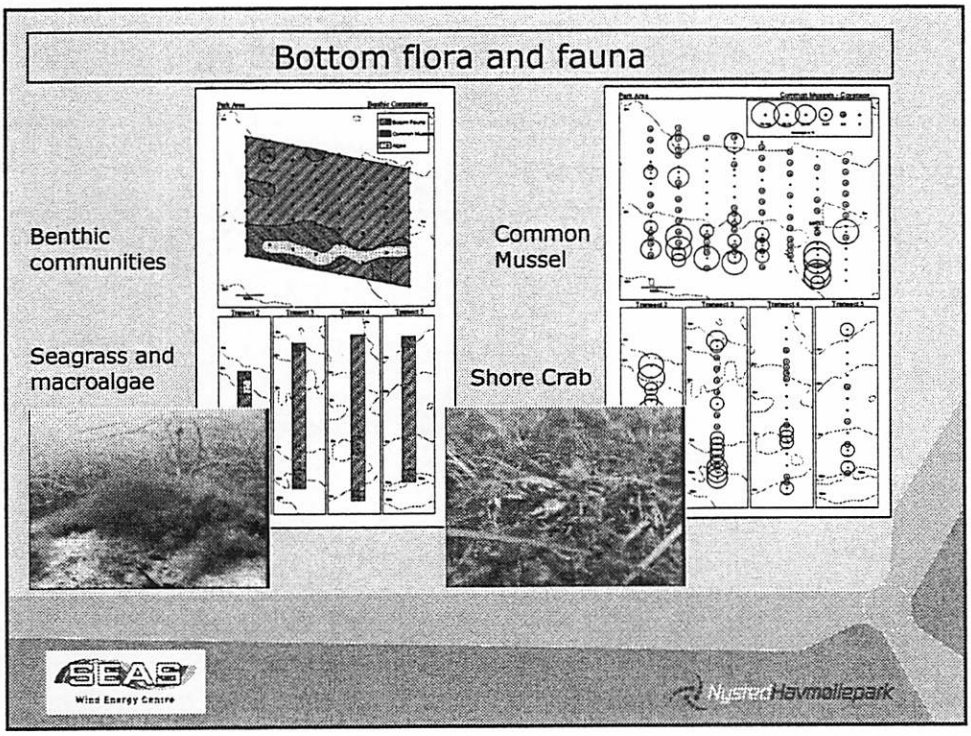
Morphology

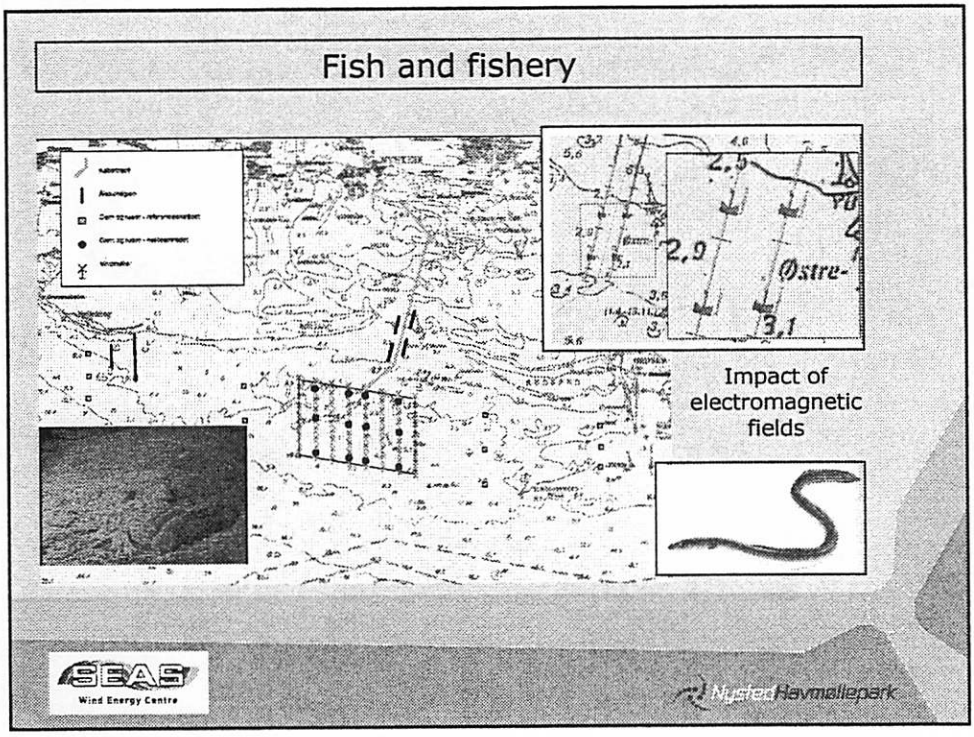


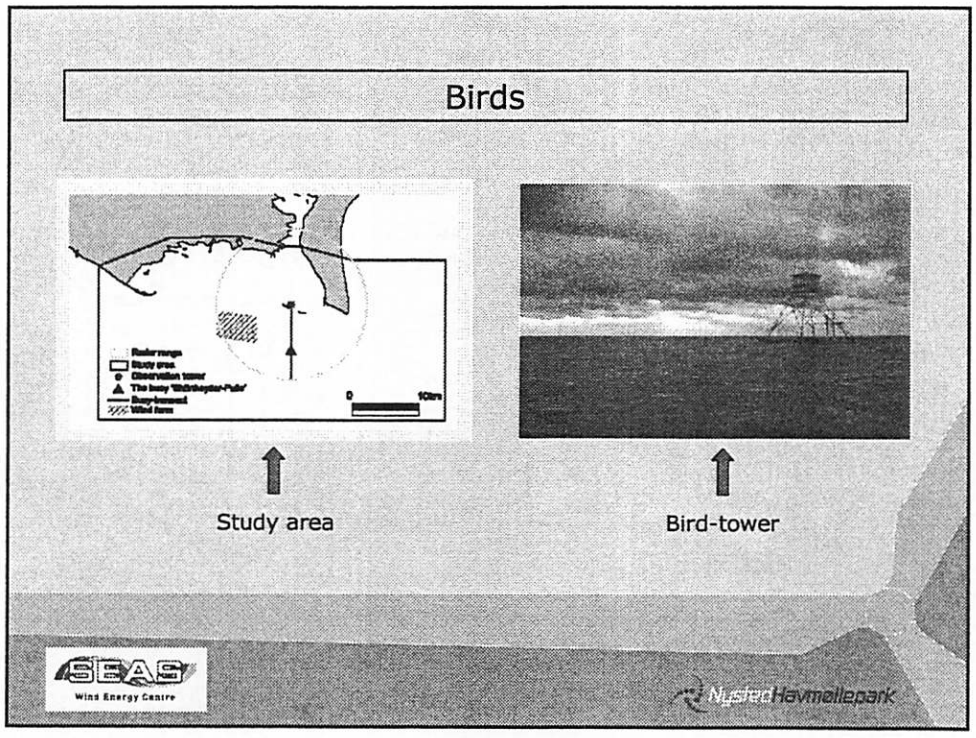
Development of the Eastern Rødsand Barrier since 1945

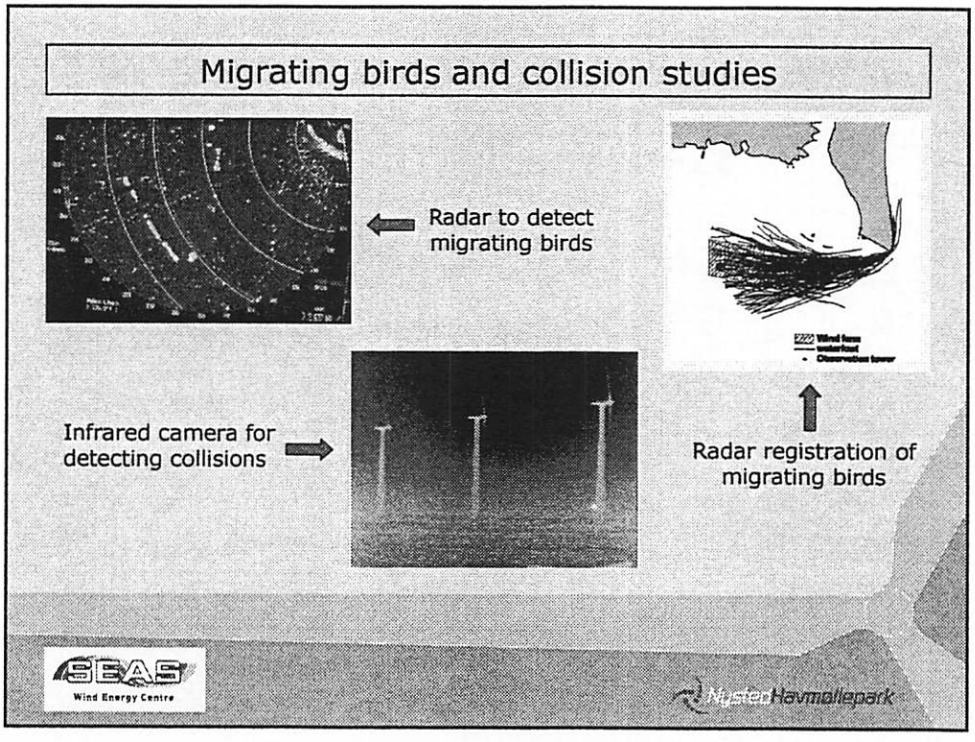
SEAS Wind Energy Centre

NystedHavmøllepark


Bottom flora and fauna
Benthic communities
Common Mussel
Seagrass and macroalgae
Shore Crab
SEAS Wind Energy Centre
NystedHavmøllepark

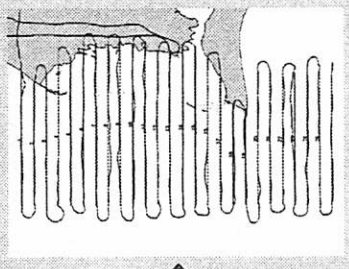

Fish and fishery
Impact of electromagnetic fields
SEAS Wind Energy Centre
NystedHavmøllepark


Birds
Study area
Bird-tower
SEAS
Wind Energy Centre
Nysted Havmøllepark


Migrating birds and collision studies
Radar to detect migrating birds
Infrared camera for detecting collisions
Radar registration of migrating birds
SEAS
Wind Energy Centre
Nysted Havmøllepark

Resting birds

Aeroplane for bird counts

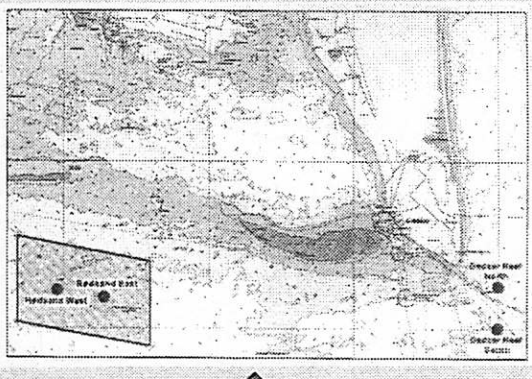


Flight route during bird counts

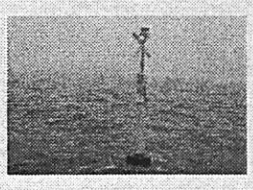
SEAS Wind Energy Centre

Nysted Havmøllepark

Harbour Porpoise



PODs hydrophones in the wind farm and reference area



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Nysted Havmøllepark

Seals

- Satellite tracking
- Video camera
- Flight counts

Aerial photo of seals in the sanctuary

SEAS Wind Energy Centre

Nysted Havmøllepark

Satellite tracking of seals

SEAS Wind Energy Centre

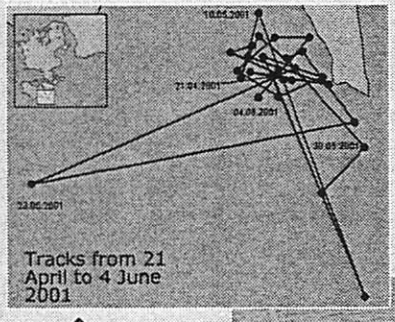
Nysted Havmøllepark

Behaviour during satellite tracking

SEAS Wind Energy Centre

Nysted Havmøllepark

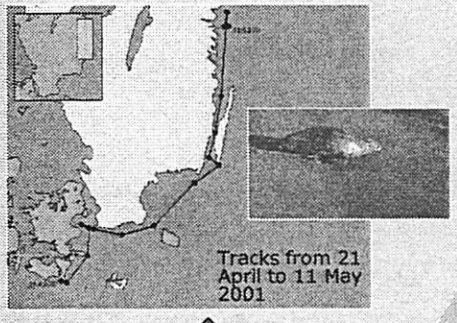
The Harbour Seal
Selma's route



Tracks from 21 April to 4 June 2001

Selma stays in the local area

The Grey Seal
Marie's route



Tracks from 21 April to 11 May 2001

Marie went to the Swedish east coast

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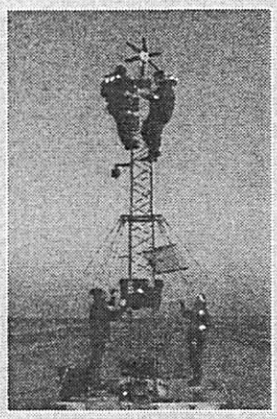
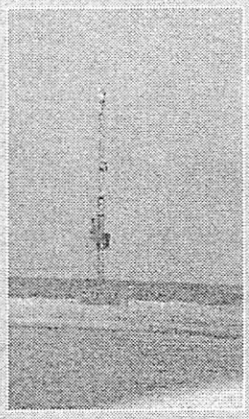
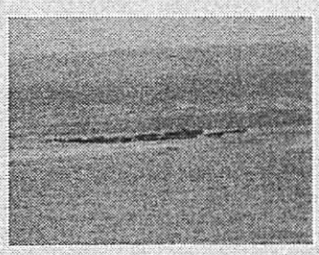
Video camera filming the seals in the seal sanctuary





Camera mast



Camera picture of the seals in the sanctuary

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Nysted Havmøllepark

Environmental studies for Nysted Offshore Wind Farm

- Infrared camera: Bird collision
- Web camera: Seal behaviour
- Satellite tracking: Seal activity and mobility
- Porpoise detectors (PODs): Harbour porpoise occurrence and activity
- Fish study along cable trace: impact of cable work and electromagnetic fields
- Noise measurements: under/above water noise, infra-sound, vibrations from monopiles

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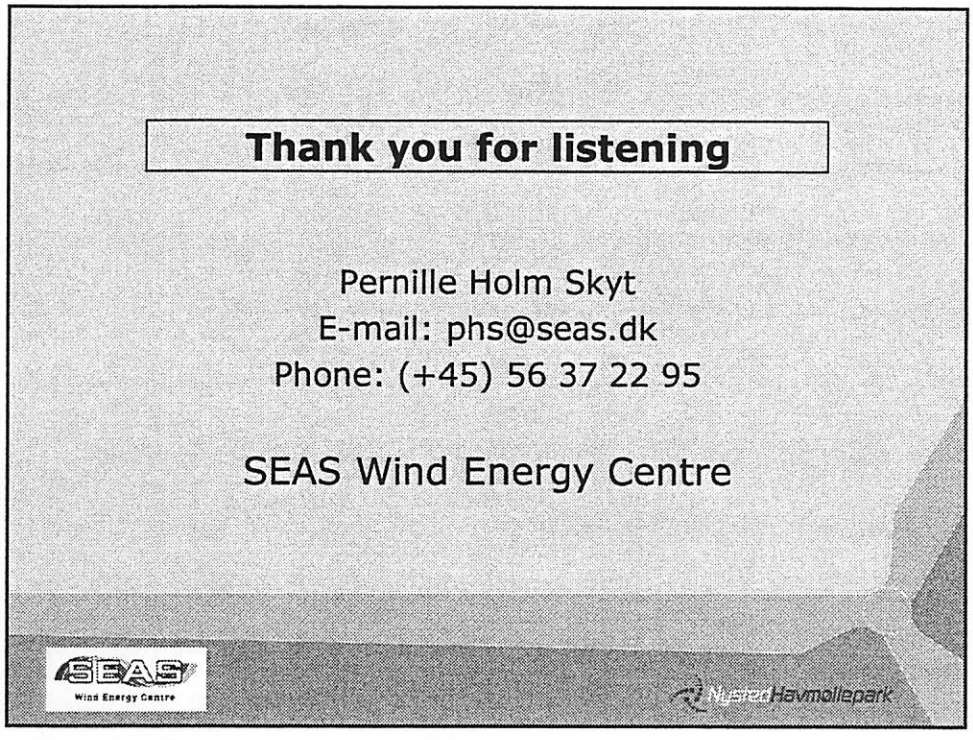
Thank you for listening
Pernille Holm Skyt
E-mail: phs@seas.dk
Phone: (+45) 56 37 22 95
SEAS Wind Energy Centre
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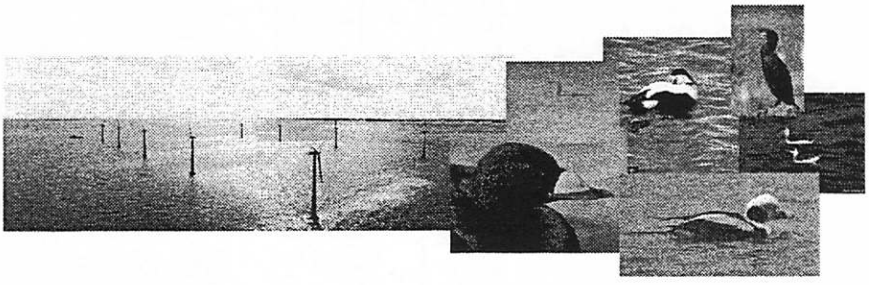
Wind Energy Centre
Nysted Havmøllepark

Offshore wind farms and birds

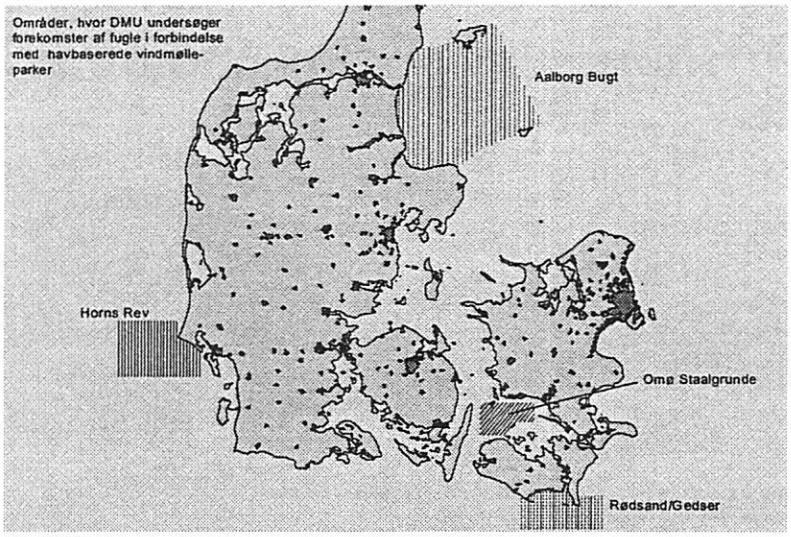


Topical Expert Meeting: Environmental issues of offshore wind farms
Husum, Germany: 23-24 September 2002 2002

Department of Coastal Zone Ecology,
Danish National Environmental Research Institute,
Kalø

Development of offshore wind farms

- 1997 Action plan



Development of offshore wind farms

- 1998 The minister directed the power companies SEAS and ELSAM/ELTRA to build offshore wind farms
- 1998 Applications delivered
- 1999 Principal approval with permission to carry out pre-studies and preparing EIAs
- 2001 Final approval for constructing wind farms at Horns Rev and Rødsand

Monitoring programme

- a period before installation of the wind farm
- the construction period
- the initial phase of operation

Monitoring programme

- the wind farm area
- an impact area
- one or more reference areas

NERI's study programme

- reviewing literature
- occurrence, abundance and distribution of birds
- bird migration at Rødsand
- EIA analyses

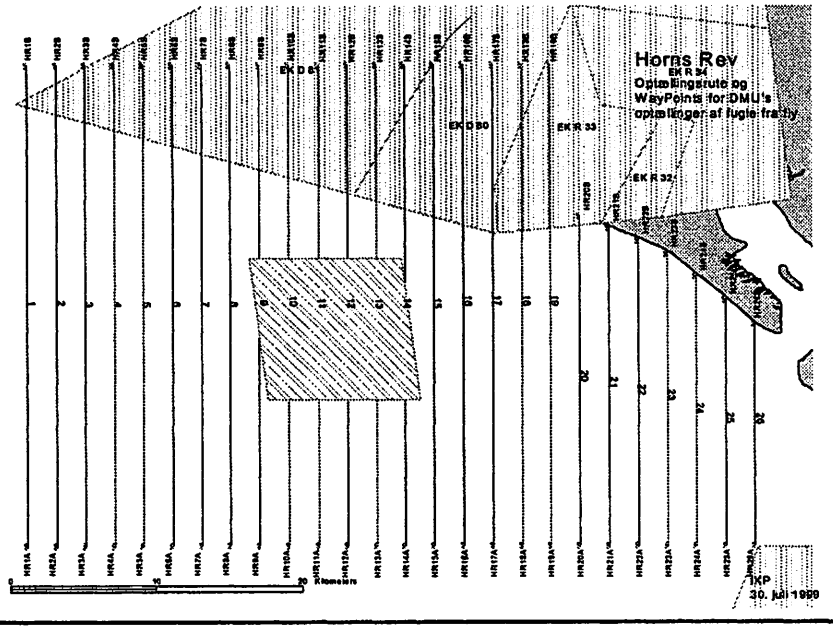
Potential impacts

- physical change of the habitat
- disturbance/avoidance effect
- collision risk

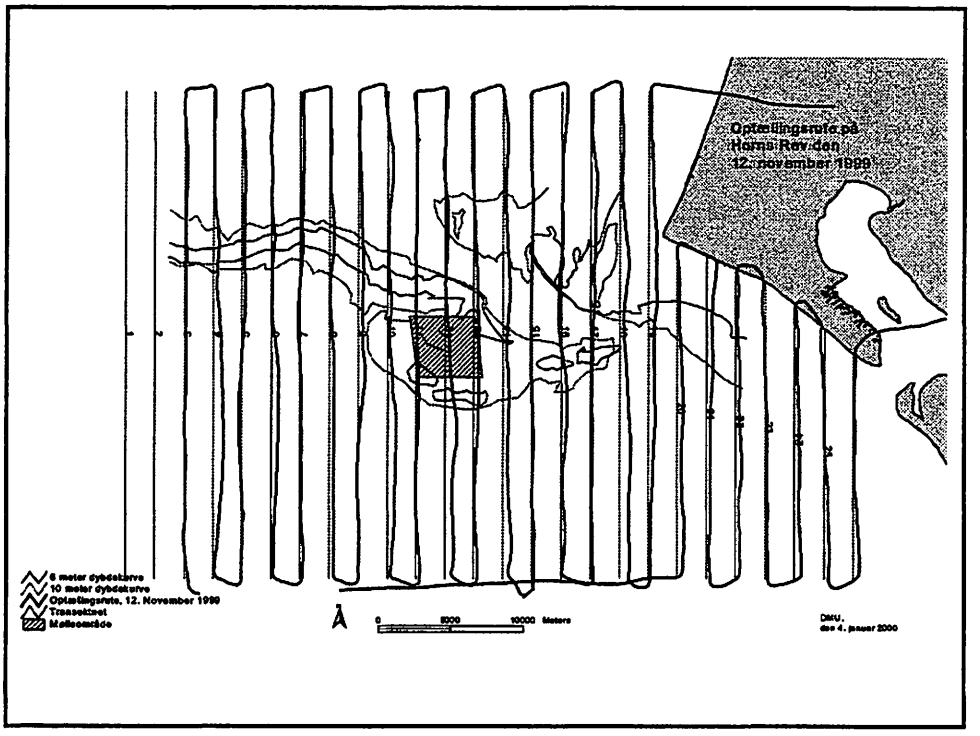
Study area

- the wind farm area
- an impact area
- one or more reference areas

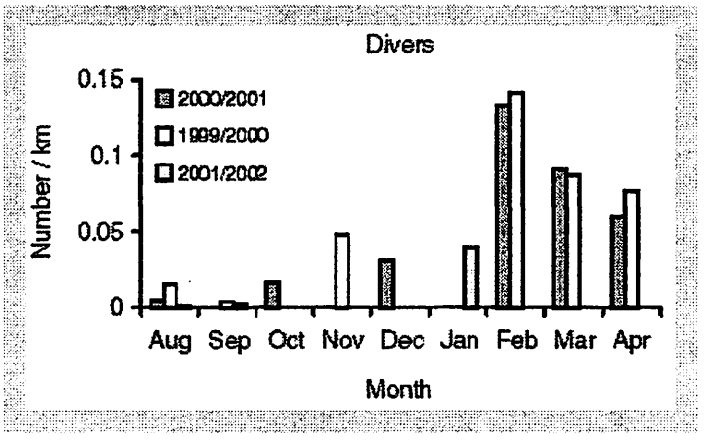
Study area and transect lines

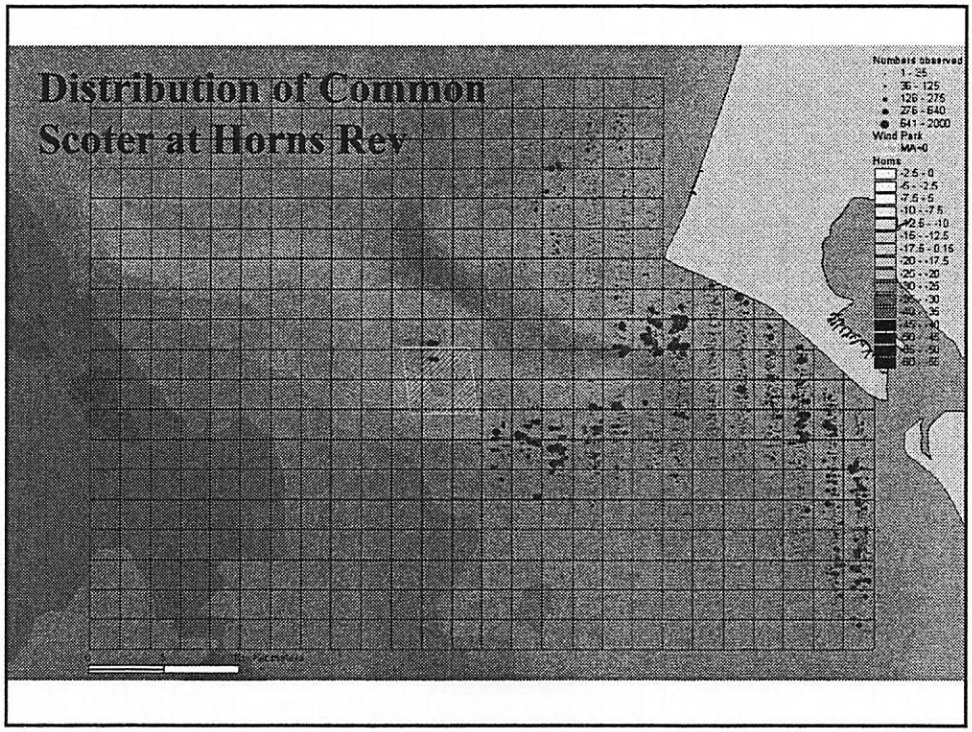


Results

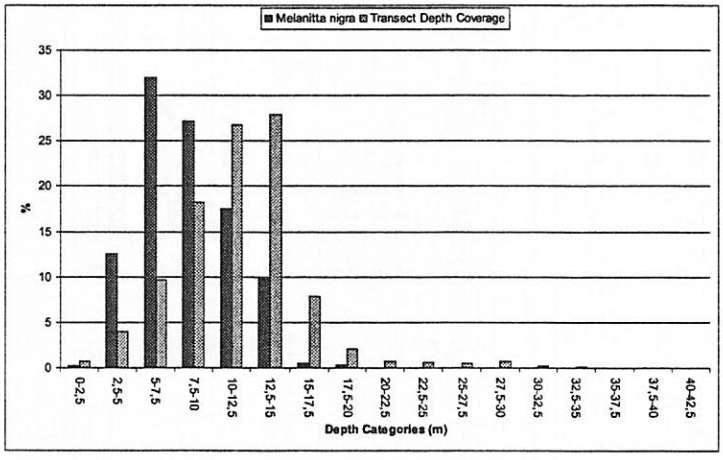


No. of divers per transect km

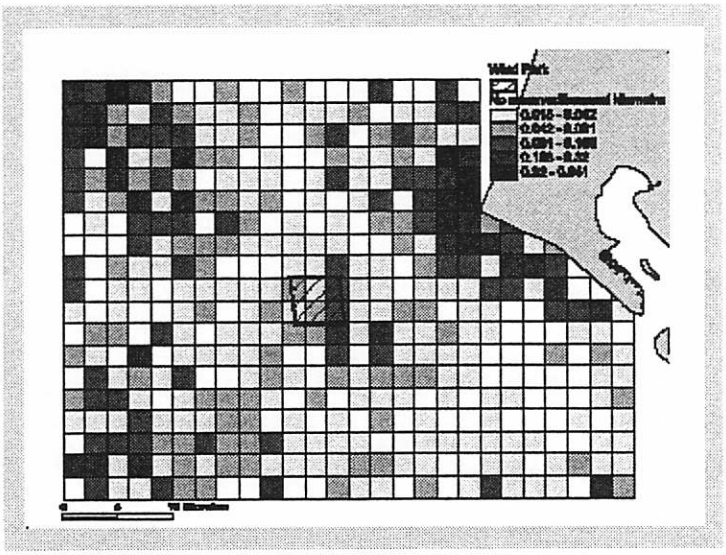




Common scoter select for shallow water depths



Distribution of divers from 13 counts



Development of spatial modelling software

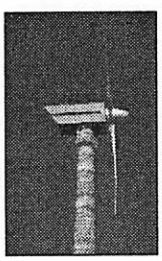
- Conversion of line transect sightings of birds into densities incorporating environmental and other covariates

Example covariates

- **Latitude/longitude**
- **Water depth**
- **Bottom aspect**
- **Bottom sediment**
- **Month**
- **Current**
- **Distance from disturbance loci**
- **Salinity**
- **Water temperature**

Collisions of birds

Johnny Kahlert
Dept. Coastal Zone Ecology
National Environmental Research Institute



Collisions

Mortality factor

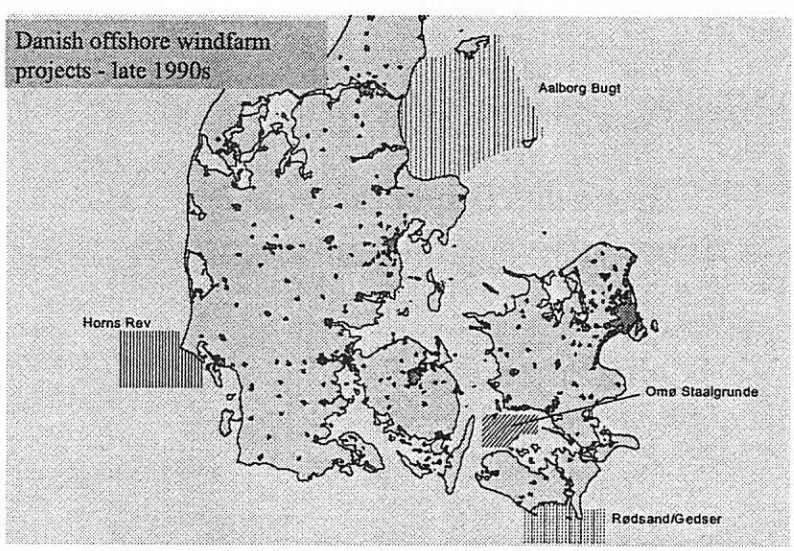
Long-lived species with low reproductive output most sensitive

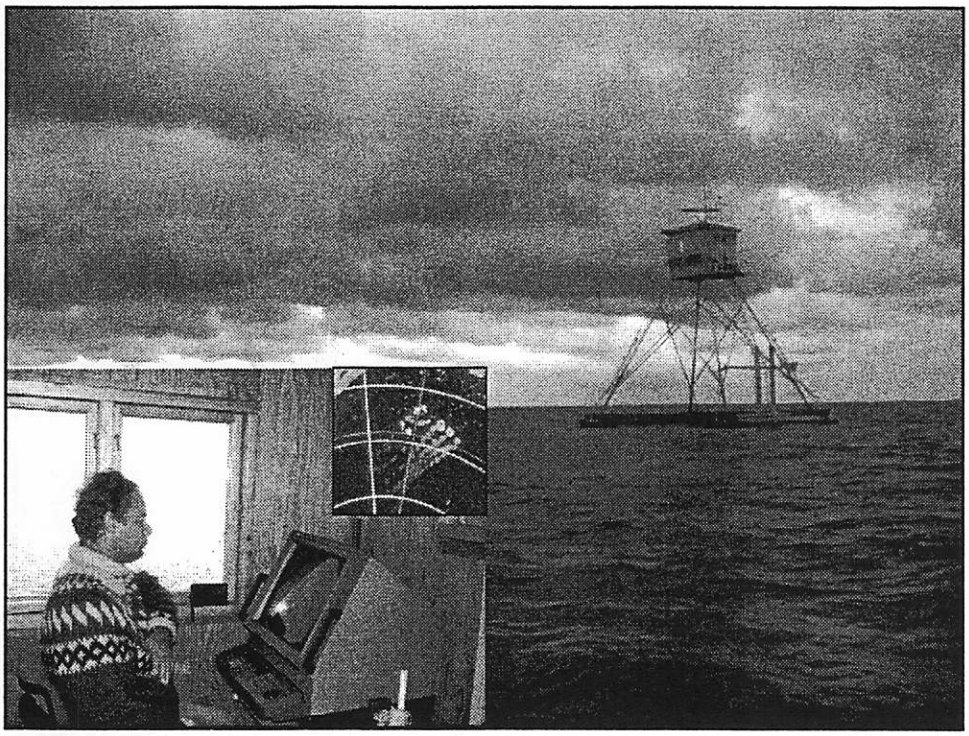
Highest probability during periods with low visibility

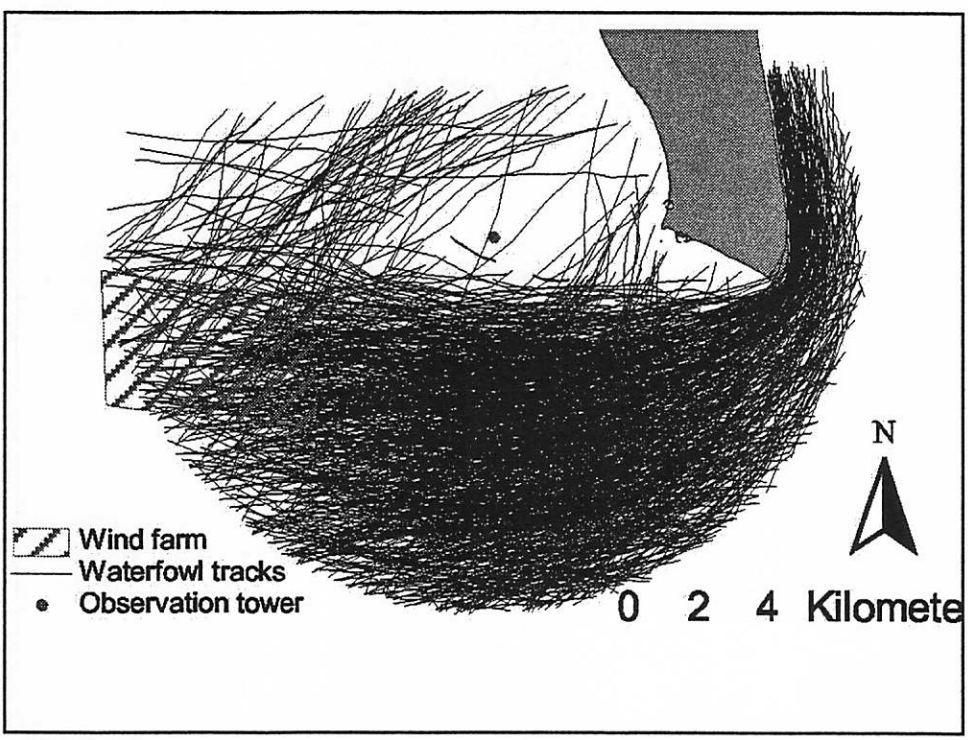
Tailwind elevates flight altitude and migration intensity

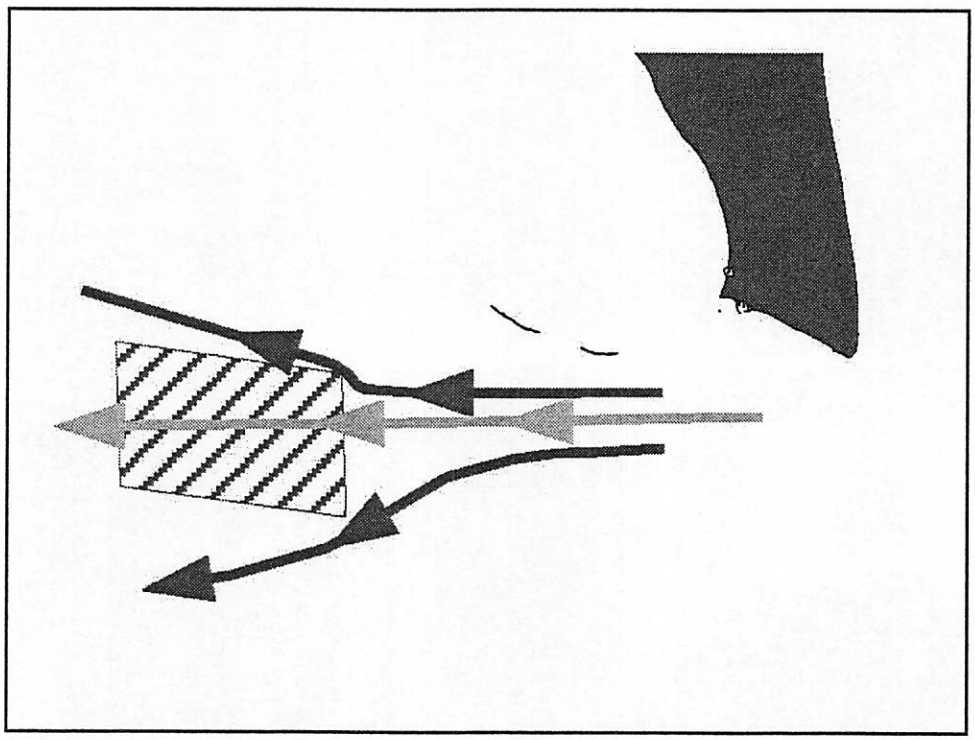
Studies related to collision

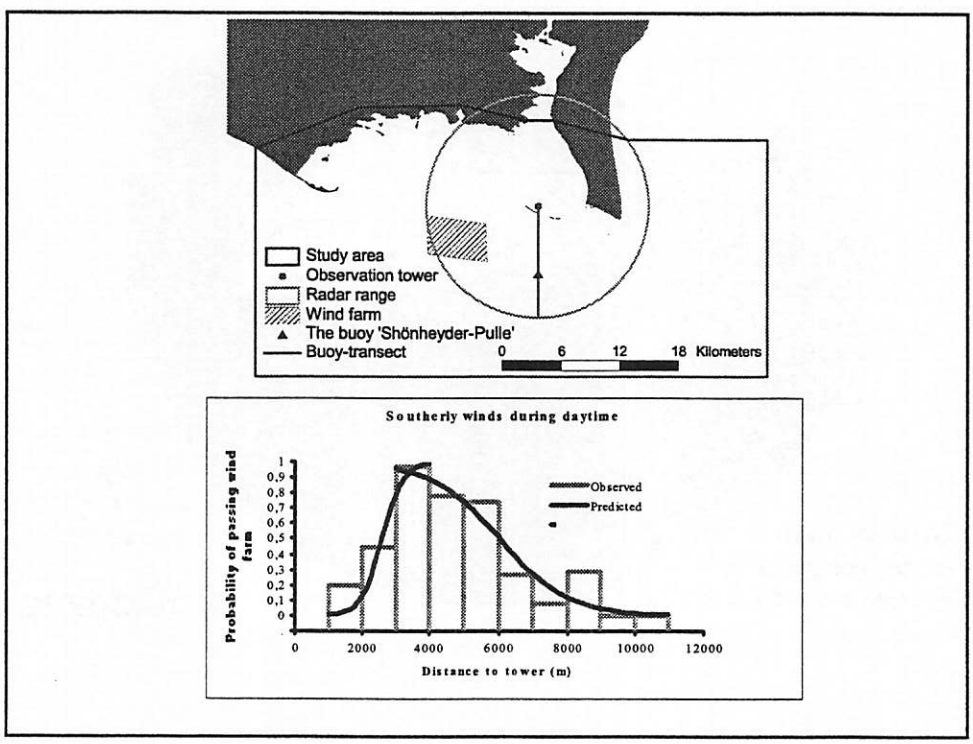
Defining the problem
Response of migratory birds
Collision frequency






Wind farm
Waterfowl tracks
Observation tower
N
0 2 4 Kilomete




Study area
Observation tower
Radar range
Wind farm
The buoy 'Shönheyder-Pulle'
Buoy-transect
0 6 12 18 Kilometers
Southerly winds during daytime
Probability of passing wind farm
Observed
Predicted
0 2000 4000 6000 8000 10000 12000
Distance to tower (m)

Information achieved by radar studies

Flight trajectories of birds as:

they approach

they pass

they have passed

Probabilities of crossing wind farm area

Response distance of migratory birds

What can the information be used for?

"Globally"

An understanding of the mechanism which determines collision frequency

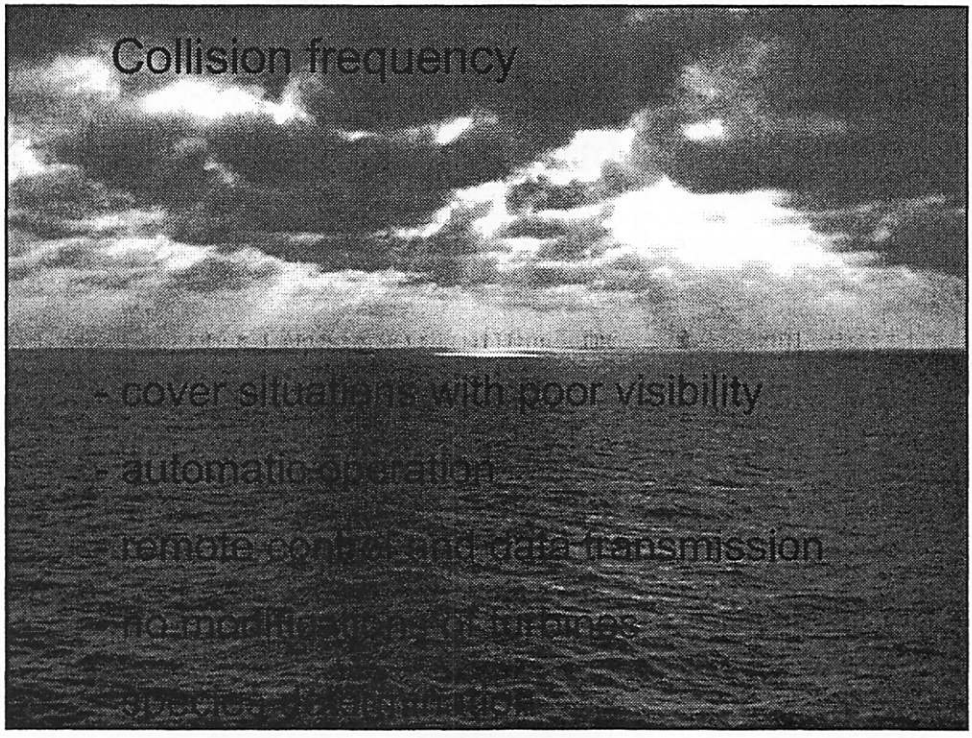
Provide the background for models which predict collision risk

What can the information be used for?

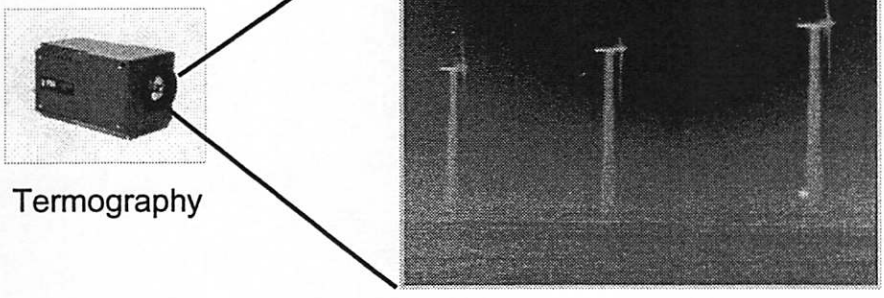
"Locally"

Design of project

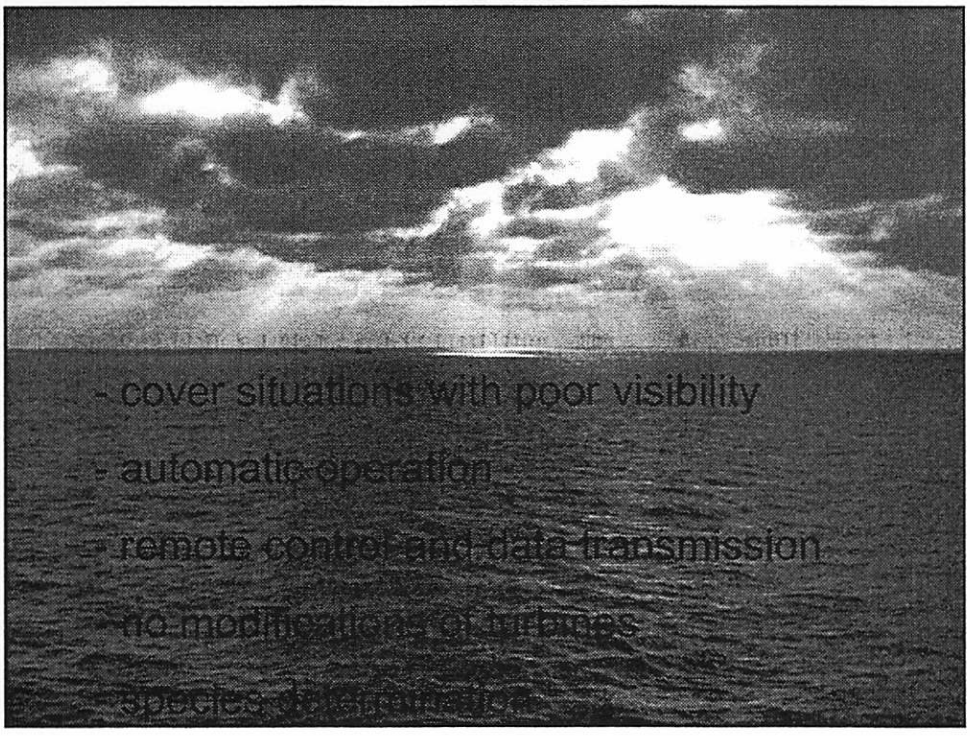
Assessment of most suitable sites for establishment of new modules in connection with existing wind farms

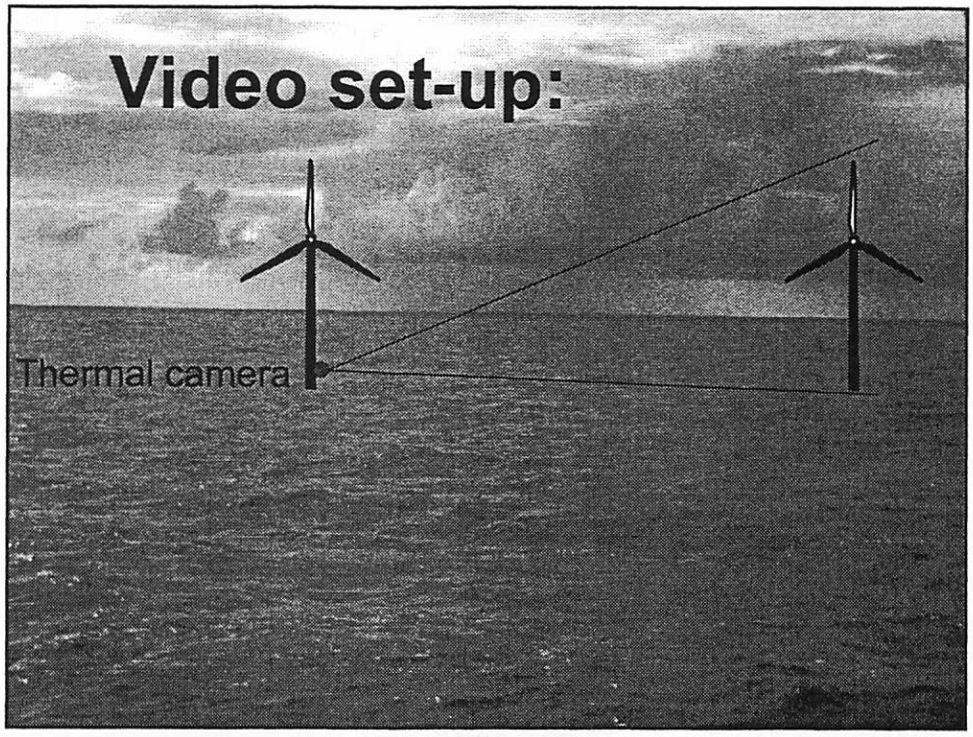


Development project:



Termography



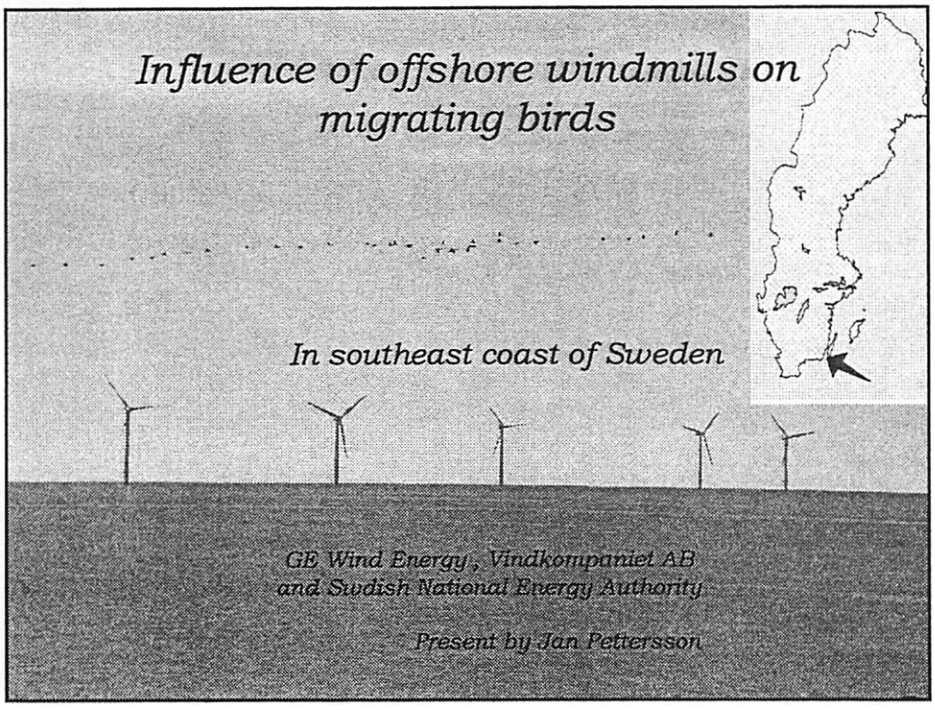


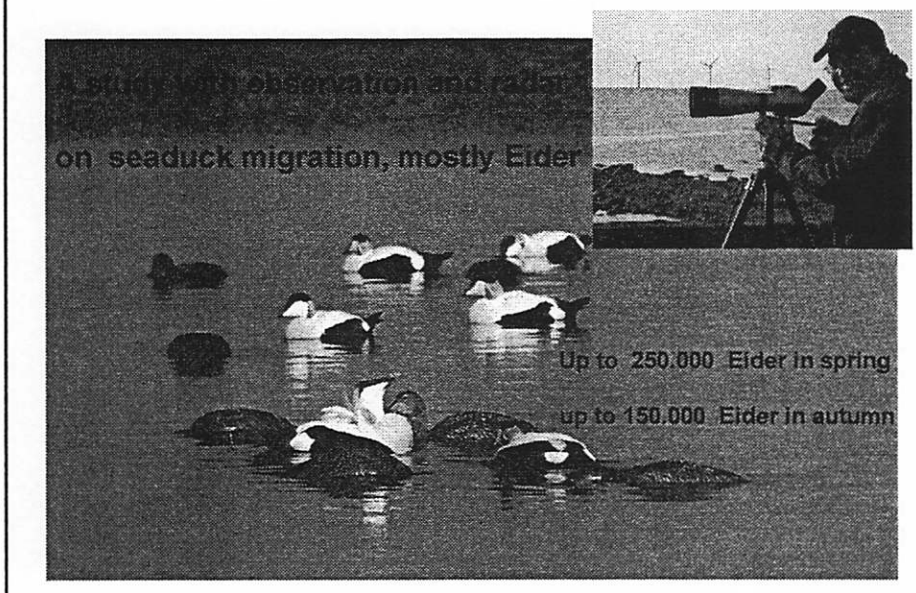
What can the information be used for ?

Collision frequency at one turbine

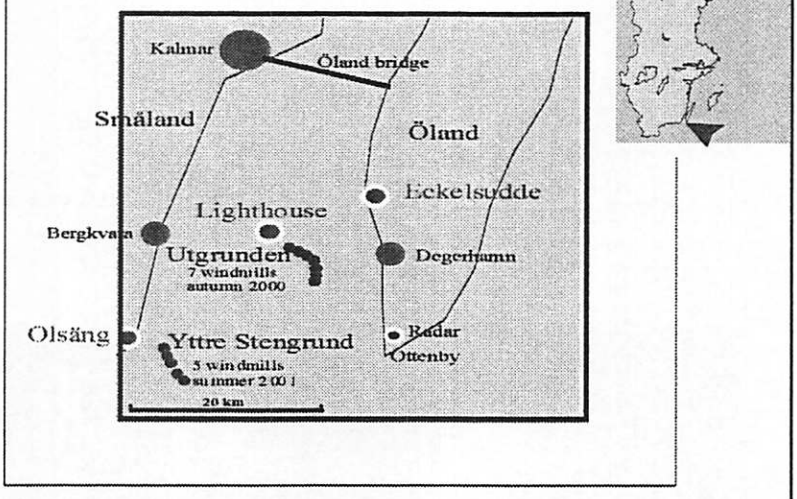
Provide a background for future design of study

How many cameras are needed and for how long should be observed to get reliable estimates?

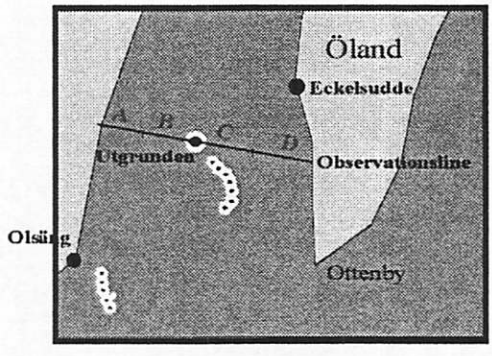

Influence of offshore windmills on migrating birds
In southeast coast of Sweden
GE Wind Energy , Vindkompaniet AB and Swdish National Energy Authority
Present by Jan Pettersson

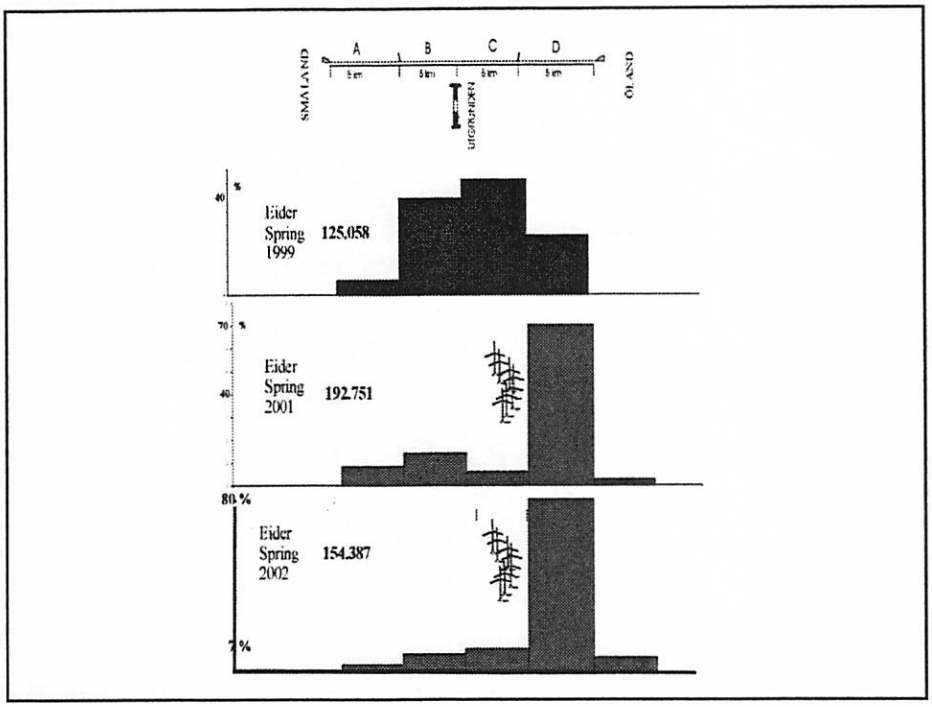

on seaduck migration, mostly Eider
Up to 250.000 Eider in spring
up to 150.000 Eider in autumn

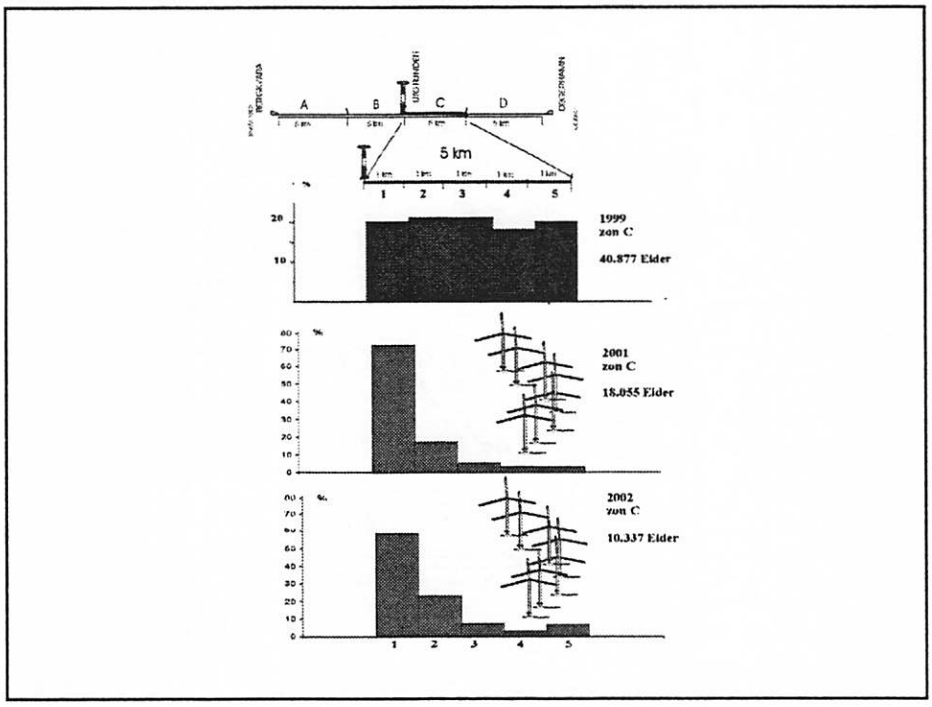
Kalmarsund in southeast coast of Sweden



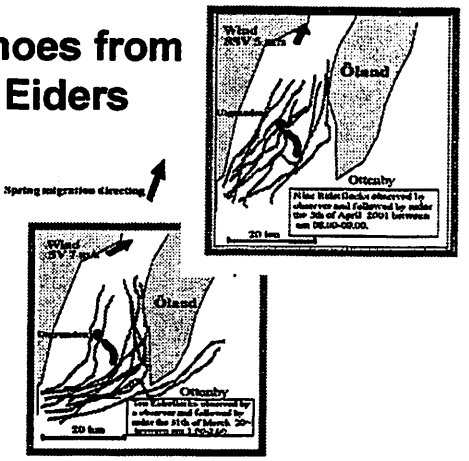
Observationline in Kalmarsund



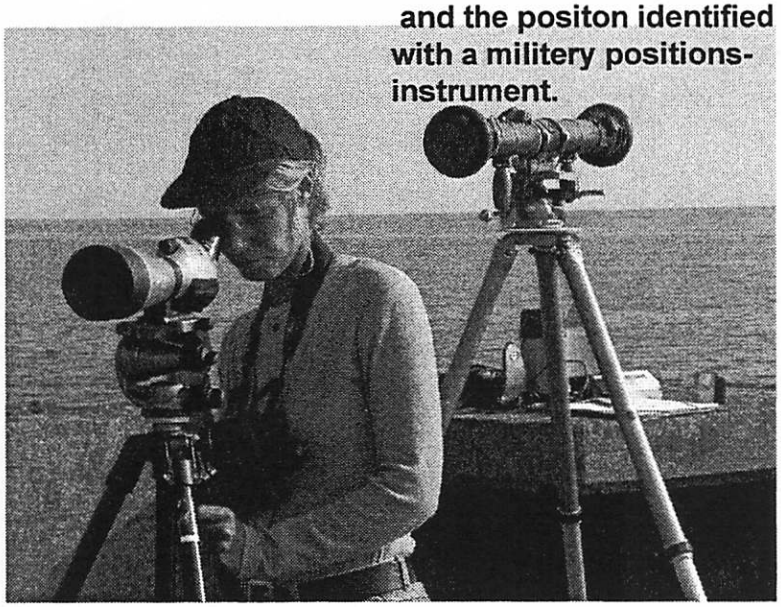

SMÅLAND
A
B
C
D
ÖLAND
Eider
Spring
1999
125.058
Eider
Spring
2001
192.751
Eider
Spring
2002
154.387


A
B
C
D
5 km
1999
zon C
40.877 Eider
2001
zon C
18.055 Eider
2002
zon C
10.337 Eider

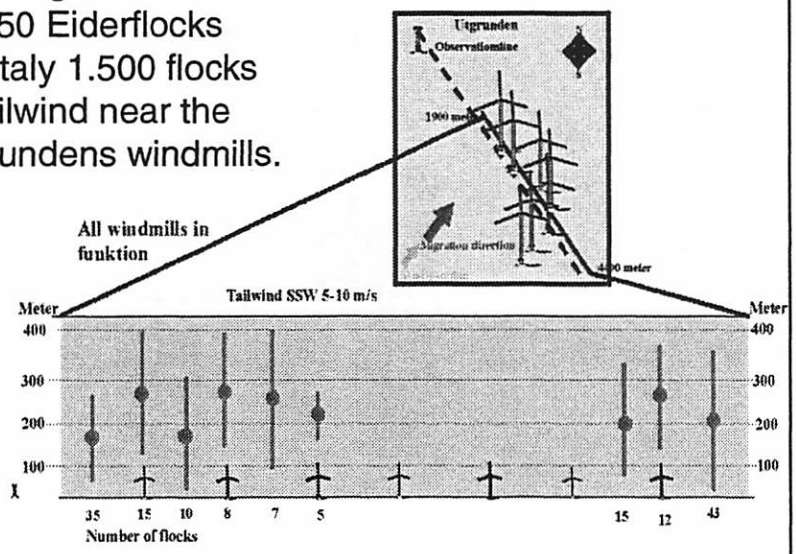
Radar echoes from flocks of Eiders

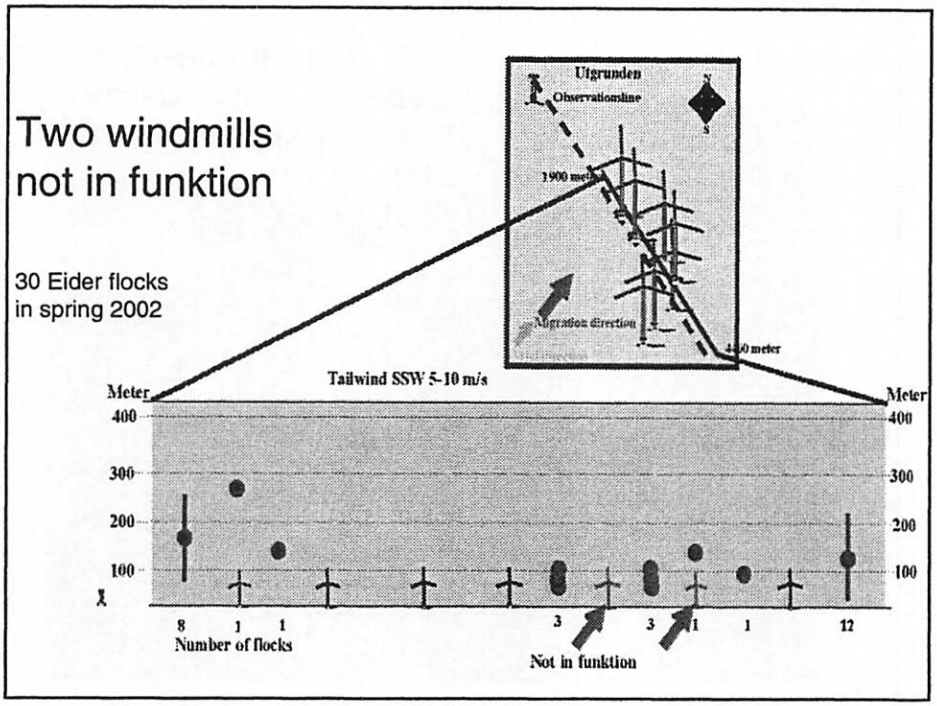


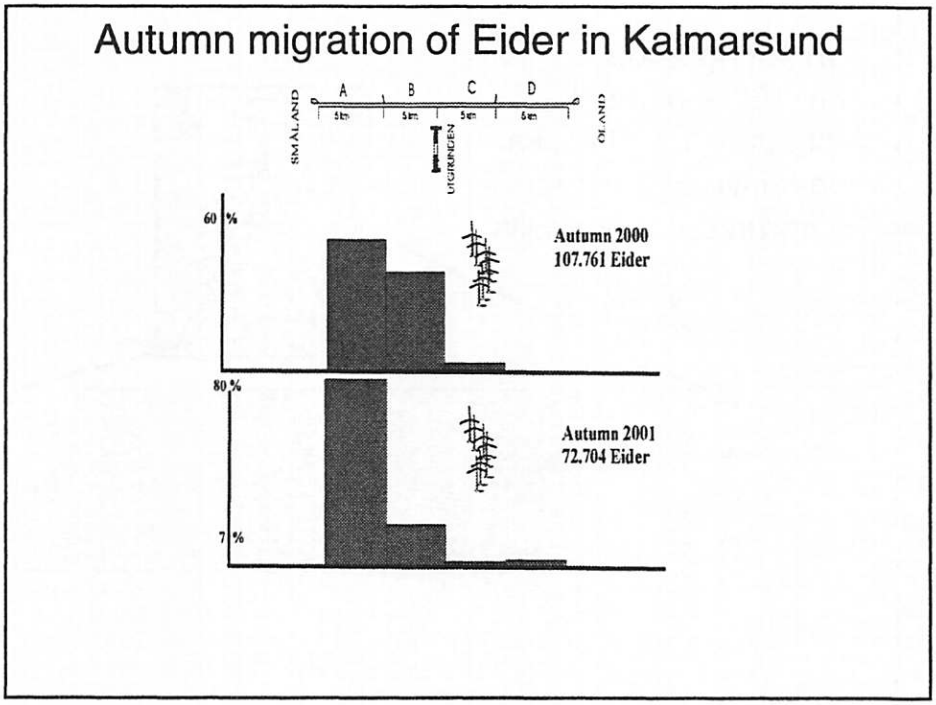
Radar echoes from Eiders



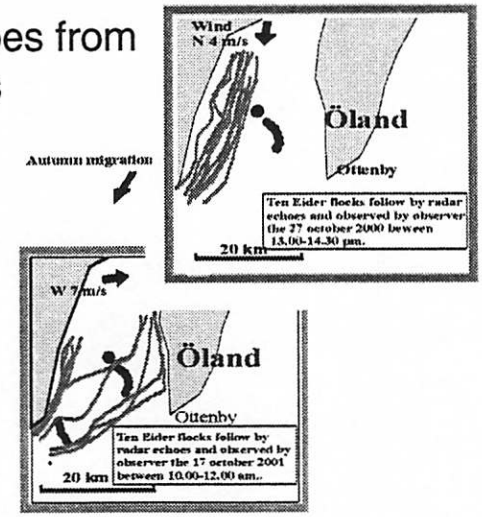
In spring 2002
fly 150 Eiderflocks
of totaly 1.500 flocks
in tailwind near the
Utgrundens windmills.



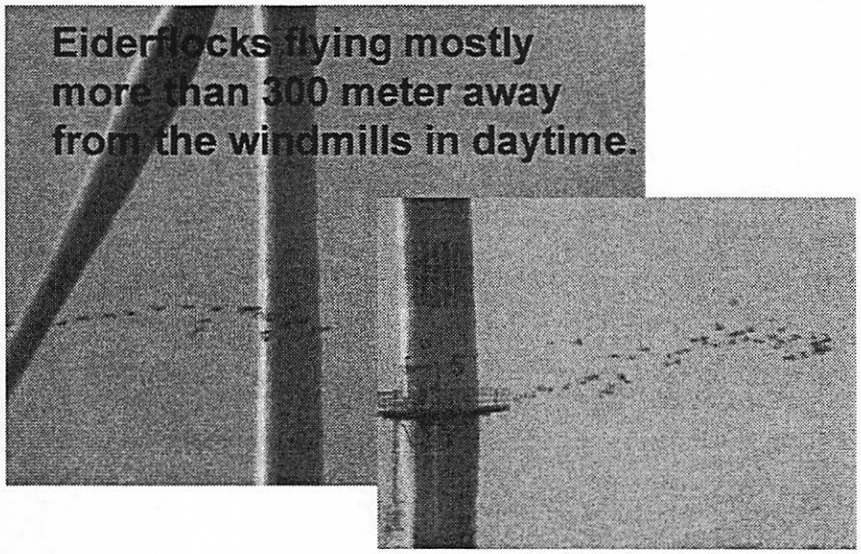

Two windmills
not in funktion
30 Eider flocks
in spring 2002
Utgrunden
Observationsline
1900 meter
Migration direction
4450 meter
Tailwind SSW 5-10 m/s
Meter
400
300
200
100
8
1
1
3
3
1
1
12
Number of flocks
Not in funktion

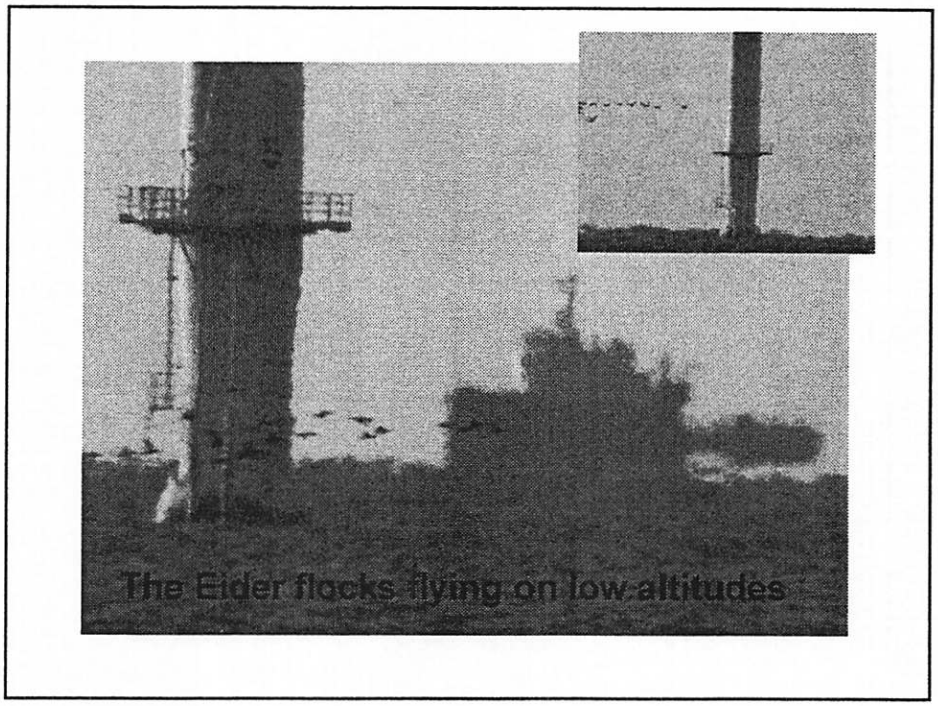

Autumn migration of Eider in Kalmarsund
A
B
C
D
SMÅLAND
ÖLAND
UTGRUNDEN
60 %
Autumn 2000
107.761 Eider
80 %
7 %
Autumn 2001
72.704 Eider

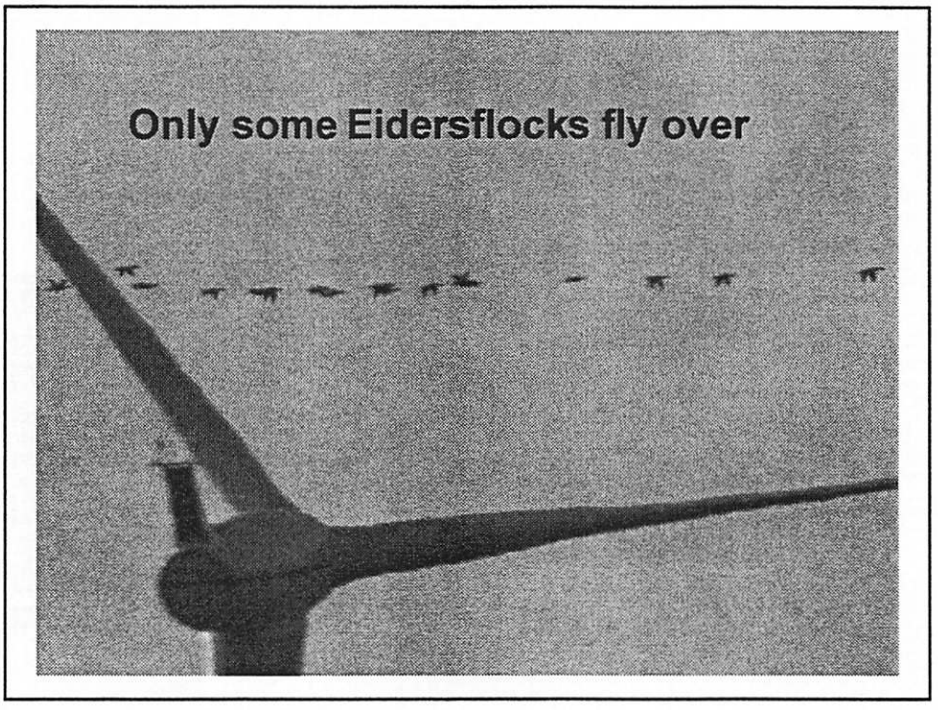
Radar echoes from Eider flocks

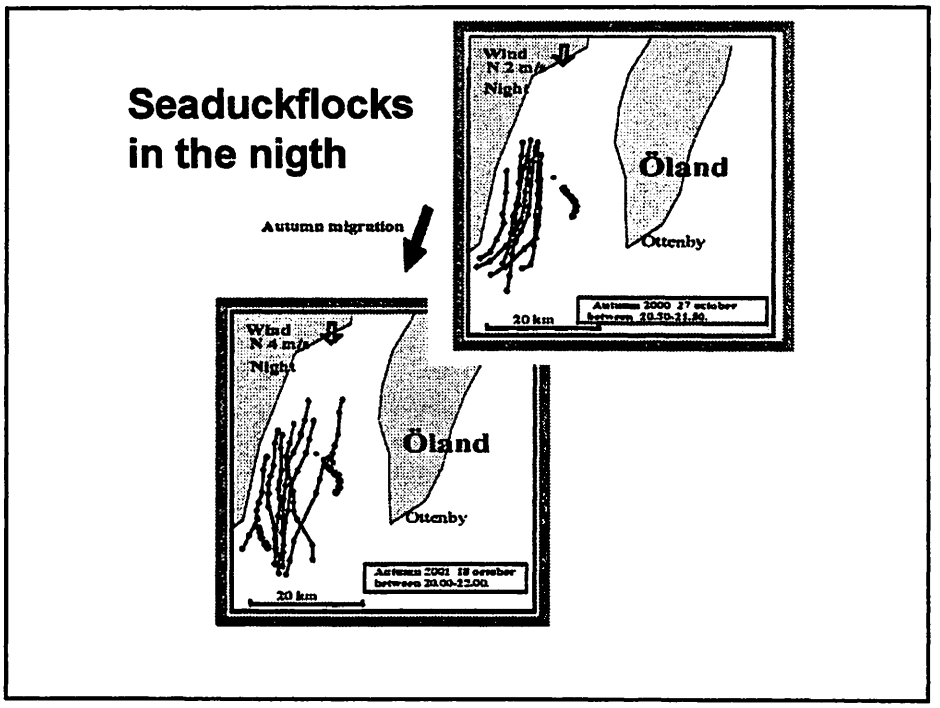


51




The Eider flocks flying on low altitudes


Only some Eidersflocks fly over


Seaduckflocks
in the nigth
Autumn migration
Wind
Öland
Ottenby
20 km
Wind
Öland
Ottenby
20 km

ECN Offshore wind
Environmental issues

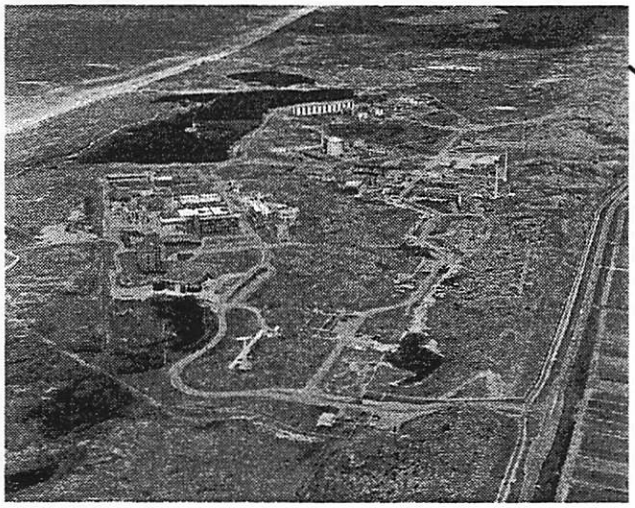
Chris Westra
Energy research Centre of the Netherlands ECN

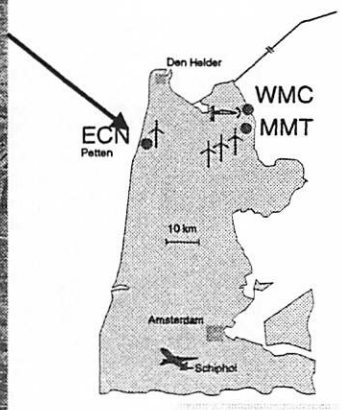
IEA Workshop on Environmental Issues of offshore wind farms

Husum, Germany 22-23 september 2002

ECN

ECN Wind Energy

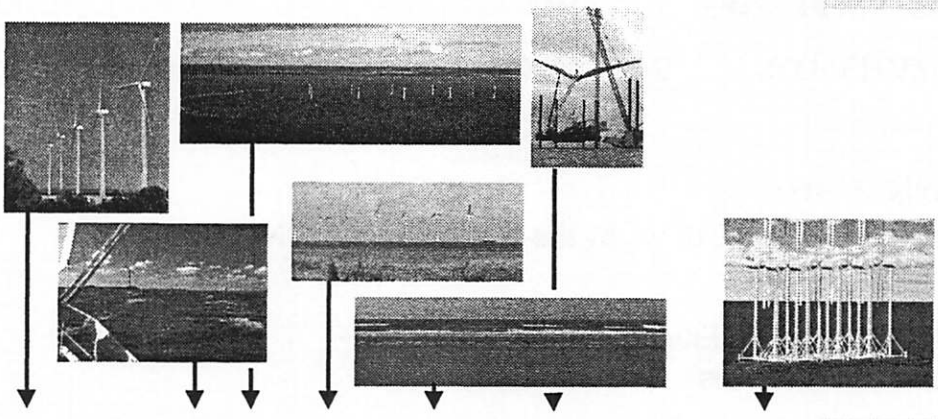




July 2002

ECN

Wind energy: the development



onshore shallow water near shore far offshore

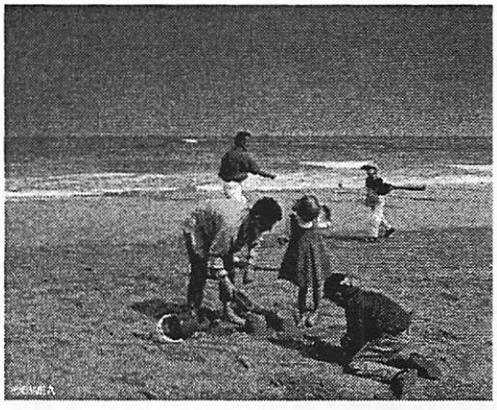
1990 2000 2020

ECN

Recent developments and trends

from onshore ...

... to offshore



ECN

Present achievements
Existing offshore projects (95,3 MW)

	First rotation	Installed power [MW]	Status per 09-2001	Details
S: Nogersund. Baltic Sea	1991	Bonus: 1 x 0.22 = **0.22**	Abandoned in 1998	Tripod foundation on solid rock.
DK: Vindeby.	1991	Bonus: 11 x 0.45 = **4.95**	In operation	Caissons on saindy soil. (2.5 – 5 m water depth.) 1.5 – 3 km from coast.
NL: Medemblik. IJsselmeer	1994	NedWind: 4 x 0.50 = **2.00**	In operation	Mono pile foundation. Corrosion life time 50 years. Fresh water.
DK: Tunø Knob Kattegat	1995	Vestas: 10 x 0.50 = **5.00**	In operation	Caissons on sandy soil
NL: Dronten. IJsselemeer	1996	Nordtank: 28 x 0.60 = **16.80**	In operation	Monopiles a few meyers outside dike body
S: Bockstigen. Baltic Sea	1998	Wind World: 5 x 0.50 = **2.50**	In operation	Monopile foundation. (5.5 – 6.5 m water depth) 4.5 km from coast.
DK: Middelgrunden	05-2001	Bonus: 20 x 2.00 = **40.00**	In operation	Gravitational foundation. (3 – 5 m water depth) Between 1.7 and 3.5 km from coast
GB: Blyth. North Sea		Vestas: 2 x 2.00 = **4.00**	Temporary out of operation	Mono pile foundation. (Water depth 6 m (+ 5 m tides))
S: Utgrunden. Baltic, Kalmarsund	12-2000	Enron: 7 x 1.43 = **10.00**	In operation	Monopiles (7.2 – 9.8 m water depth) 12.5 km from coast.
S: Yttre Stengrund. Baltic, Kalmarsund	07-2001	Neg Micon: 5 x 2.00 = **10.00**	In operation	Monopile foundation. 5 km from coast.

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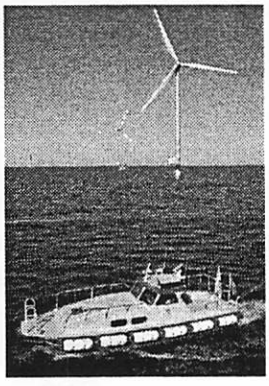
Present achievements: plans
Offshore plans (> 6000 MW)



	Exp. First rotation	Installed power [MW]	Status per 09-2001
DK: Horns Rev	2002	Vestas: 80 x 2.0 = **160.0**	Suppliers selected, Electrical infrastructure under construction
S: Klasärden	2002	NEG Micon: 21 x 2.0 = **42.0**	
S: Lillgrunden		Enercon: 48 x 1.8 = **86.4**	
NL: Egmond aan zee	2003/4	**100.0**	Envirnmental Impact Ass. And other spacing procedures finalized. Shell / NUON (EIA)
NL: North Sea Q7	2003/4	Vestas: 60 x 2 = **120.0**	Environmental Impact Assessment finalized.
B:	2002/3	**100.0**	Call for proposals issued
DK: Rødsand	2003	**150.0**	
DK: Læsø	2003	**150.0**	
EIR: 2 projects	2003/5	**640.0**	
D: 21 projects	??	**>> 5000**	

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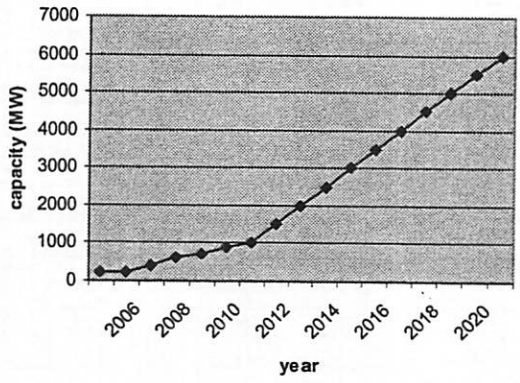
Offhore implementation speed

Dutch goal (6000 MW)



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The future: 6,000 MW offshore

Some unresolved issues

- **Not a clear permit procedures (under development)**
- **Risk management offshore projects (standards !)**
  (Use experience with shallow water and near shore projects)
- **Integrated dedicated system concepts, including transport, installation, environment (2X)**
- **Environmental issues (zero assessment)**

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Definition phase of a

R&D programma (2004-2007)

managed by ECN & TU Delft

- Technology
- education & training
- infrastructure
- logistics
- policy issues
- environmental issues: Physical noise
  biological
  human issues

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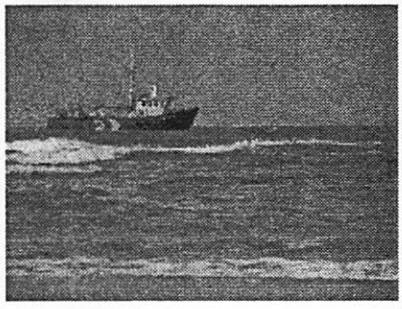
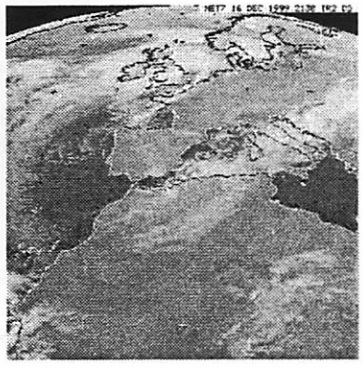
ECN *Wind energy*
Wind & Waves

Forecasting and characterisation of wind and waves



www.meteopagina.net



Wind & Waves

Aerodynamics & Aeroelastics

Concepts & Design

Operational Technology & Systems

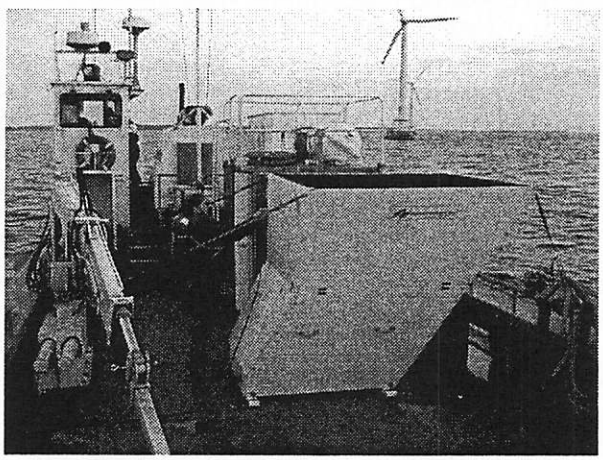
Measurement & Software

Projects

ECN

ECN *Wind energy*
Wind & Waves

Forecasting and characterisation of wind and waves



Wind & Waves

Aerodynamics & Aeroelastics

Concepts & Design

Operational Technology & Systems

Measurement & Software

Projects

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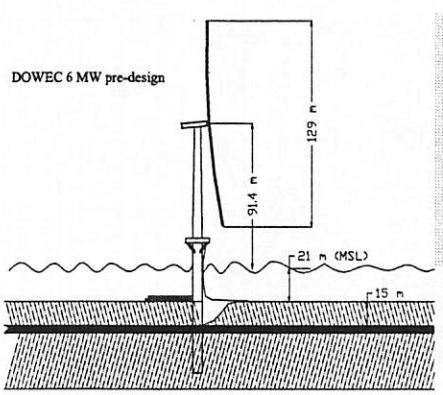
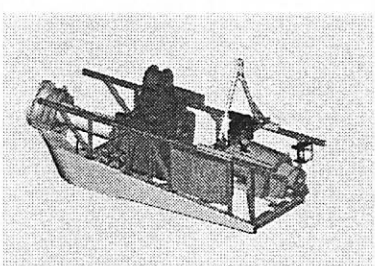
ECN *Wind energy*
Concepts & Design

Integral design: wind farm assessment, economics, technical aspects, etc.





DOWEC

Wind & Waves

Aerodynamics & Aeroelastics

Concepts & Design

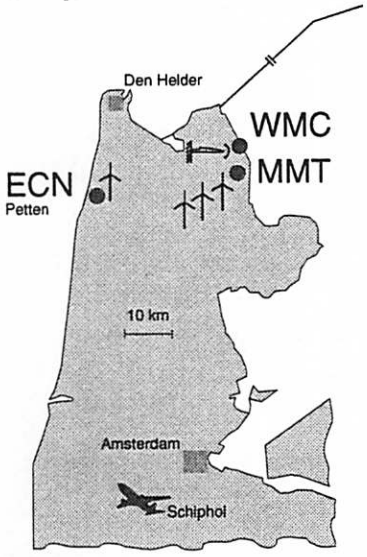
Operational Technology & Systems

Measurement & Software

Projects

ECN

ECN *Wind energy*
Projects



WMC Laboratory:

rotor blade and turbine testing facilities, opening 2003

Multi Megawatt Test site:

testing of turbines up to 6 MW, opening 2002

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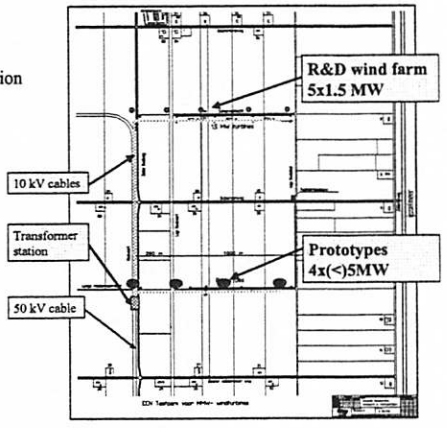
ECN *Wind energy*
Projects

- 5 turbines for research and energy production (1.5 - 2 MW machines)
- 4 prototype locations (upto 5 MW each)
- Control centre
- Meteo tower
- Transformer station
- Access roads



Wind & Waves

Aerodynamics & Aeroelastics

Concepts & Design

Operational Technology & Systems

Measurement & software

Projects

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ECN
offshore involvement

- **Development:**
  - **technical**
  - **wind forecasting**
  - **monitoring programmes**
    - *** condition (maintenance management)**
    - *** MEP (environmental monitoring)**
    - *** birds & drifter collisions**

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Monitoring acoustic noise

- condition monitoring
  -->maintenance management system
- birds collisions
- drifters (collisions) (ships, containers....)
- monitoring fish migration
- safety

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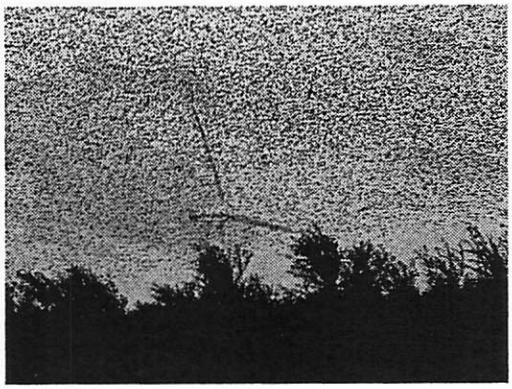
Offshore wind turbine systems

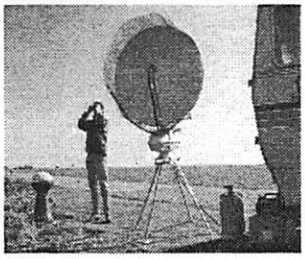
Environmental aspects: birds, under water sea life



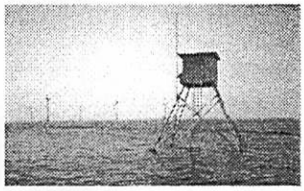
- **Long term monitoring of birds collissions, under water fauna devt.**
- **Impact on under water soil transport**
- **Safety: monitoring of impacts on structures**

ECN

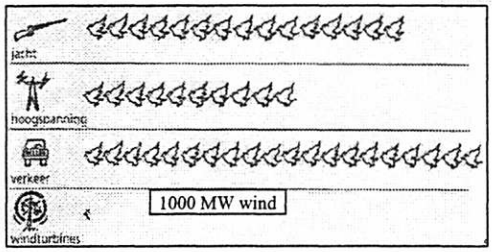
Wind energy and birds



Radar observations in The Netherlands



Birds observation stationTunø Knob (DK)



Birds victims caused by:

one bird stand for 100.000 victims

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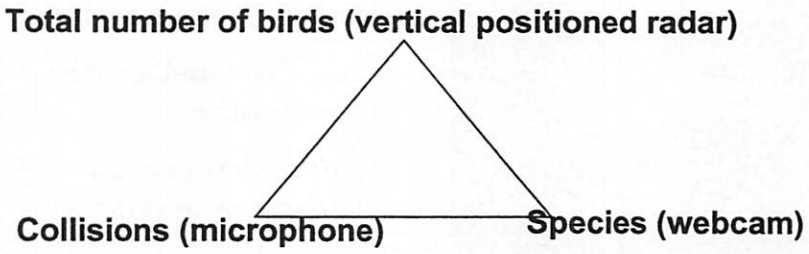
Dectection system for bird collisions

(the idea)



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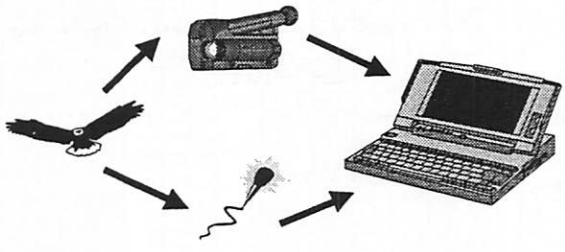
The principle



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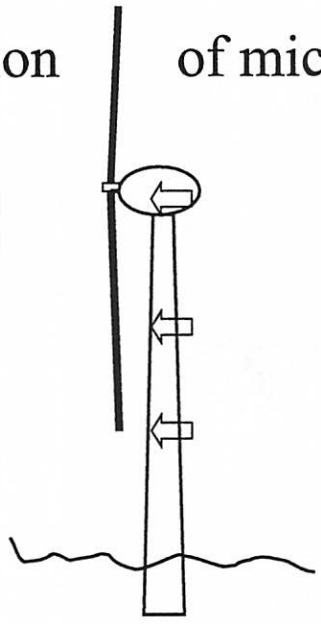
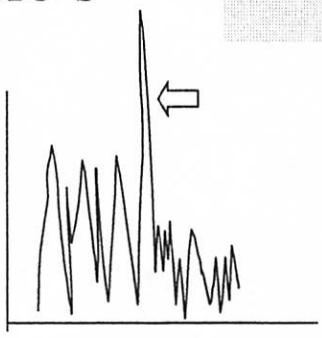
Position of micro's

Analyse acoustic noise

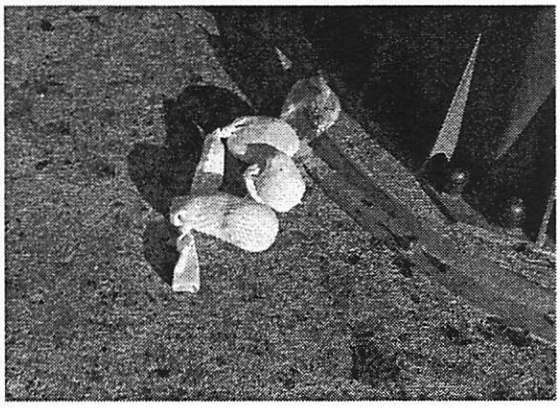
Bird specific: velocity mass ($E=1/2\ mv^2$)





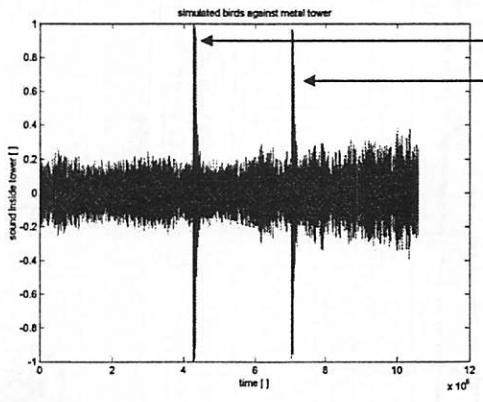
ECN

Dummy's of birds



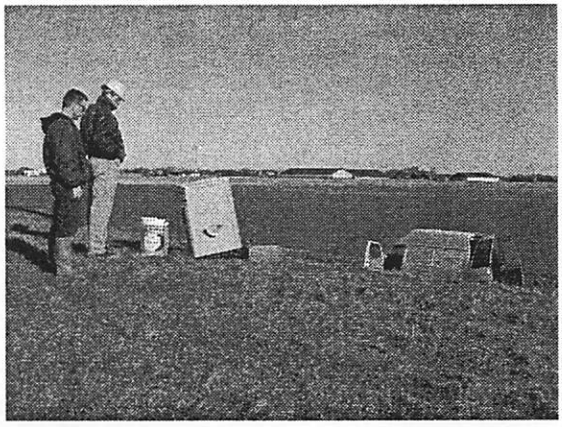
ECN

The sound of dummy's

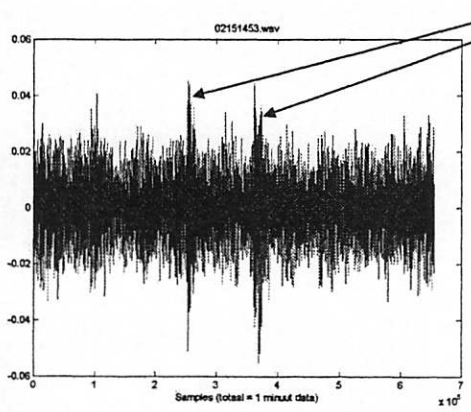


impact

Tennisball machine

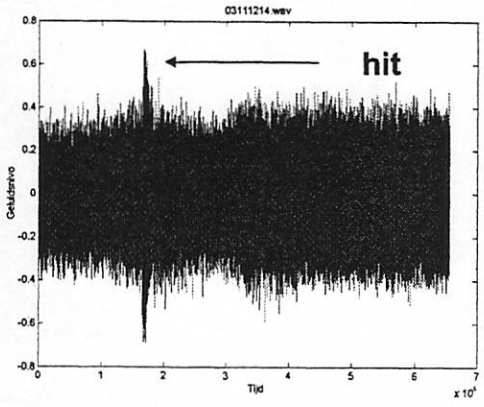


Rotating windturbine



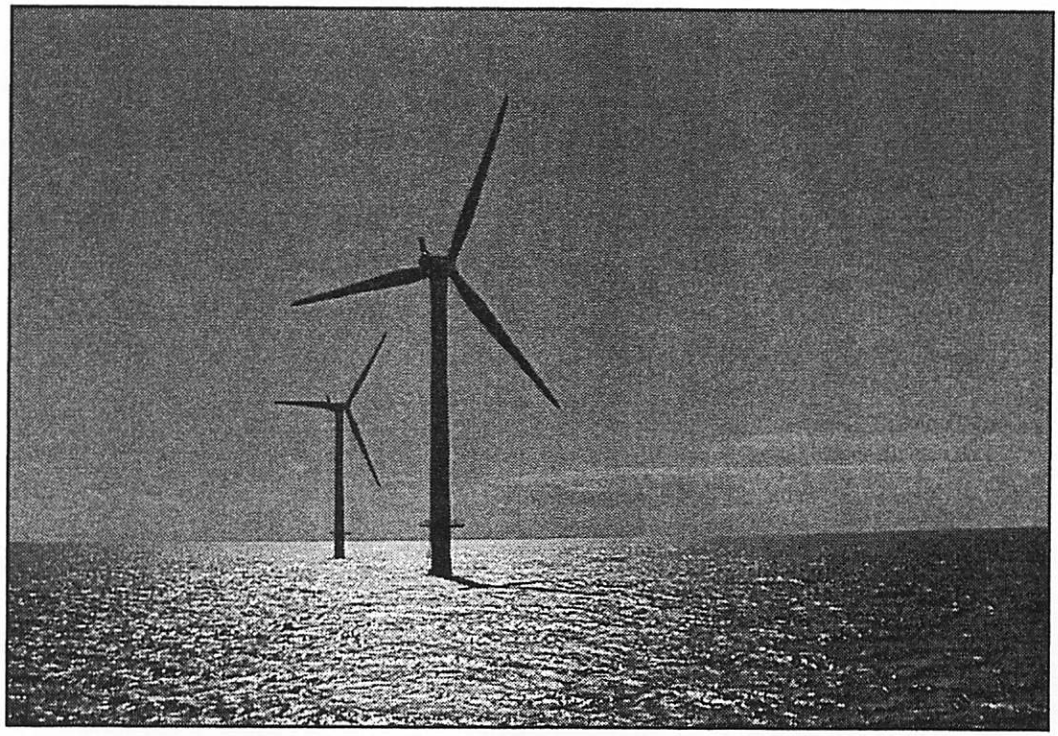
ECN

field tests (blade)



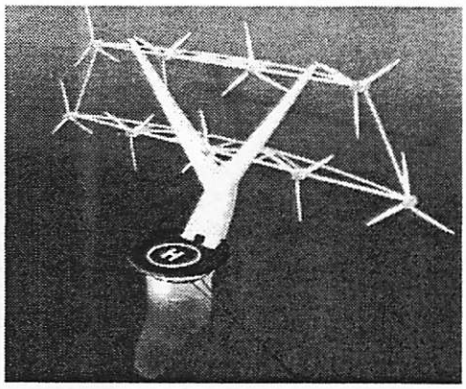
Test with tennisballs

ECN



From modified land turbines to dedicated offshore installations

ENRON Tacke



Lagerwey the Windmaster (NL)

onshore shallow water near shore far offshore

ECN

Future

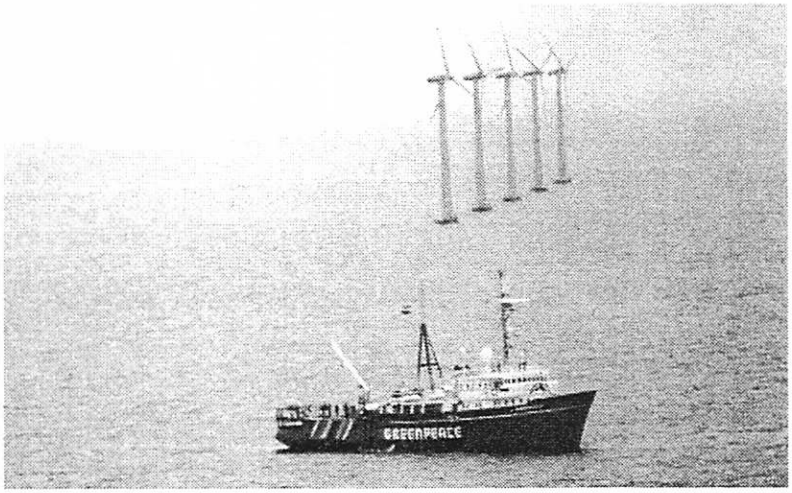
from

Sounds, platen, grunden, sands

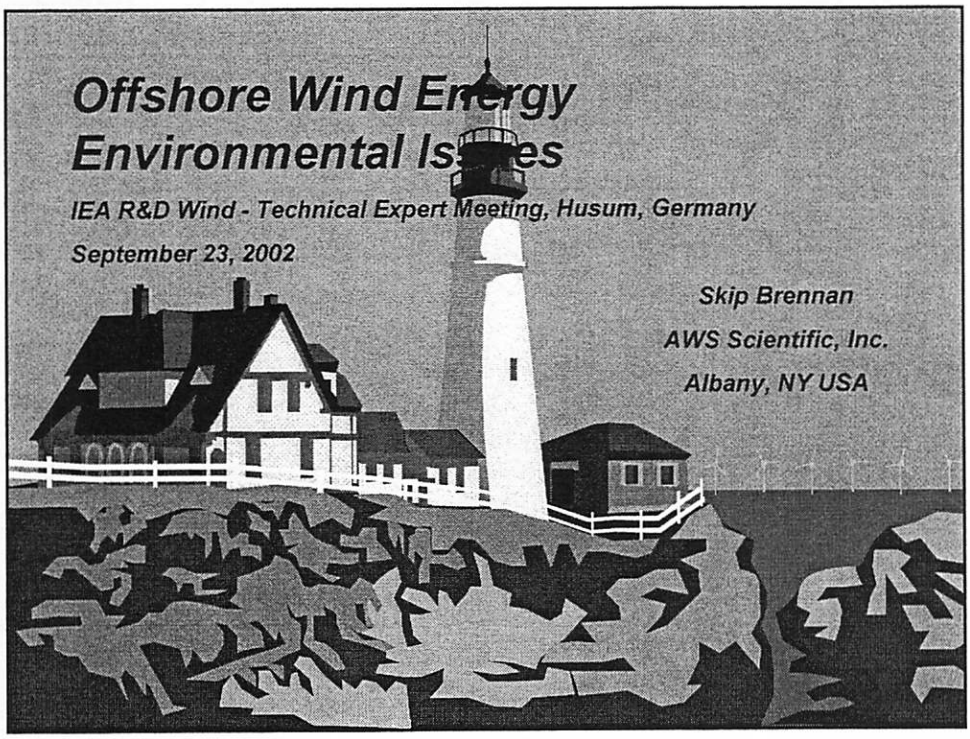
real seas and oceans

ECN

The future



ECN

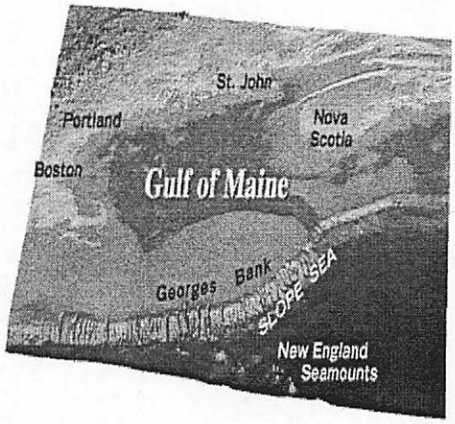


Presentation Overview

- United States Offshore Potential
- Project Profile
- Environmental Information Status

aws scientific

Why Go Offshore?



Similar reasons in Europe & Northeast

- Shortage of land sites
- Near major load centers
- Windier than land
- High energy costs
- Green initiatives

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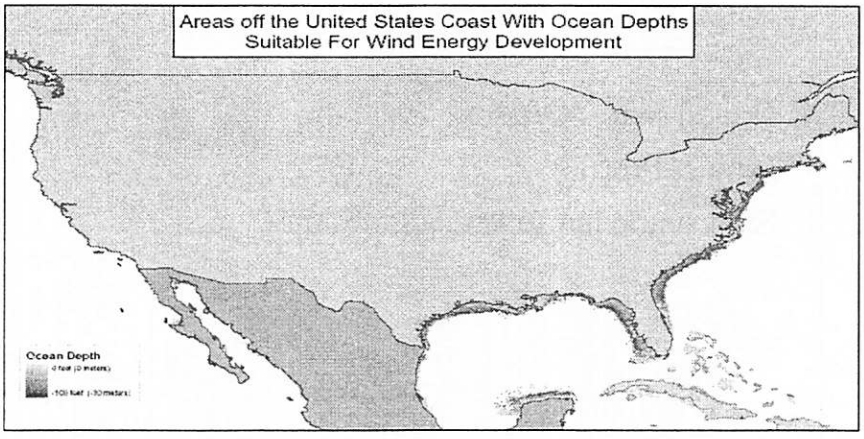
U.S. Offshore Resource Potential



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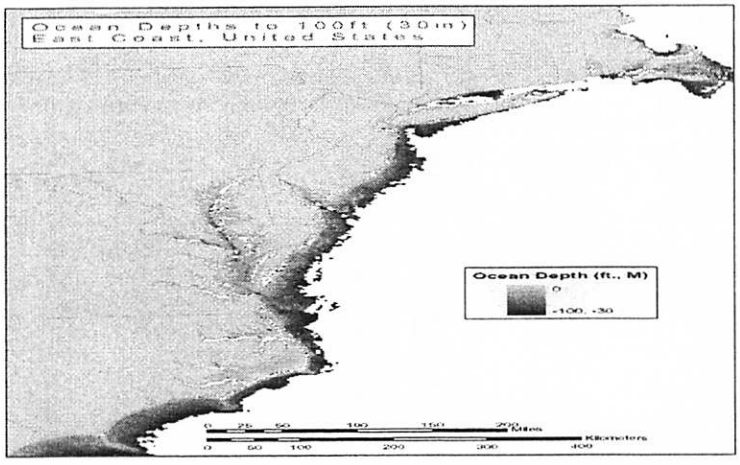
U.S. East Coast Offshore Resource Potential



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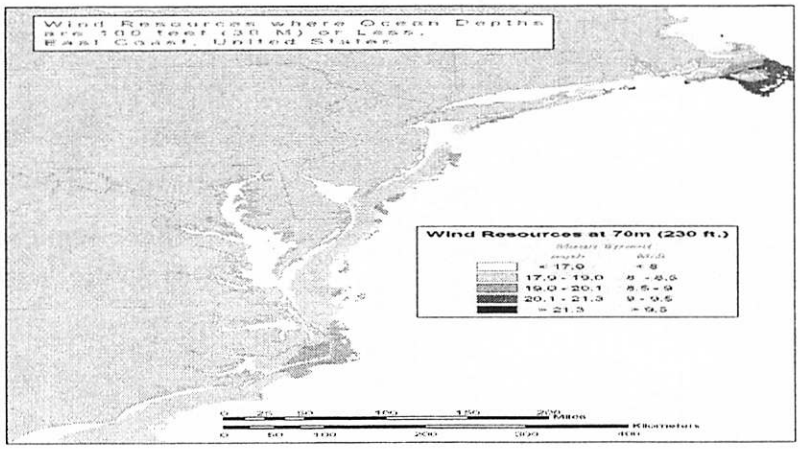
U.S. East Coast Offshore Resource Potential



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U.S. Offshore Projects

- Long Island Power Authority
  - Offshore Long Island
- Cape Wind Associates
  - Nantucket Sound
- Sea Energy Generation, Inc.
  - Offshore Massachusetts

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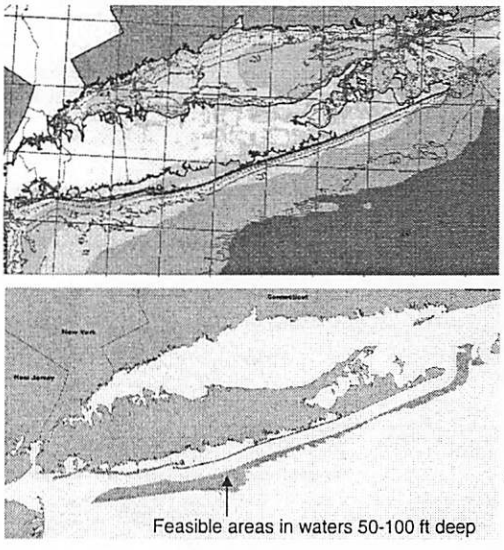
Long Island Power Authority Offshore Wind Initiative

LIPA



- Sponsored by LIPA & NYSERDA
- Establish siting criteria
- Produce wind map
- Investigate legal & environmental issues
- Estimate transmission interconnection costs and impacts

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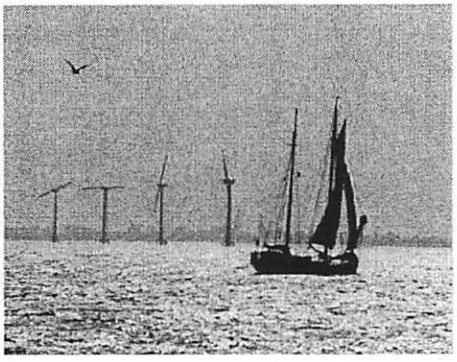
Phase I Feasibility Study Objectives

LIPA
Long Island Power Authority

Objectives:

- Survey the offshore technology
- Identify viable offshore areas
- Stimulate dialogue among stakeholders



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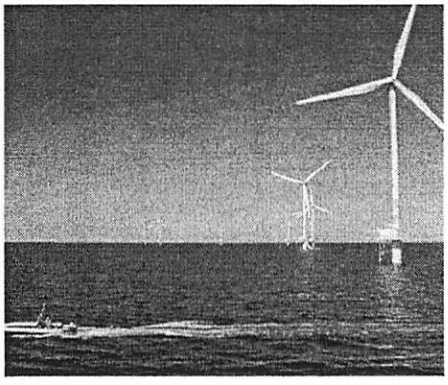
Offshore Components

LIPA
Long Island Power Authority

- Turbines rated between 2 & 4 MW
- Tower heights >200 ft
- Rotor diameters of 250-350 ft
- Monopole or other foundation
- Marine cable



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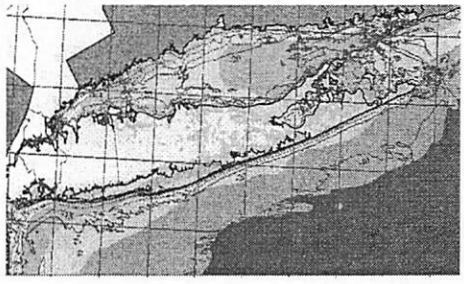
Primary Siting Considerations

LIPA Long Island Power Authority

- Strength of wind resource (>18 mph, or 8 m/s)
- Water depth (up to 100 ft)
- Shipping lanes excluded



- Distance from shore
- Minimum Project size
- Regulatory Process
- Avian Impacts
- Transmission

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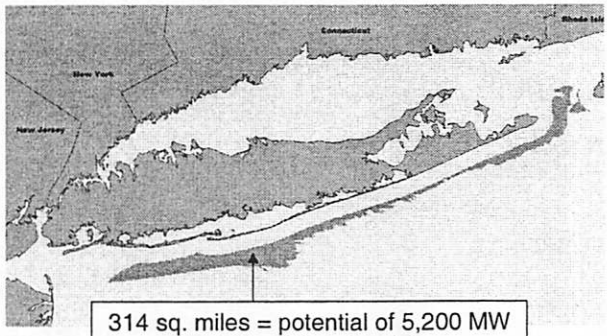
Site Screening

LIPA Long Island Power Authority



314 sq. miles = potential of 5,200 MW
= 77% of LI's electricity

Winds >18 mph at 65 m

Depth <100 ft

Distance >3 mi.

Outside of shipping lanes

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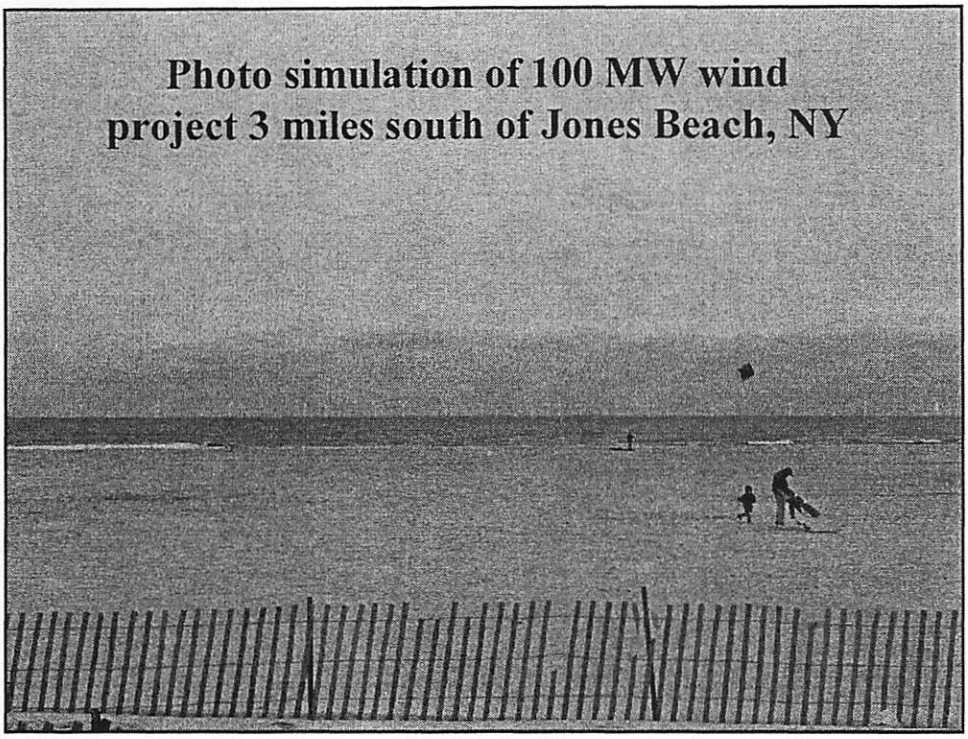

Phase 2 Siting Assessment

LIPA
Long Island Power Authority

Issues to be examined

- Geophysical/oceanographic - Tides & waves, bottom conditions, geology, sediment transport, extreme winds (hurricanes)
- Biological & environmental – Fisheries, benthos, marine life resources, fish spanning, marine mammals, birds, archeological resources
- Human Issues – Visual issues, fishing, navigation, aviation, economic benefits
- Transmission – Shoreline landfall options, interconnection design, grid impacts, costs
- Legal & regulatory issues – Draft likely permitting process and identify sites with fewest conflicts

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Phase 2 Siting Assessment

Overall Goals

- Broader fatal flaw analysis of technical and regulatory issues
- Identify a short list of promising sites
- Develop a blueprint for the planning, permitting & construction process
- Support outreach and networking activities

- To Be Completed in Fall 2002 -

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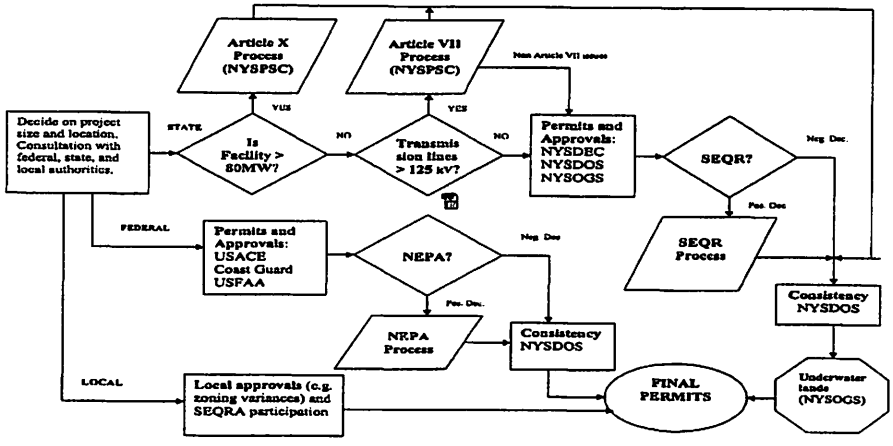
Permitting Process...*no precedence*



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Environmental Issues And Concerns

- Avian Risk
- Aviation Flight Patterns
- Marine Life
  - Marine Mammal
  - Essential Fish Habitat
  - Other Sensitive Resources
- Scope /Parameters of Studies
- Shoreline Landfall Conditions
- Visual Impacts

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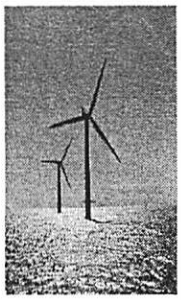
GIS Data Library

- Avian
  - Waterbird Colonies
  - Waterbird Breeding Habitat and Surveys
  - Bird Conservation Regions
- Bathymetry
- Environmentally Sensitive Areas
  - Essential Fish Habitat
  - Marine Protected Areas
  - National Estuarine Research Reserve System



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GIS Data Library Continued

- Nautical Charts
  - National Imagery and Mapping Agency
- Coastal Zone Management Areas
- Coastal Fish and Wildlife Boundaries
- Tidal Wetlands
- Scenic Areas
- National/State Parks

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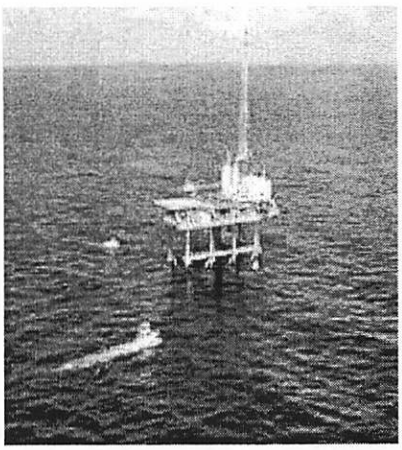
Studies/Joint Research



- National Academy of Sciences
  - Ocean Studies Board
- DOI - Minerals Management Service
- Offshore Oil Industry

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Offshore Environmental Challenges

- Utilize Early Offshore Wind Study Precedents
- Organize U.S. Research Initiative
- Establish Amended Regulatory Framework

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Conclusions

- Offshore is the *only* viable option for large-scale wind for Long Island
- Significant siting opportunities exist offshore
- Most opportunities in waters 50-100' deep 3 - 6 miles off the south shore
- Pioneering European experiences will provide useful lessons & should be closely watched

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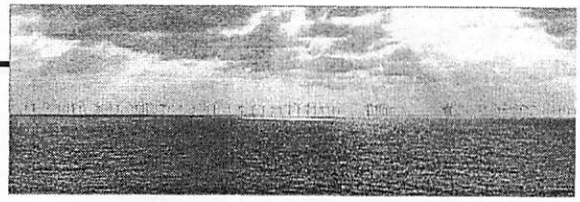
Conclusions



- Green energy initiatives are driving offshore development
- Offshore is the *only* option for large-scale wind in many coastal areas
- Pioneering European experiences will provide useful lessons

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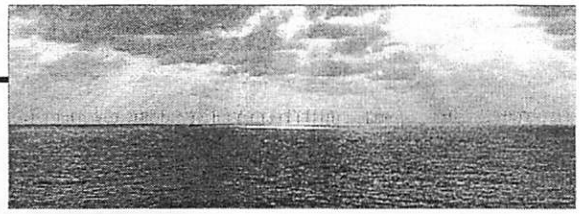
Conclusions



- Communities, energy companies, and other stakeholders should begin serious dialogue about the opportunities and implications
- No precedence for offshore in the U.S.
- 3 – 5 year timeframe to commission a wind plant
- Advanced site screening studies are underway

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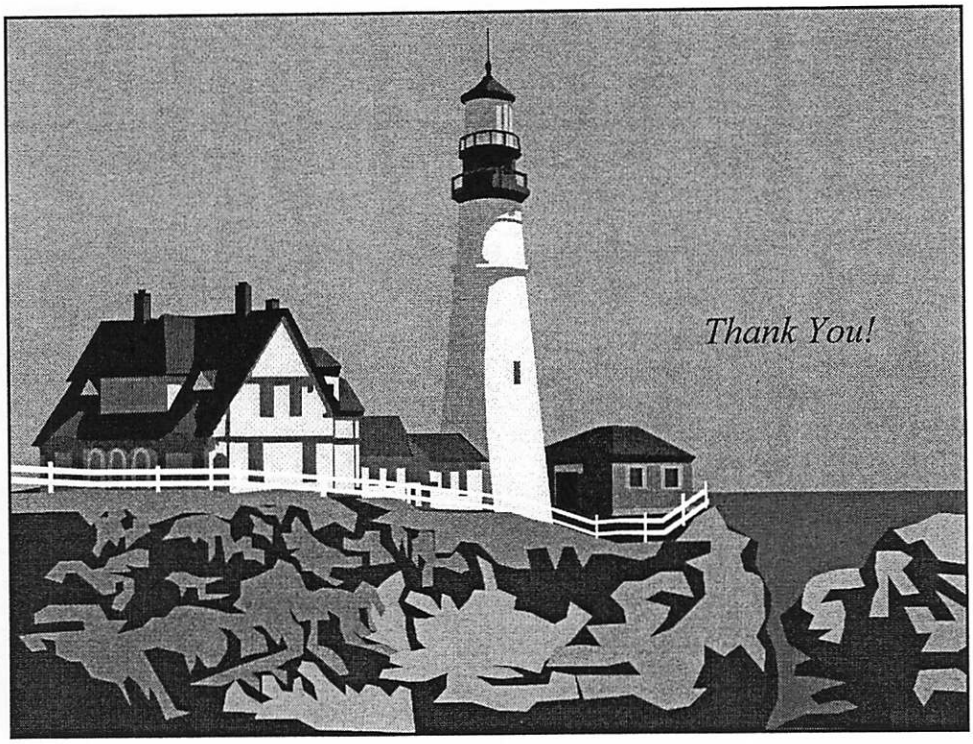
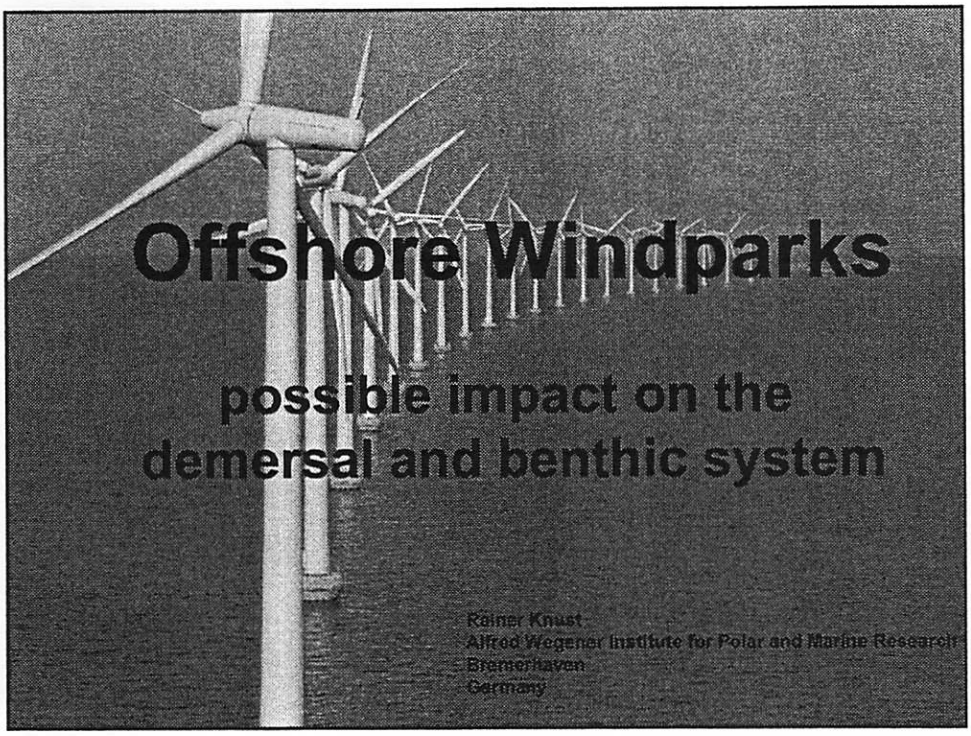
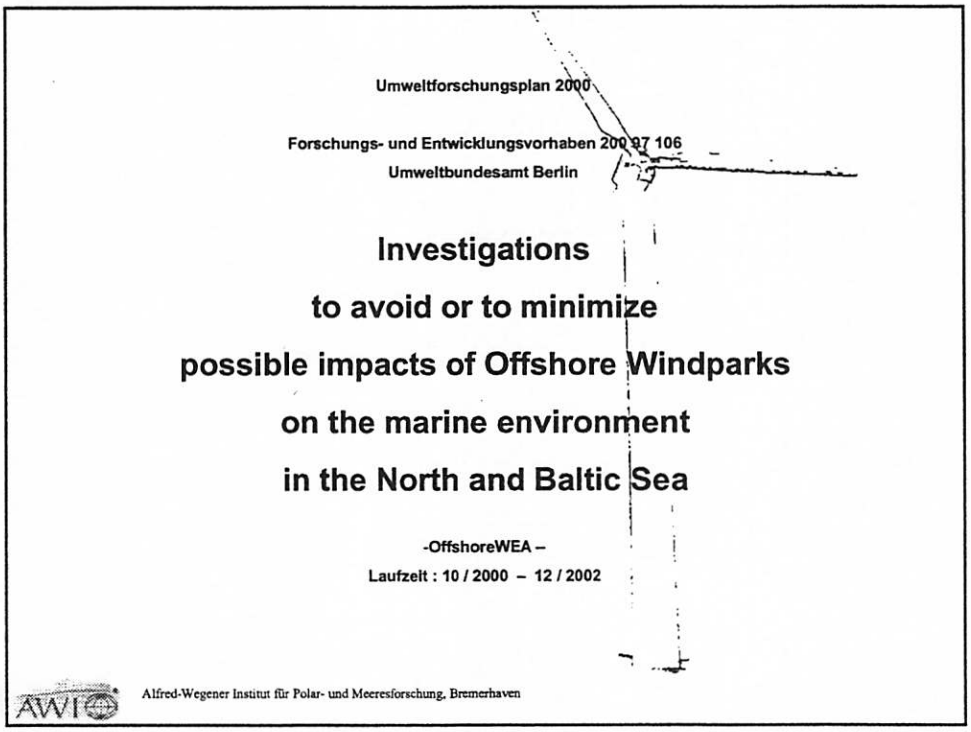

Thank You!

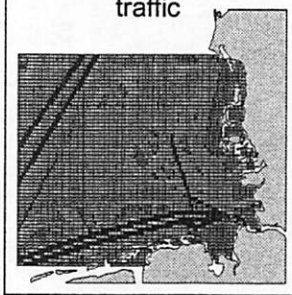

Offshore Windparks
possible impact on the
demersal and benthic system
Rainer Knust
Alfred Wegener Institute for Polar and Marine Research
Bremerhaven
Germany


Umweltforschungsplan 2000
Forschungs- und Entwicklungsvorhaben 200 97 106
Umweltbundesamt Berlin
Investigations
to avoid or to minimize
possible impacts of Offshore Windparks
on the marine environment
in the North and Baltic Sea
-OffshoreWEA –
Laufzeit : 10 / 2000 – 12 / 2002
AWI
Alfred-Wegener Institut für Polar- und Meeresforschung, Bremerhaven

To compile all knowledge about

- Accident probability and the ecological risks

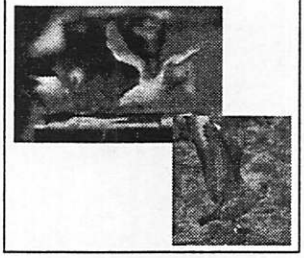
traffic



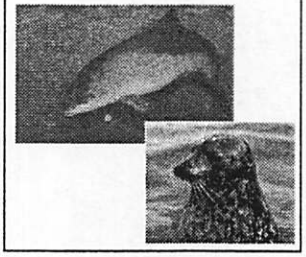
- Possible impacts on the biota

communities on the sea floor

birds



marine mammals



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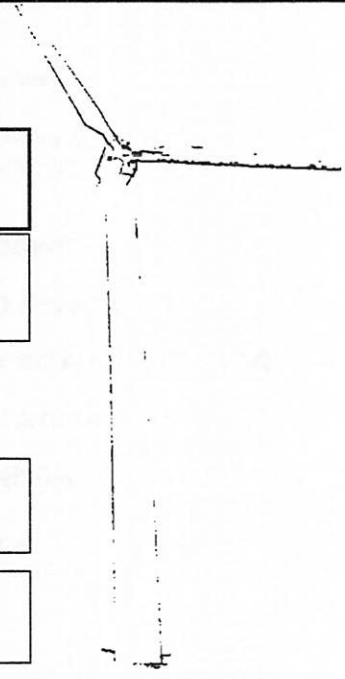
CO-ORDINATION

Alfred Wegener Institute
for Polar and Marine Research

Projects Impacts on environment Co-ordination **AWI**	Projects Techniques and risks Co-ordination **Germanischer Lloyd**
BENTHOS + FISH AWI	**BENTHOS + FISH** GL - Wind
BIRDS Institut für Vogelforschung	
NOICE Marine mammals + fish DEWI -> FTZ	**NOICE** Technical aspects DEWI - itap
ACCIDENT RISKS AWI	**ACCIDENT RISKS** GL - Wind



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OUTCOMES

- Standards for environmental assessment studies und monitoring programs

- Compiling the expert knowledge and literature data :

  risk of accidents between ships and wind parks and the possible consequences for the marine environment

  possible impacts on the marine environment (benthos, fish, birds, mammals)

  advices to avoid and / or minimize possible impacts on the environment

-Identification of further research needs

➡ **final report 12/2002 – 01/2003**

www.bundesumweltamt.de

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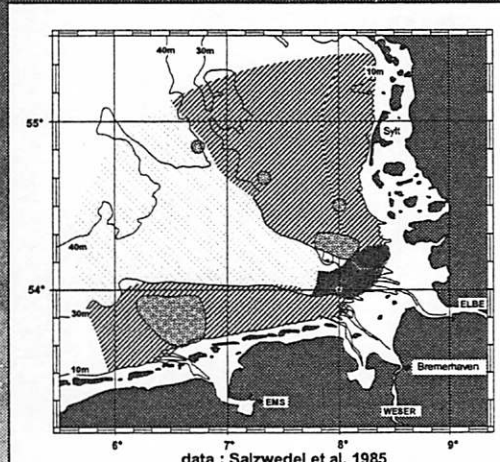
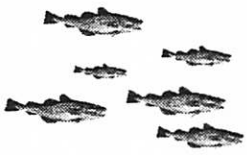
Macrozoobenthos communities in the German Bight



data : Salzwedel et al. 1985

.... and the associated fish fauna

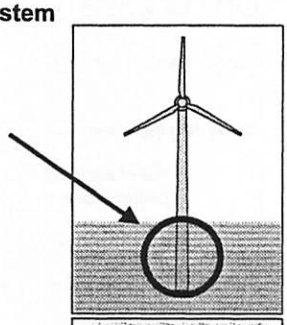


- Amphiura filiformis ass.
- Tellina fabula ass.
- Nucula nitidosa ass.
- Goniadella Spisula ass.

Possible impact on the demersal and benthic system

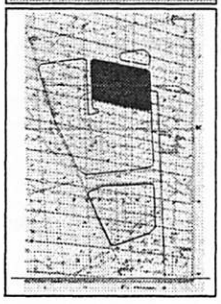
Small scale

direct effects on the seafloor in the near of the piles



Intermediate scale

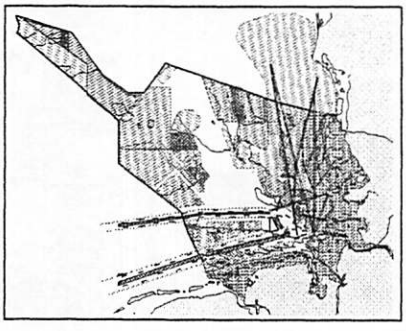
local effects on the seafloor inside and in the surroundings of a windpark

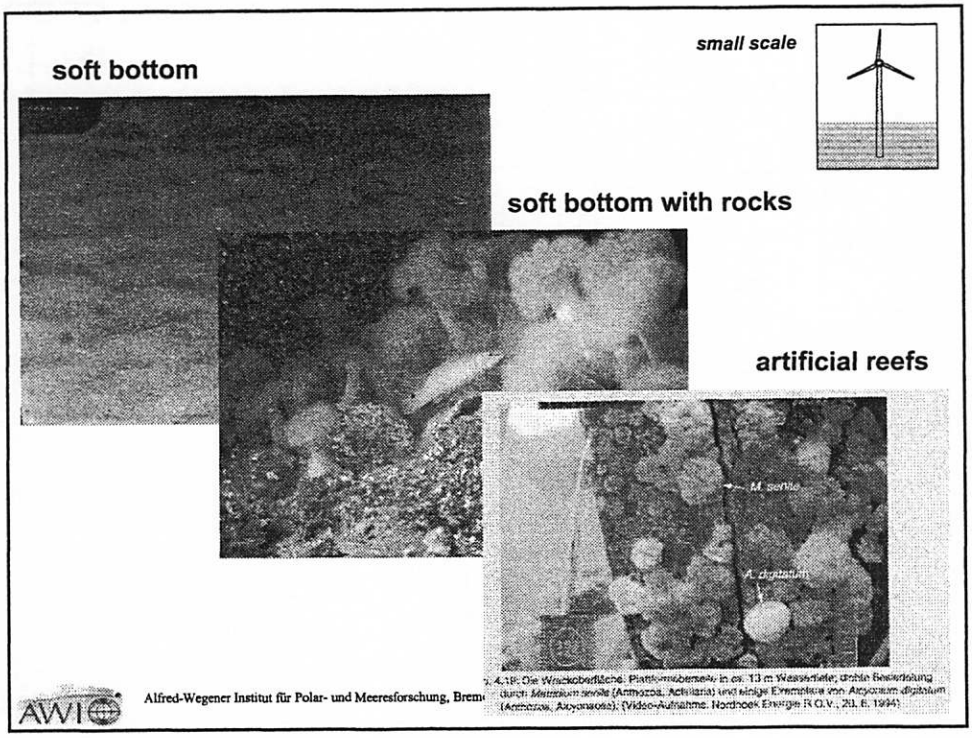


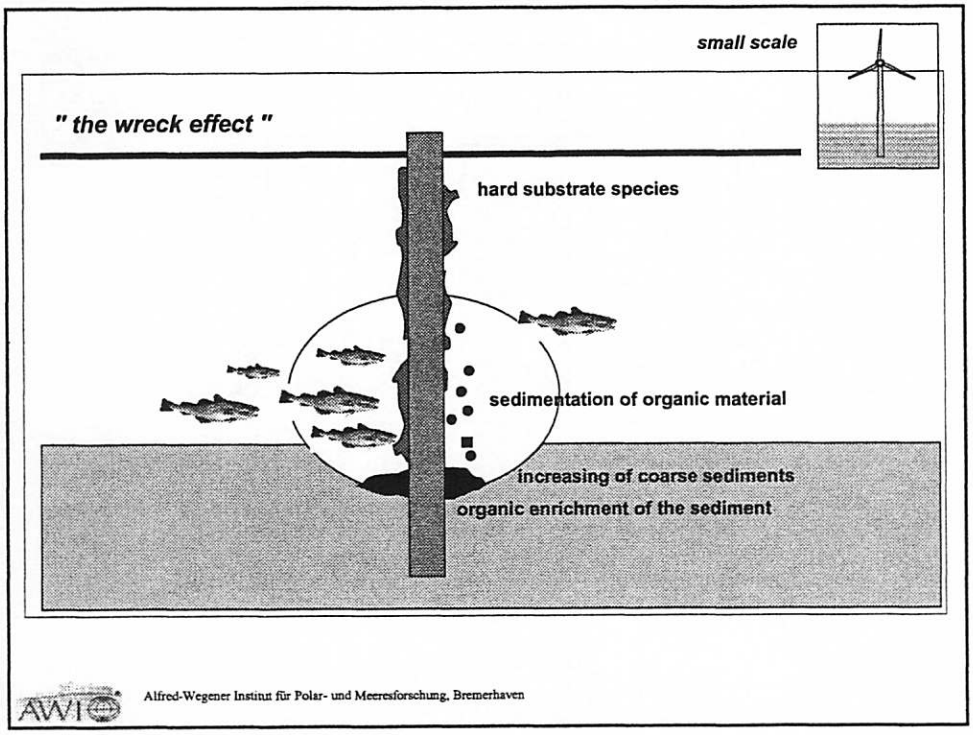
Possible impact on the demersal and benthic system

Large scale

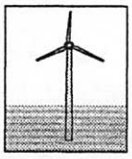
cumulative effects of "all" windparks applied in the German Bight



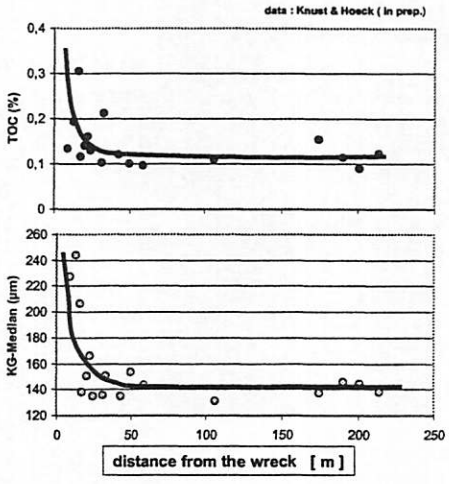

small scale
soft bottom
soft bottom with rocks
artificial reefs
M. senile
A. digitatum
Alfred-Wegener Institut für Polar- und Meeresforschung, Brem


small scale
" the wreck effect "
hard substrate species
sedimentation of organic material
increasing of coarse sediments
organic enrichment of the sediment
Alfred-Wegener Institut für Polar- und Meeresforschung, Bremerhaven

small scale



" the wreck effect "



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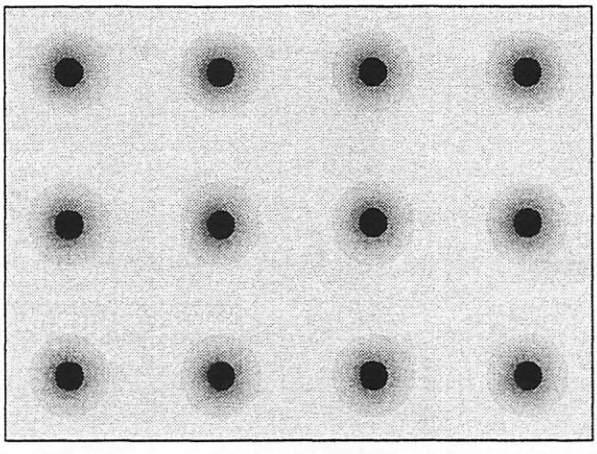
Intermediate scale

" the cumulative effect of all piles "



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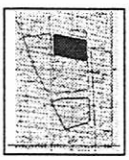
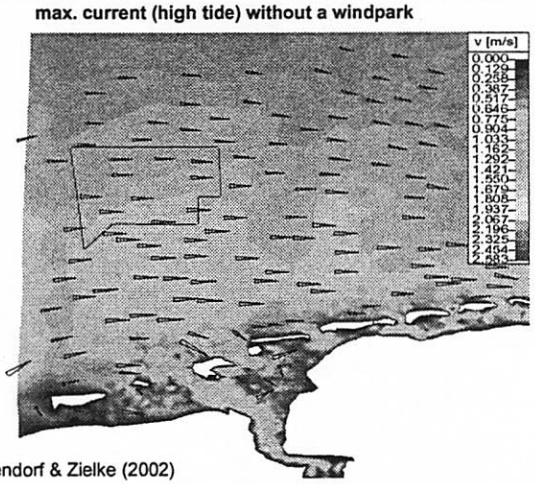
Intermediate scale



" the cumulative effect of all piles "

max. current (high tide) without a windpark

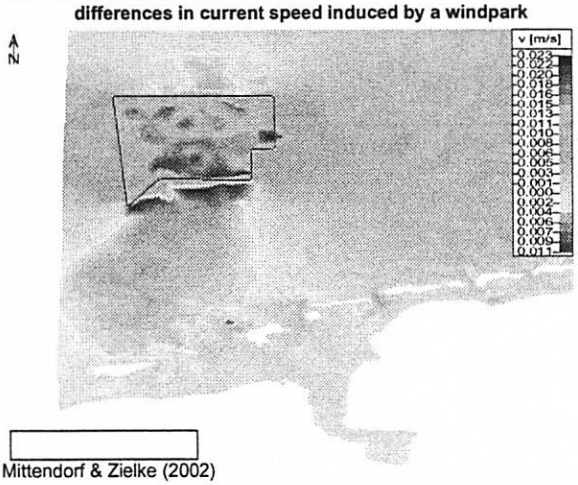


Mittendorf & Zielke (2002)

Intermediate scale

" the cumulative effect of all piles "

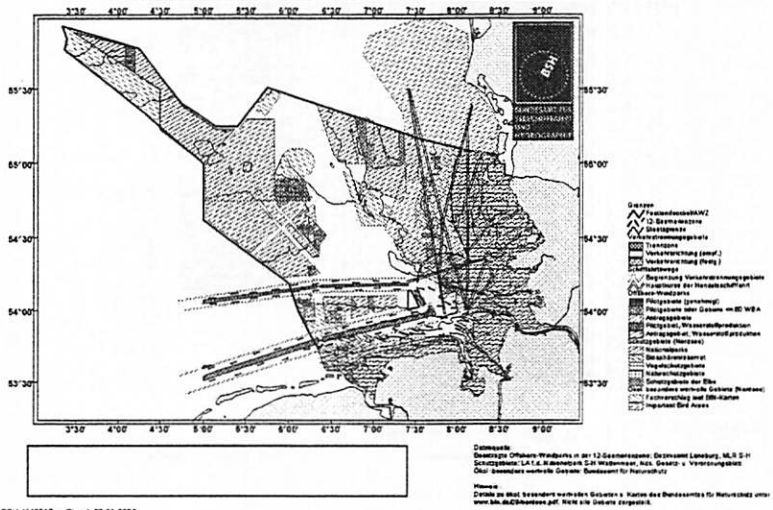
differences in current speed induced by a windpark



Mittendorf & Zielke (2002)

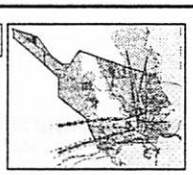
large scale

Applied windparks in German waters



BSH / MS212 - Stand: 20.08.2002

large scale

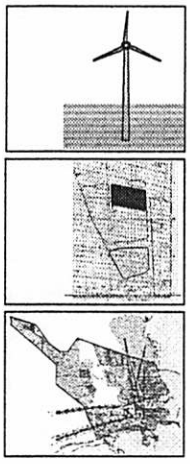


" the cumulative effect of all windparks "

hints from the literature (artificial reefs)

- **changes in the hydrodynamic system**
- **changes of the sediment characteristics**
- **changes of the benthos composition (increase of epibenthos)**
- **changes of the fish fauna with possible implication to fisheries**

conclusions and working hypothesis



The installation of windparks will have a significant impact on the biota of the seafloor and the associated fish fauna

The main forces driving these changes are:

- **artificial hard substrate in soft bottom communities**
- **changes of the hydrodynamics**
- **changes of the sediment characteristics**

The changes will be measurable on different spatial scales

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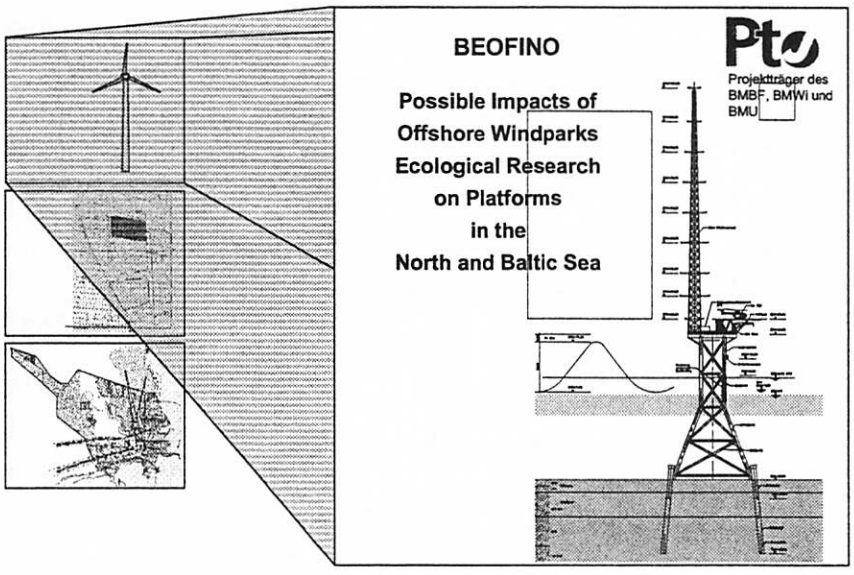
what will be done and what should be done



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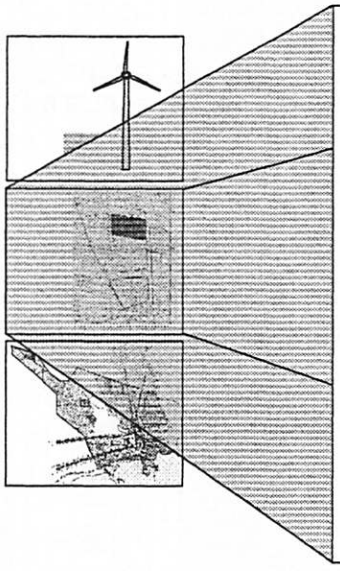
what will be done and what should be done



environmental assessment studies

Measurements of possible impacts in the windpark and in a reference area done by different private companies

The different measurement are "on the way" to become standardized

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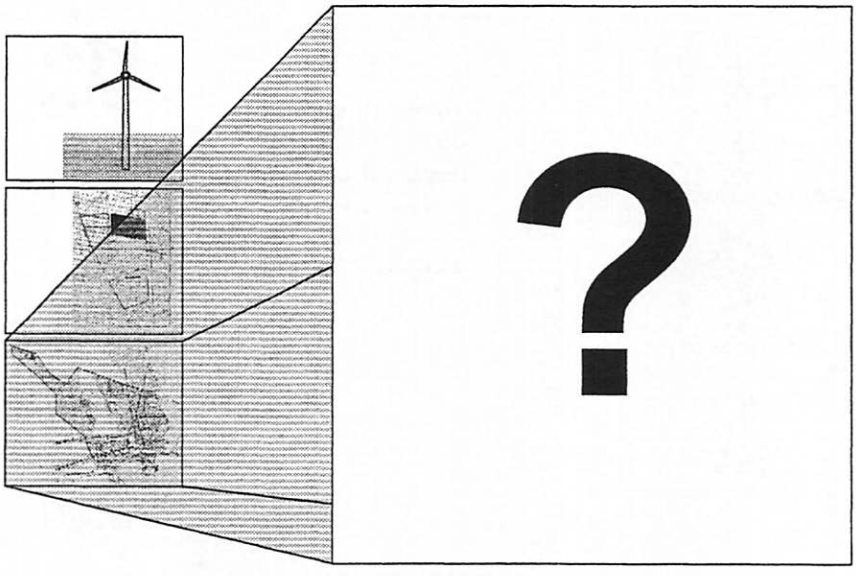
what will be done and what should be done



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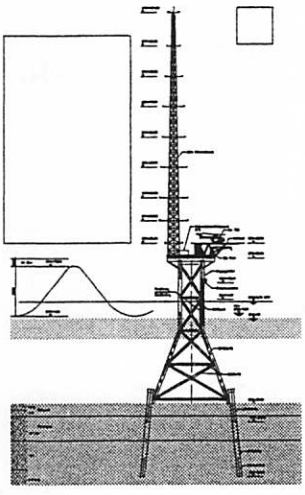
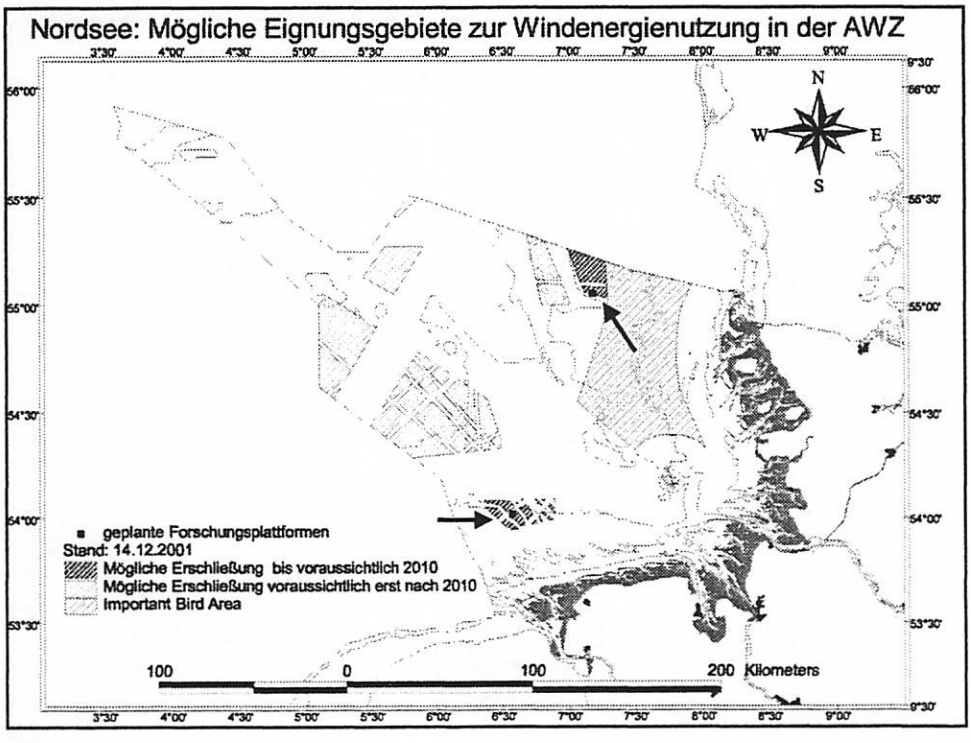
BEOFINO



Possible Impacts of
Offshore Windparks
Ecological Research
on Platforms
in the
North and Baltic Sea

AWI



Beteiligte Institutionen

Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven

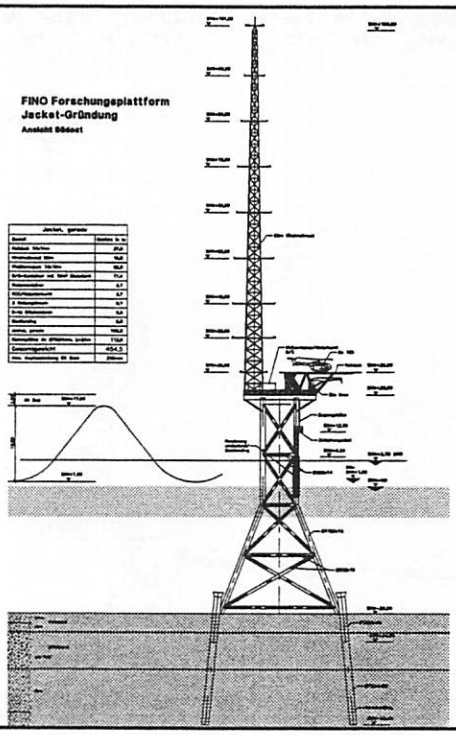
- Koordination
- Lebensgemeinschaften des Meeresbodens

Institut für Ostseeforschung, Warnemünde

- elektro-magnetische Felder
- Lebensgemeinschaften des Meeresbodens

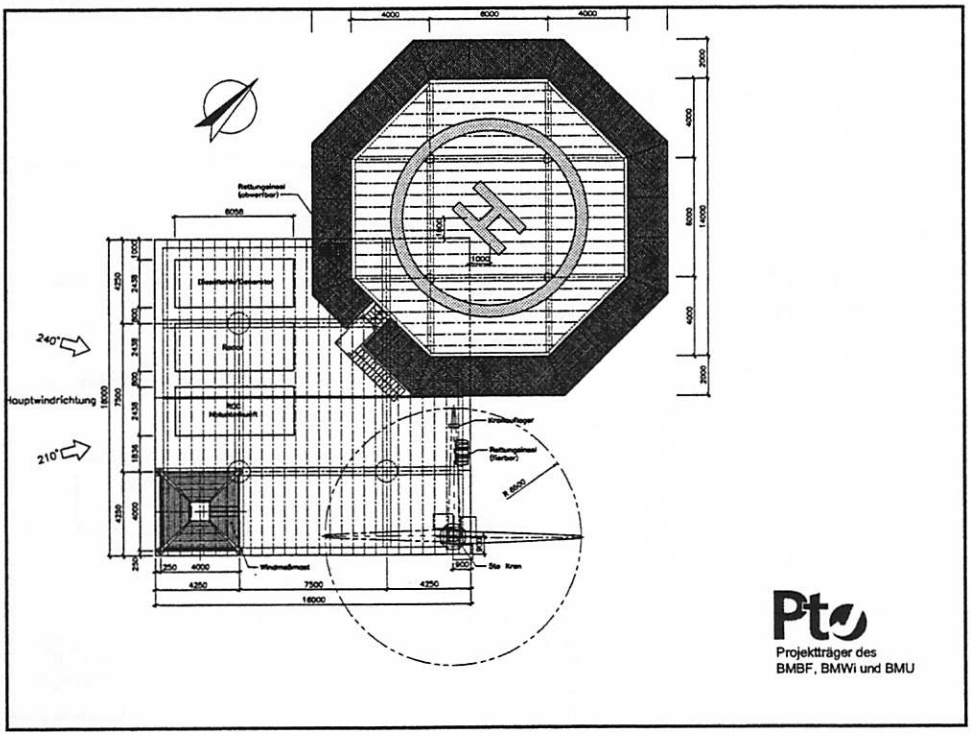
Institut für Vogelforschung, Wilhelmshaven / Helgoland

- Vogelzug



Masthöhe:	100 m
Deckhöhe:	20 m
Wassertiefe:	- 28 m
Rammtiefe:	- 52 m

Projektträger des
BMBF, BMWi und BMU



GESAMTZIEL

- Untersuchung möglicher Auswirkungen von Offshore-WEA auf die marine Umwelt
- Entwicklung von Methoden und Kriterien zur Beurteilung von Belastungen

Belastungspfade:

- Auswirkungen auf den Vogelzug und Gefahr des Vogelschlages
- Auswirkungen auf die Lebensgemeinschaften des Meeresbodens
- Auswirkungen elektro-magnetischer Felder auf marine Organismen

AWI

Auswirkungen auf den Vogelzug

Ziel		Methode
Zugverhalten über See (tageszeitliche Verteilung, Zughöhen)	⟹	Radar (horizontal u. vertikal), Video
Arten-Erkennung (Vögel und Fledermäuse)	⟹	Video und akustische Verfahren (z.B. Richtmikrophone)
		Alle Daten sollen fernübertragen werden

Methoden zur Abschätzung des Kollisionsrisikos fliegender Vögel und Fledermäuse mit WEA sowie von Messeinrichtungen zu deren Quantifizierung sollen entwickelt werden

AWI

Auswirkungen elektro-magnetischer Felder (EMF)

Ziel		Methode
Erfassung eines möglichen Einflusses durch Unterseekabel erzeugte EMF auf marine Organismen (Makrozoobenthos u. Kleinfische)	⟹	**Labor**: Versuche mit künstlichen elektromagnetischen Feldern (Helmholtz-Spulen)
	⟹	**Freiland**: Visuelle Beobachtung vorhandener Organismen im Bereich existierender Seekabel

AWI

Prozesse im Nahbereich der Piles

Ziel	Methode
Erfassung von Veränderungen in der Sedimentzusammensetzung und damit einhergehender Veränderung der benthischen Gemeinschaft	⇒ Probennahmen mit van Veen – Greifer im direkten Umfeld (bis 20 Meter) eines Piles
	Videoaufnahmen am Boden
	Meroplankton und Ansiedlungs-prozesse
Dokumentation des Aufwuchses an den Piles	⇒ Stufenlos am Pile verfahrbare Video-/Photokamera (Ferndatenübertragung)
	Wenn möglich, zusätzlich durch Taucher gewonnene Kratzproben

AWI

Offshore Windfarms – Possible Effects on Marine Mammals and Objectives of Concomitant Research

Adolf Kellermann
National Park Regional Office
Schleswig-Holsteinisches Wattenmeer
Toenning, Germany

Construction and Operation of Windfarms:

- What are the impacts?
- What do they cause?
- What is known and where are gaps in knowledge?

During construction:

Impacts:

- Foundation's construction
- Pile ramming
- Cable transects
- Logistics: Transport of material and personal (ships, helicopters)
- Accidental inputs from ships: Trash, oil, other materials)

During construction:

Direct effects

- Increased turbidity: Seston, sediment
- Noise and vibrations
- Increased disturbance
- Presence of hard substrates

During construction

Anticipated effects on marine mammals - Research topics:

- Changes in spatial and temporal distribution patterns
- Changes in behavior: Communication, orientation and discomforting
- Changes in behavior: Habituation, curiosity, avoidance?
- Immediate damages by construction activities: Sensoric physiology

In operation.

Impacts

- Presence of hard substrates
- Emission of sound waves/vibrations into water/sediment
- Logistics: Regular maintenance/transport of material and personal (ships, helicopters)
- Electromagnetic fields by cables

In operation.

Direct effects

- Change of habitat
- Change in food availability
- Increased disturbance
- Disturbance of electromagnetic sensory systems

In operation.

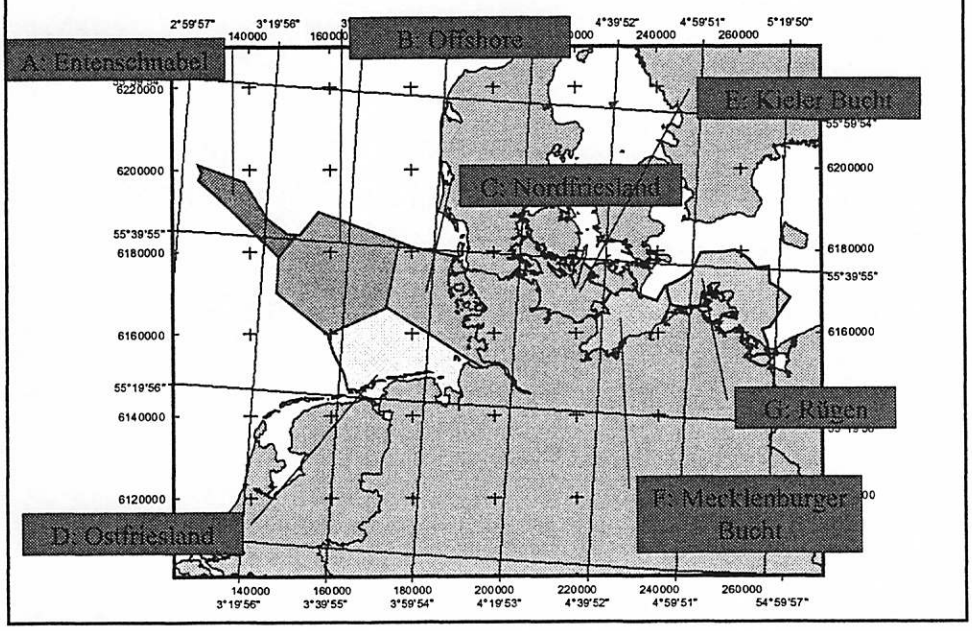
Anticipated effects on marine mammals - Research topics

- Changes in spatial and temporal distribution patterns
- Changes in behavior: Communication, orientation and discomforting
- Changes in behavior: Habituation, avoidance?

What research is underway?

- MINOS - Marine Warmblüter in Nord- und Ostsee: Grundlagen zur Bewertung von Windkraftanlagen im Offshore – Bereich
- MINOS – Marine warm-blooded animals in the North and Baltic Seas: Foundations for assessment of offshore windfarms

Untersuchungsgebiet Flugzählungen MINOS



NS Ostfriesland
NS Nordfriesland
NS offshore
NS Entenschnabel
Kieler Bucht
Mecklenburger Bucht

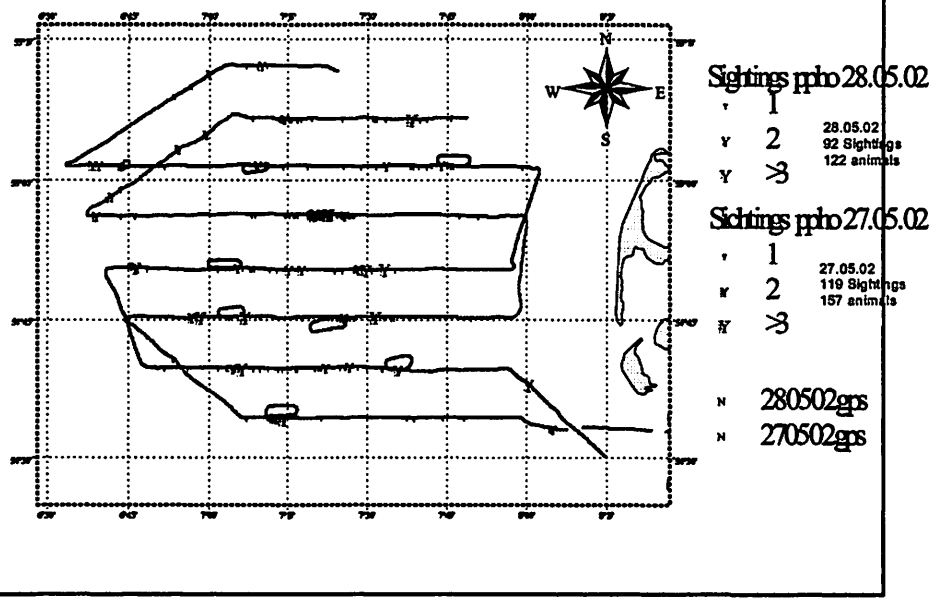
N

MINOS

- Funded in the framework of the ZIP (Investment-in-future) program,
- volume 1.51 Million Euro,
- running two years (2002-04),
- seven individual projects including sea birds, harbor seals (Phoca vitulina) and harbor porpoise (Phocoena phocoena)

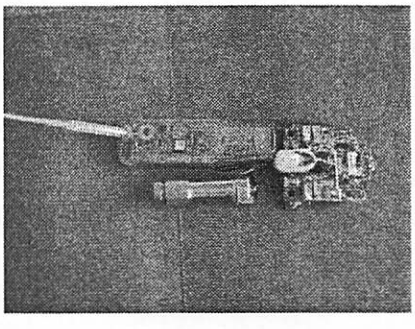
MINOS

- Large-scale field surveys study harbor porpoise distribution in the North Sea and Baltic Sea EEZ
- Method: Airborne Surveys, including accidental sightings of harbor seals



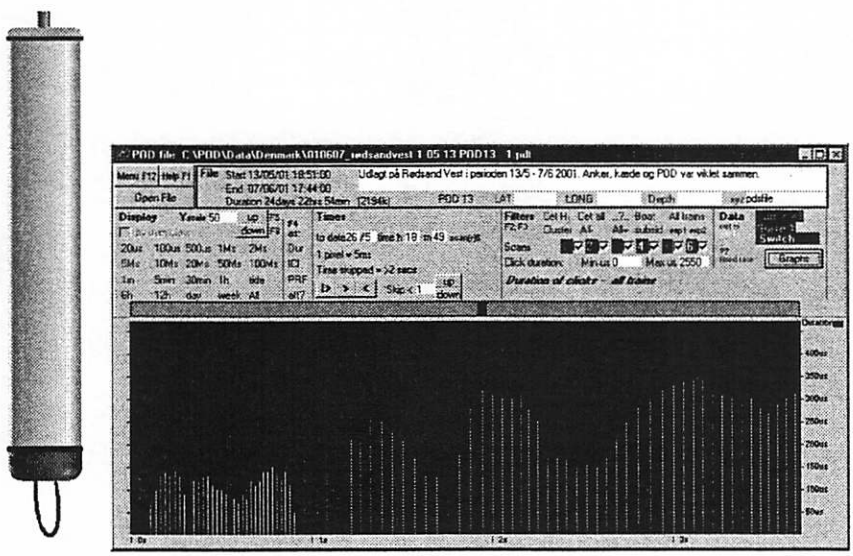
MINOS

- Large-scale field surveys study migration patterns and range of harbor seals in the North Sea EEZ
- Method: Telemetry, complemented by regular monitoring in coastal waters



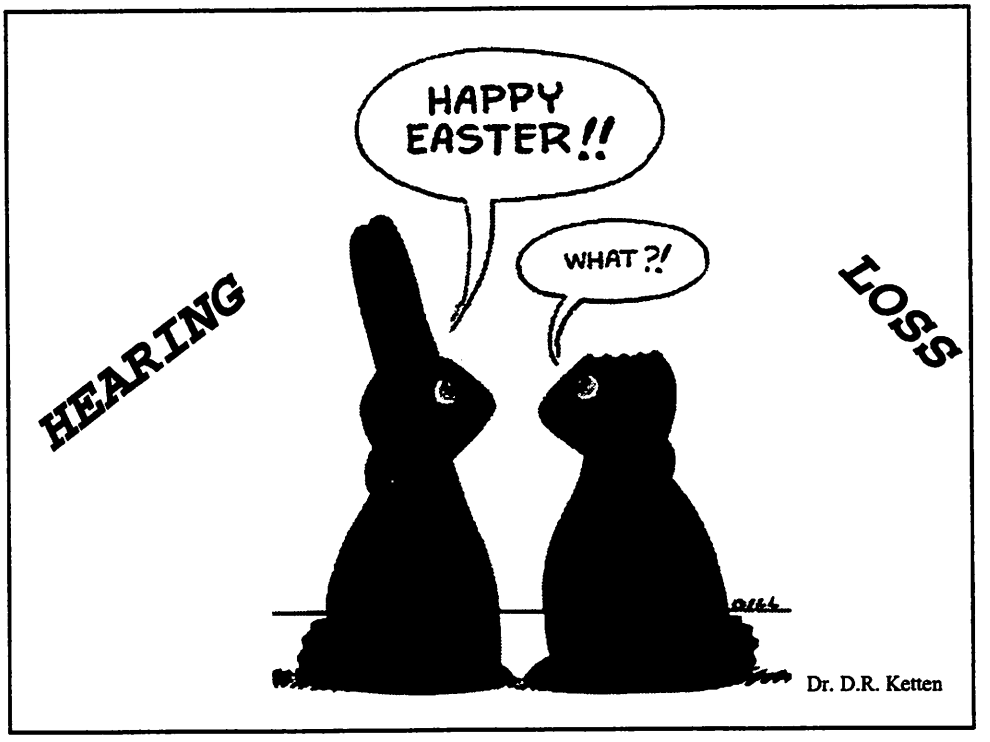
MINOS

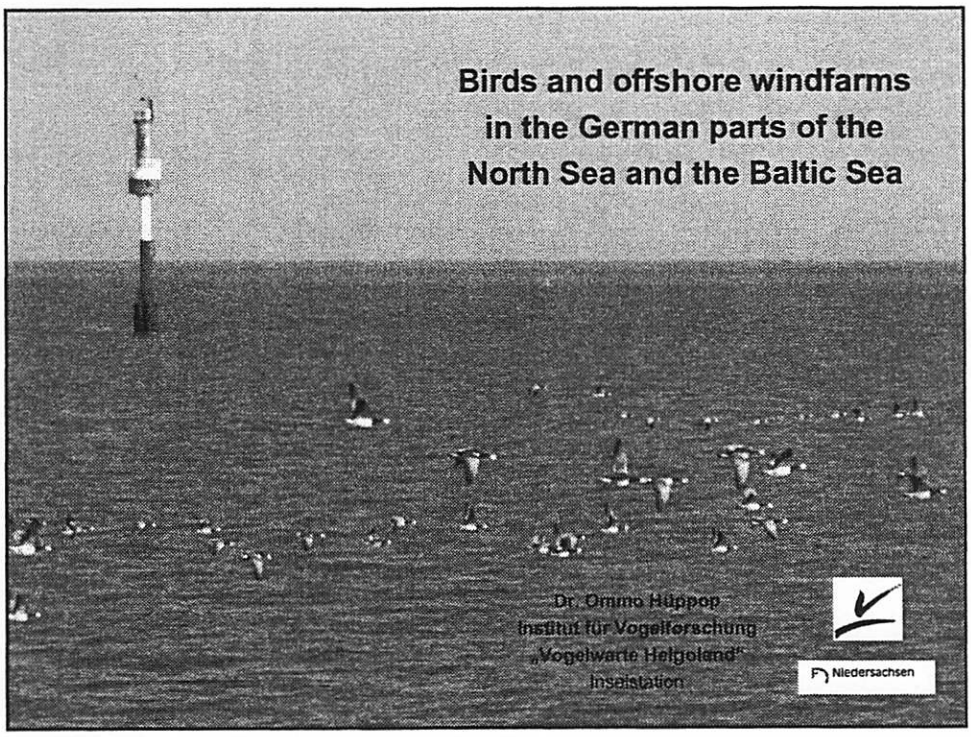
- Fine-scale field surveys study harbor porpoise utilization patterns of selected areas both in the North Sea and Baltic Sea EEZ
- Method: Stationary and towed PODs (porpoise click detectors); Long-term objective to develop routine monitoring procedure



MINOS

- Laboratory experiments study the sensory physiology of harbor seals and harbor porpoise
- Methods: Various, including exposure to selected frequency ranges and noise levels, behavior studies and pathology





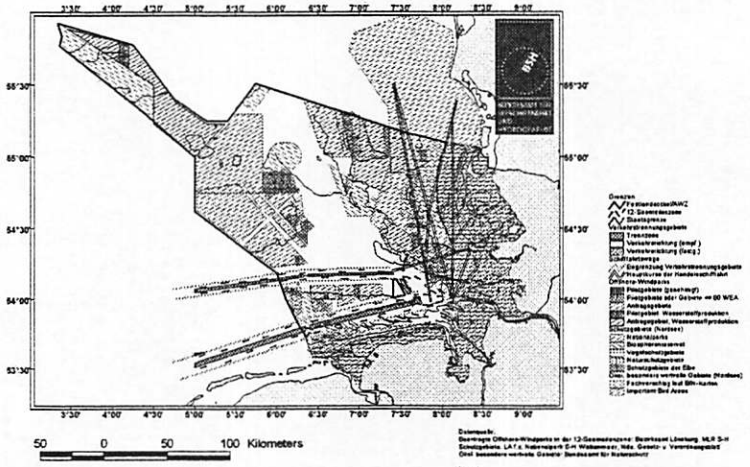
Possible effects of offshore wind farms on birds

- **Collisions ?**
- **Barriers ?**
- **Loss of resting / foraging habitats ?**
- Change of habitats / feeding conditions ?

➡ **Combination of study methods**

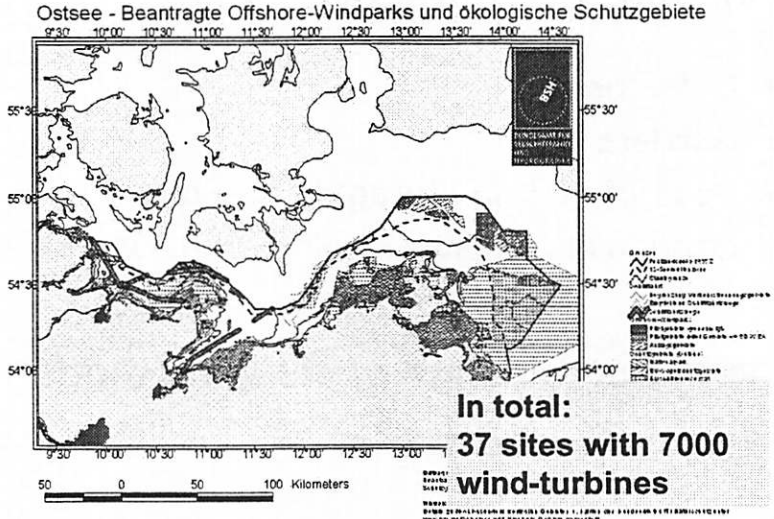
Planned offshore windfarms and protected areas in the North Sea

Nordsee - Beantragte Offshore-Windparks und ökologische Schutzgebiete



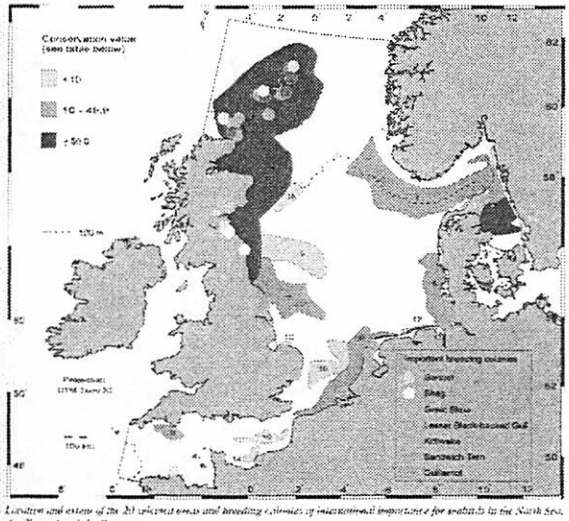
Planned offshore windfarms and protected areas in the Baltic Sea

Ostsee - Beantragte Offshore-Windparks und ökologische Schutzgebiete



In total:
37 sites with 7000 wind-turbines

Important Bird Areas in the North Sea



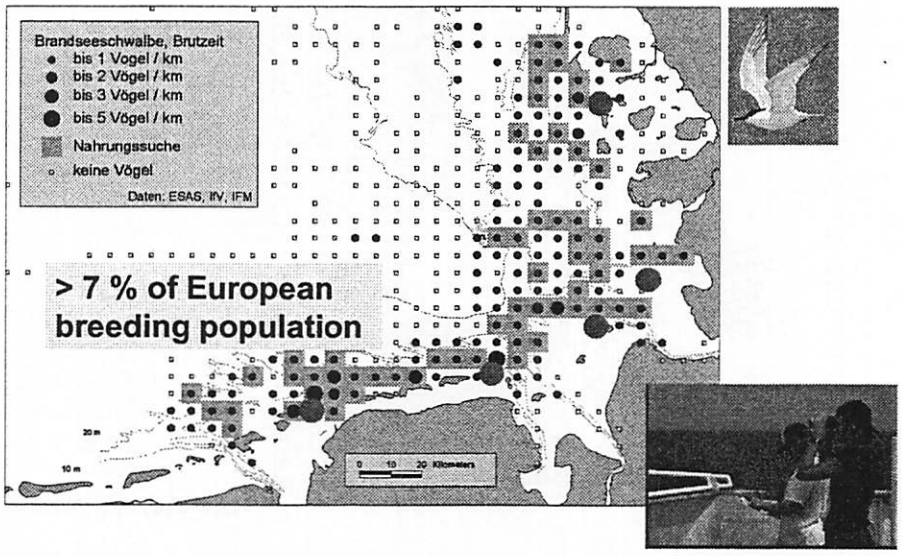
from Skov et al. (1995)

Numbers of resting birds in the eastern German Bight

species	average number	% of biogeograph. population
Red-throated / Black-throated Diver	24 000	21.8
Common Scoter	190 000	14.6
Sandwich Tern	6700	4.5
Little Gull	2900	3.9
Common Gull	21500	1.3
Red-necked Grebe	1850	1.2

after Skov et al. (1995)

Sandwich Tern breeding time distribution

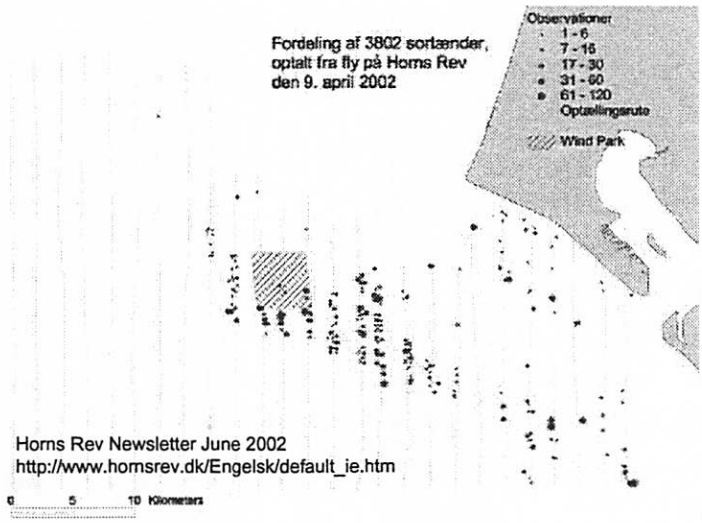


Numbers of resting birds in the Pomeranian Bay (including Polish parts)

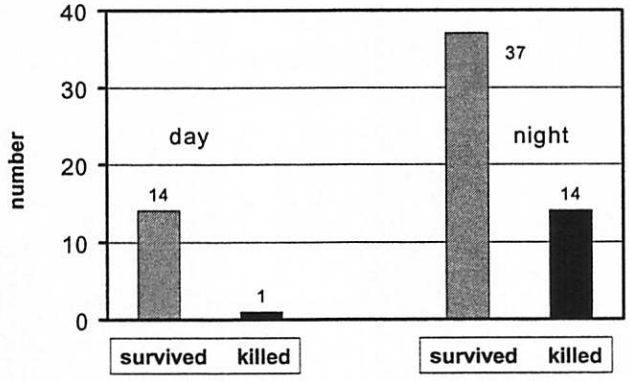
species	average number	% of biogeograph. population
Slavonian Grebe	1225	24.5
Velvet Scoter	240 000	24.0
Long-tailed Duck	837 000	17.8
Common Scoter	215 000	16.5
Black Guillemot	3975	12.0
Red-necked Grebe	1275	8.5
Great Crested Grebe	4180	4.2
Red-breasted Merganser	3000	3.0
Red-throated / Black-throated Diver	1875	1.7

after Skov et al. (2000)

Loss of habitat ?



Collision risk ?



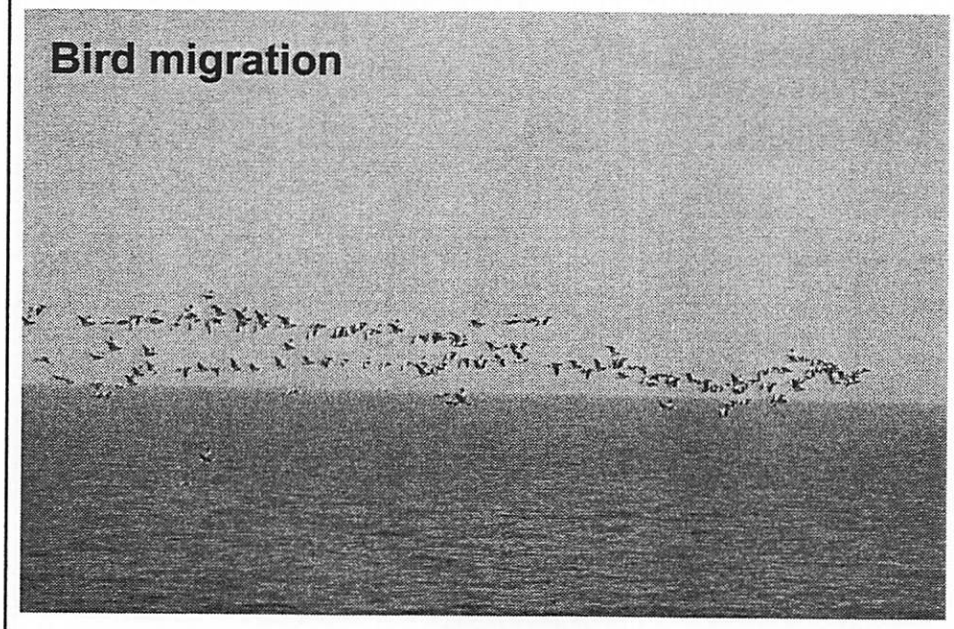
Semi-offshore (Netherlands), after Winkelman (1990)

Windenergy-Sensitivity-Index (WSI)

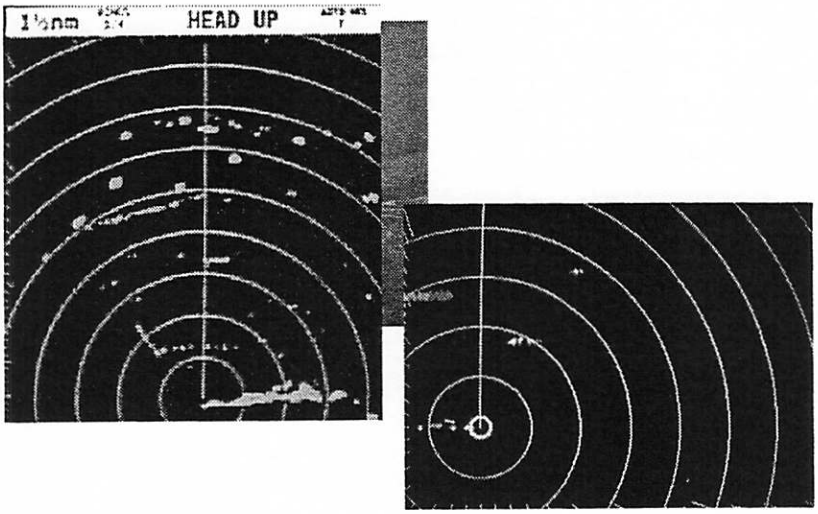
Factors included:

- **Flight manoeuvrability**
- **Flight altitude**
- **Percentage of time flying (compared to swimming)**
- **Nocturnal flight activity**
- **Flexibility in habitat use**
- **Sensitivity to disturbance by ship traffic**
- **Biogeographic population size**
- **European threat and conservation status**

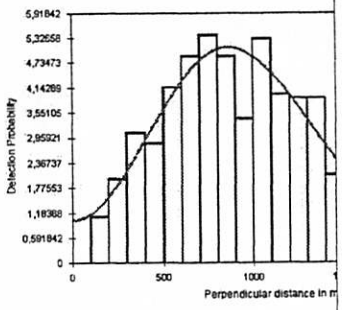
Garthe & Hüppop (in prep.)

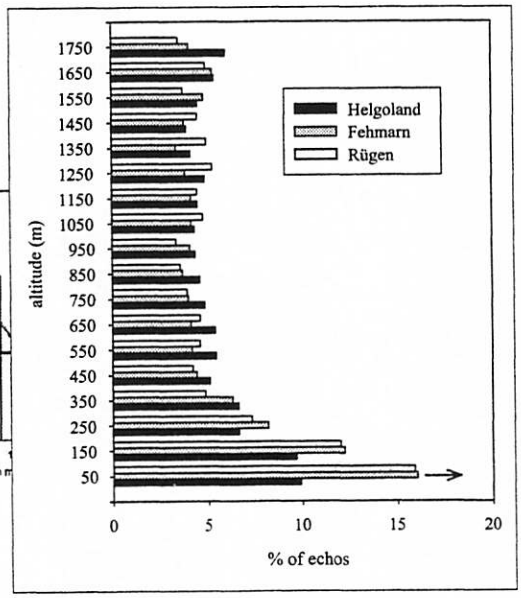


Ship radar

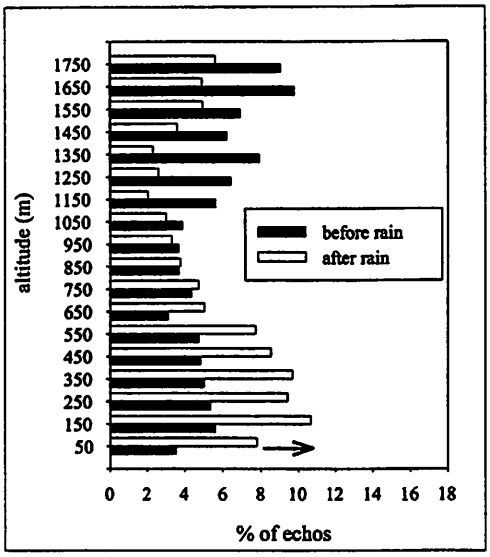


Flight altitude

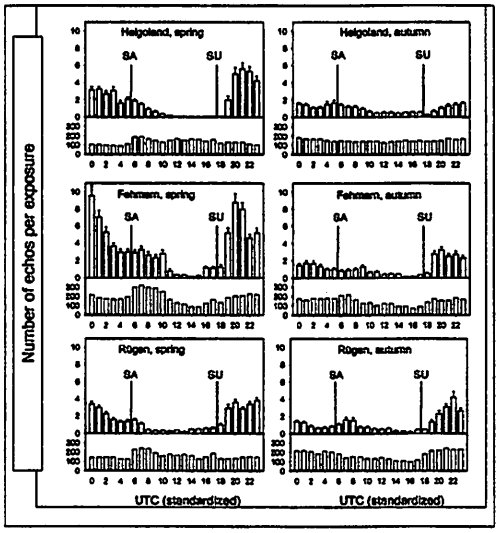


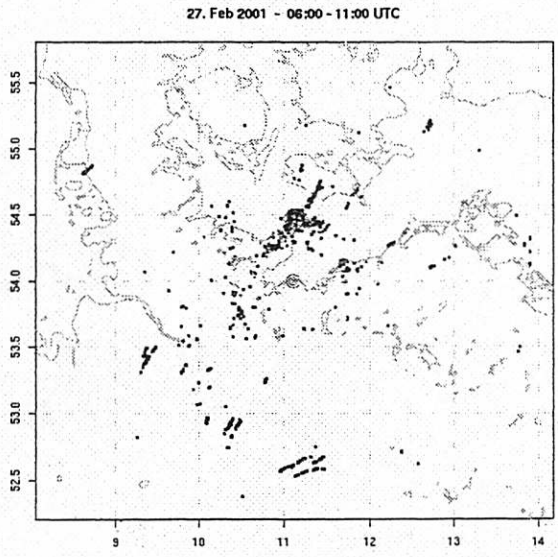


Effects of weather on flight altitude

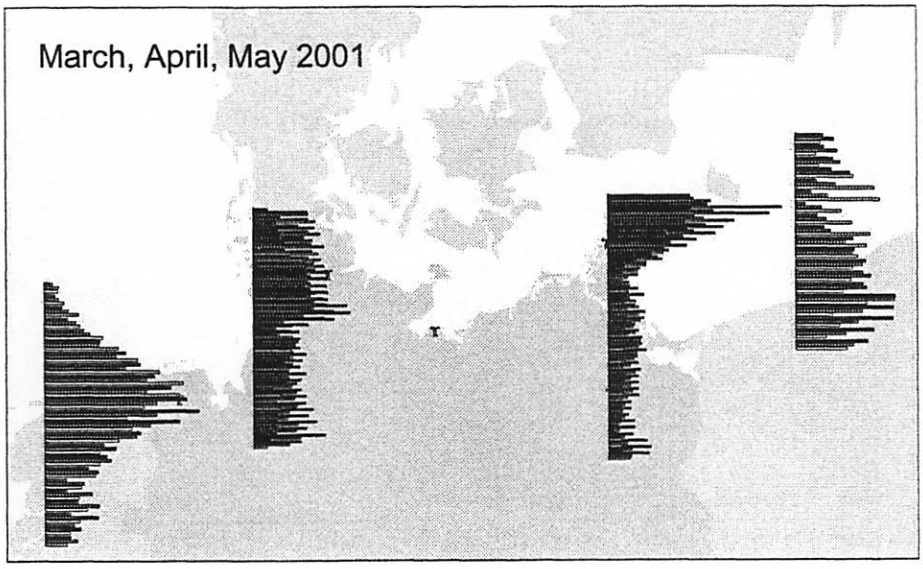


Diurnal intensity of migration

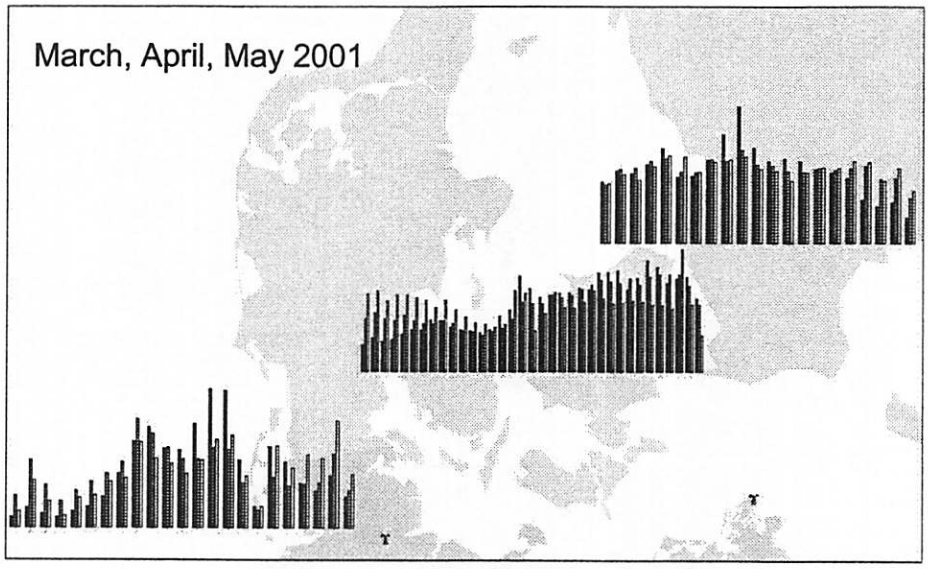




Large scale migration according to military radar data
Hüppop et al. (in prep.)

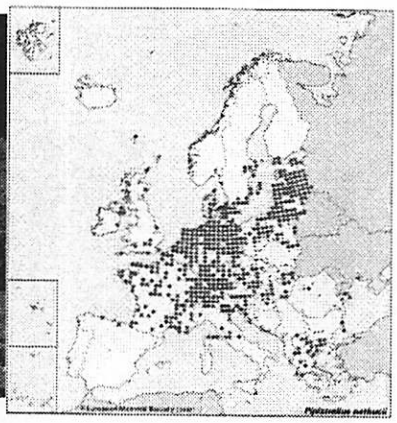


Hüppop et al. (in prep.)



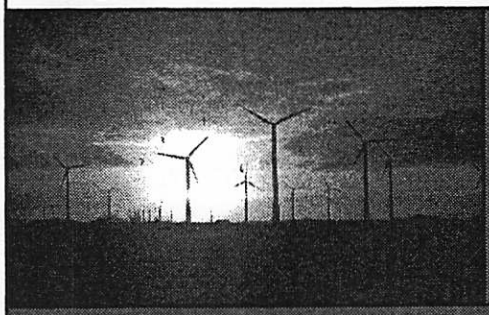
Hüppop et al. (in prep.)

Bats



Offshore Wind Energy Activities in Germany

Christian Nath
Germanischer Lloyd WindEnergie GmbH
www.gl-wind.org



Germanischer Lloyd
WindEnergie GmbH

24.09.2002

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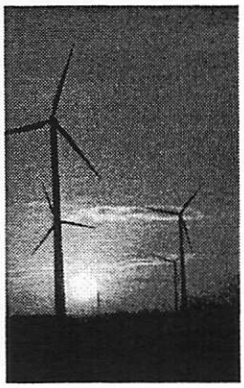

Offshore Wind Energy

- 1982 Study on offshore conditions for large wind turbines of the GROWIAN type
- 1993 German/British EU-Study on the offshore potential in Europe (German co-funding)
- 2000 Renewable Energy Law
- 2002 Offshore study of the German Government

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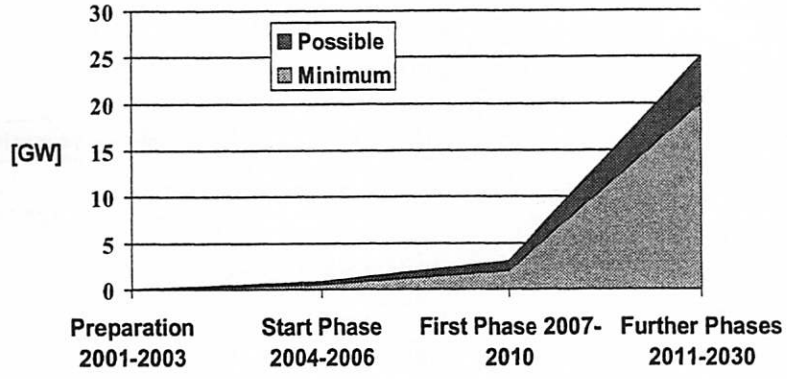
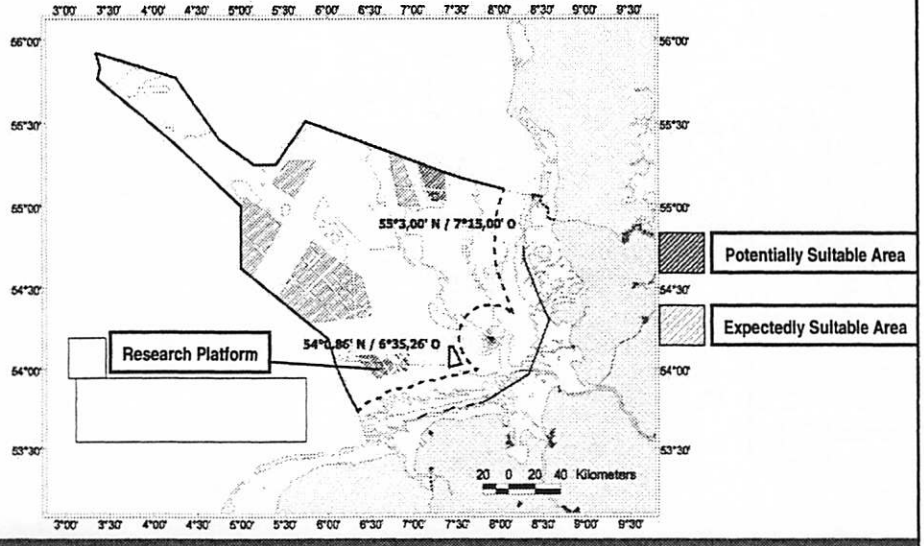
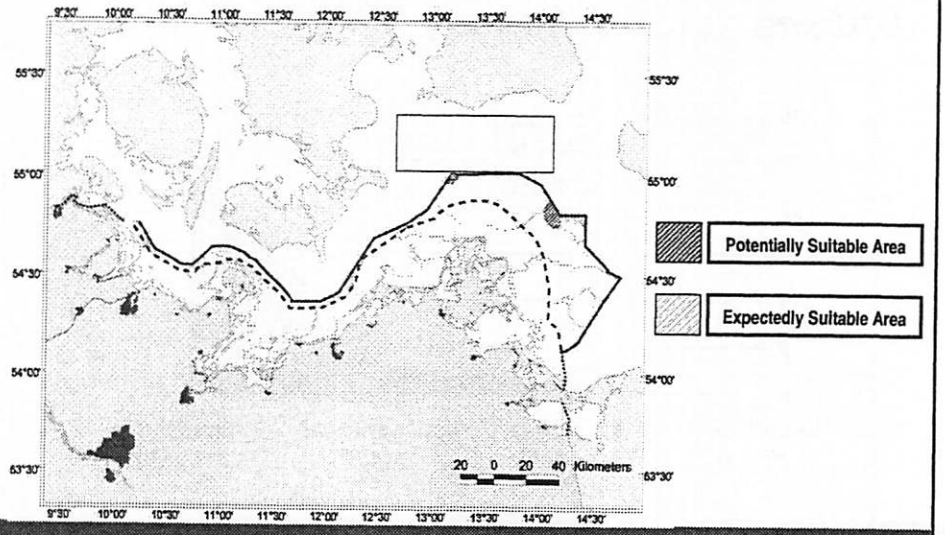
German Targets for Offshore Wind Energy Utilisation as of January 2002



Potentially and Expectedly Suitable Areas



Potentially and Expectedly Suitable Areas



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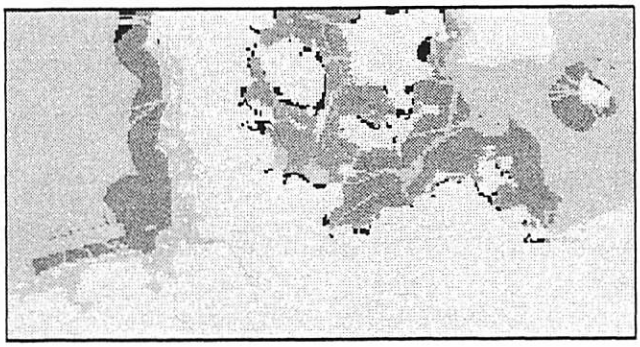
Annual Wind Speeds Offshore



Technically Possible Utilisation of Wind Energy in the German North Sea and Baltic Sea [km²]

Distance from Land [km]	Water Depth 0 - 10 m	Water Depth 10 - 20 m	Water Depth 20 - 30 m	Water Depth 30 - 40 m	Water Depth > 40 m
20 – 30	38	1806	865	607	630
30 – 40	150	800	750	400	680
40 – 50	150	150	900	600	100
50 – 60		150	600	700	
60 – 70		20	600	900	
70 – 80	Results of GL / GH-Study		300	1.200	20
80 – 90			20	1.200	200
90 – 100				600	800
> 100			30	2.300	10.700

Total Area: 15.800 km²

Source: ISET / GL-Wind / WINDTEST-Study

Wind Energy Potential

- **Considering**
  - technically possible areas
  - potentially and expectedly suitable areas
  - relevant wind speed distributions
  - power curves
- **the offshore wind energy potential in Germany is estimated to be**

  19.000 MW
- **the transport to the consumer remains a major problem**

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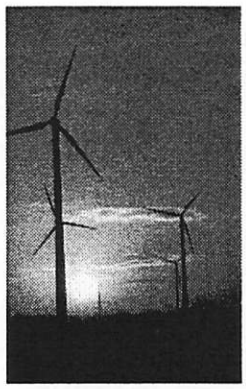
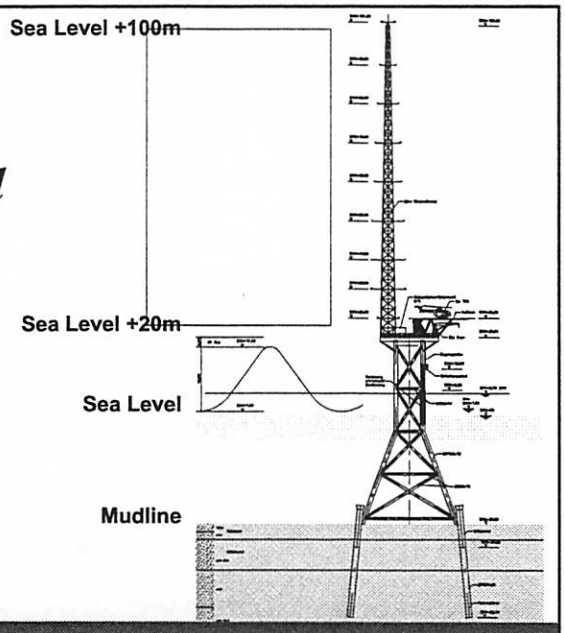
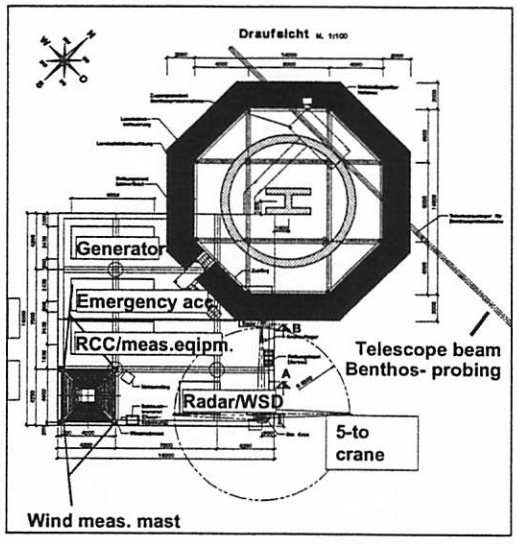
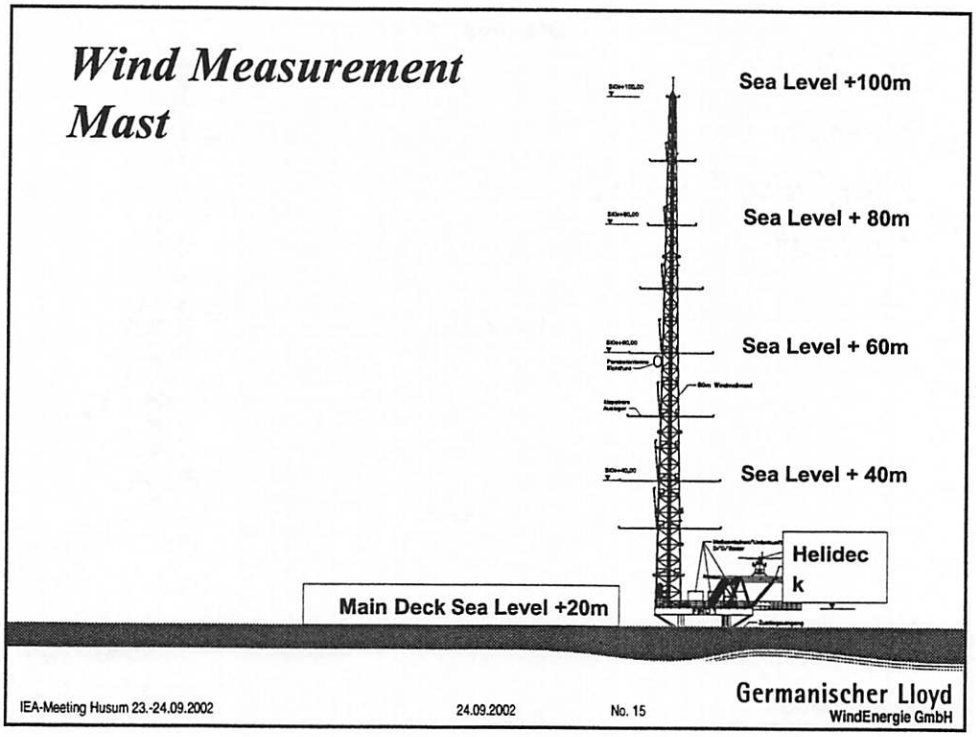


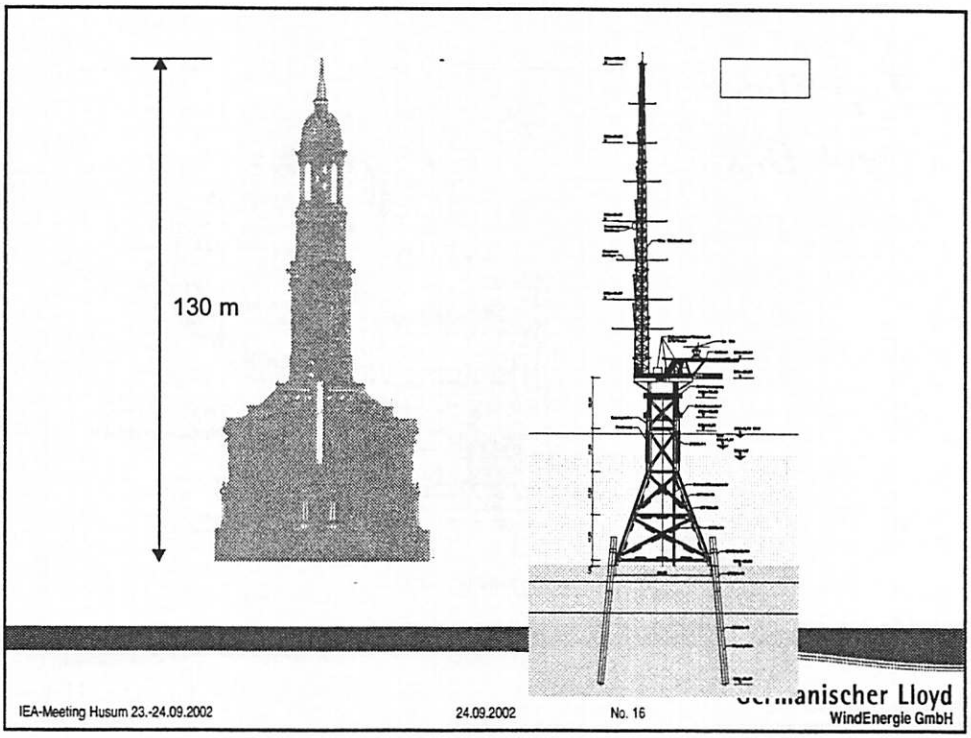
FINO Research Platform General Layout



Top View Deck Design




Wind Measurement Mast
Sea Level +100m
Sea Level + 80m
Sea Level + 60m
Sea Level + 40m
Helidec k
Main Deck Sea Level +20m
IEA-Meeting Husum 23.-24.09.2002
24.09.2002
No. 15
Germanischer Lloyd
WindEnergie GmbH


130 m
IEA-Meeting Husum 23.-24.09.2002
24.09.2002
No. 16
WindEnergie GmbH

FINO - Technical Research

- Wind speeds and directions in several heights
- Air temperature, density, solar radiation, humidity
- Tidal range
- Currents
- Wave heights, periods and directions
- Water temperature and density
- Structural loads
- Sea ice
- Sensors for inclinations and accelerations

FINO - Biological Research

- Investigations during piling
- Clickdetectors (habour porpoises)
- Investigations of bird migration (radar, acustically, optically)
- Fouling of the under-water-structure
- Benthos and fish
- Clouding of water / change of clouding

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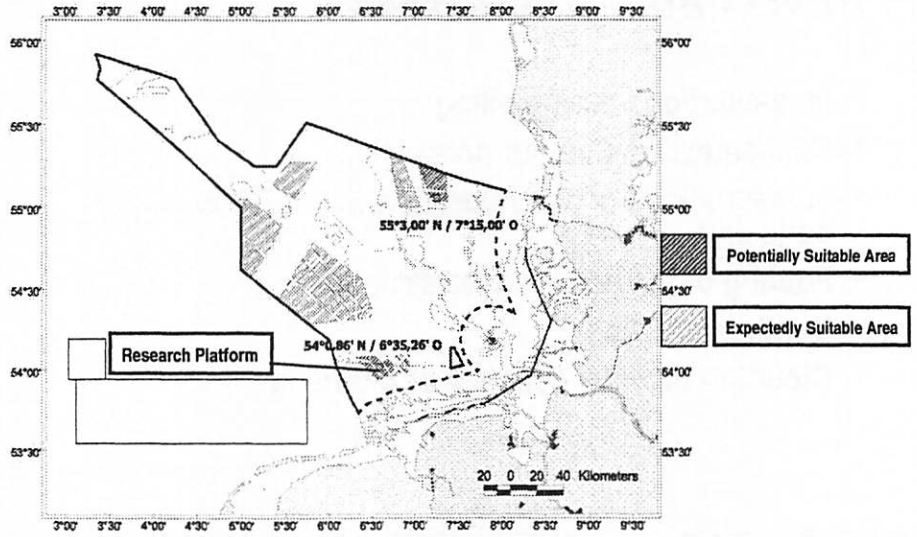
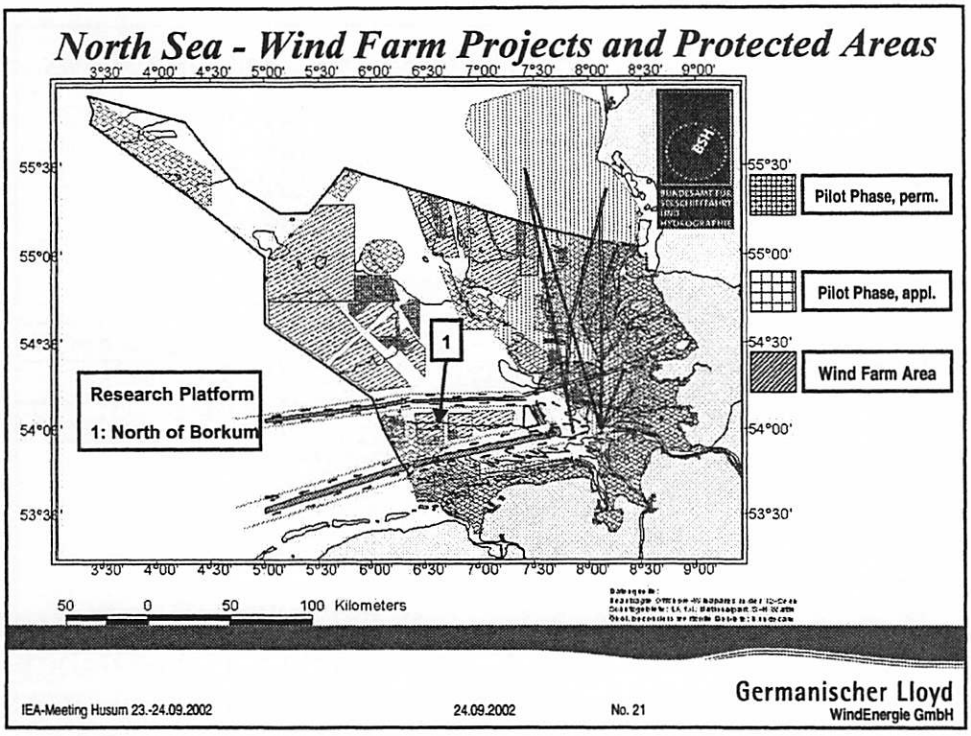
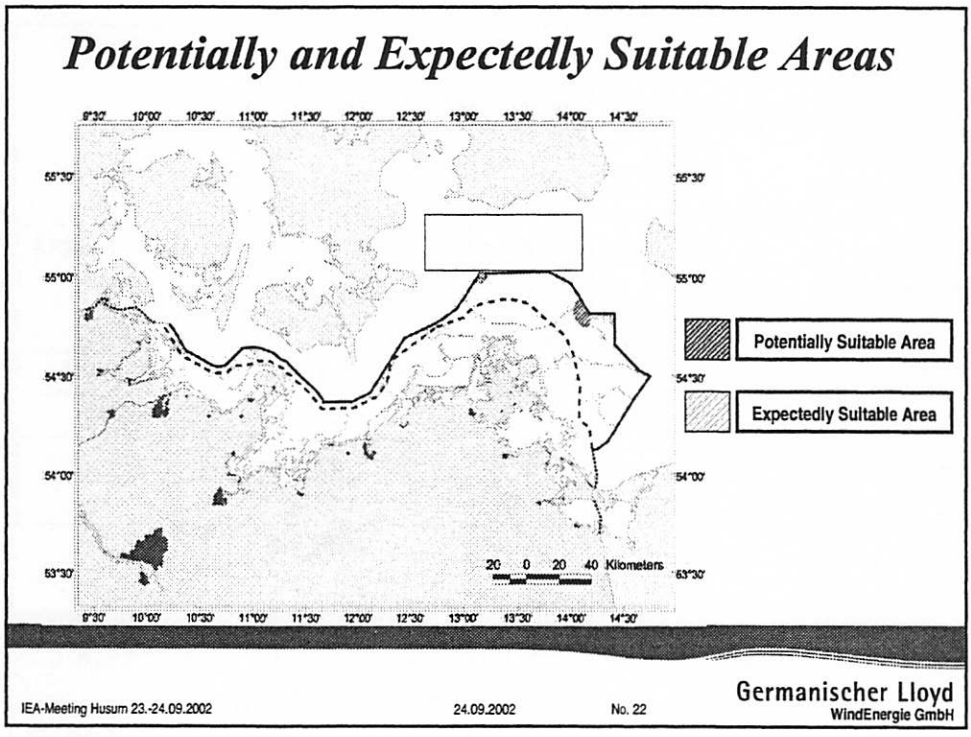
Potentially and Expectedly Suitable Areas




North Sea - Wind Farm Projects and Protected Areas
3°30' 4°00' 4°30' 5°00' 5°30' 6°00' 6°30' 7°00' 7°30' 8°00' 8°30' 9°00'
55°30'
55°00'
54°30'
54°00'
53°30'
Research Platform
1: North of Borkum
1
Pilot Phase, perm.
Pilot Phase, appl.
Wind Farm Area
50 0 50 100 Kilometers
IEA-Meeting Husum 23.-24.09.2002
24.09.2002
No. 21
Germanischer Lloyd
WindEnergie GmbH


Potentially and Expectedly Suitable Areas
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53°30'
Potentially Suitable Area
Expectedly Suitable Area
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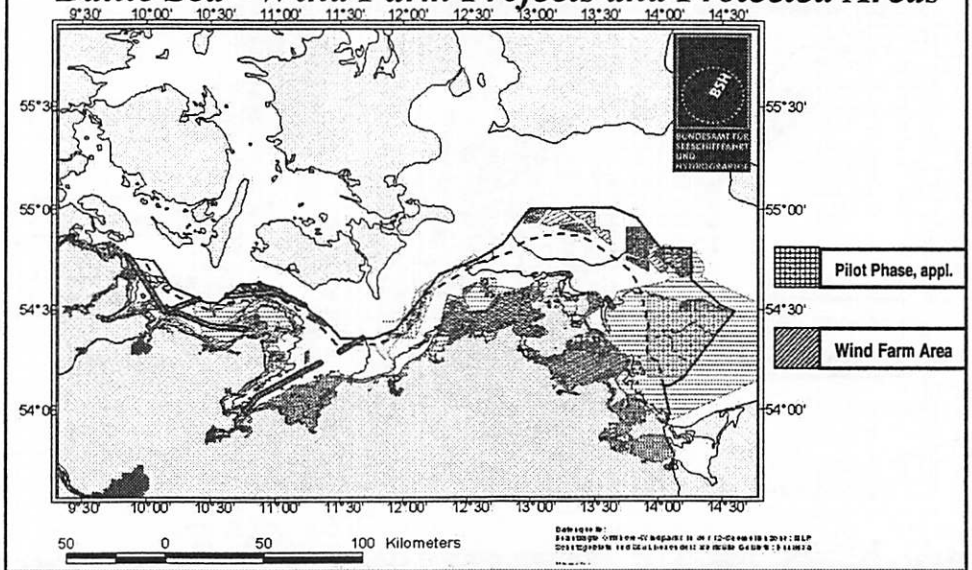
24.09.2002
No. 22
Germanischer Lloyd
WindEnergie GmbH

Baltic Sea - Wind Farm Projects and Protected Areas



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Offshore Wind Farm Projects

Area	No. of Wind Farm Applications	Total Power (MW)	Pilot Phase Power (MW)
North Sea, EEZ	23	60.000	21.000
Baltic Sea, EEZ	7	4.600	400
North Sea, 12-Mile-Zone	6	2.000	-
Baltic Sea, 12-Mile-Zone	2	140	-
		~67.000	

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Contents

1. Introduction
2. Targets
3. Potential
4. Research
5. Projects
6. Permissions
7. Conclusions

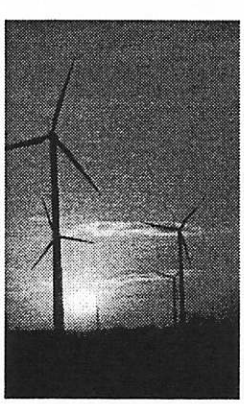
Permissions

- **Inclusion of all Groups of Interest**
- **Within the 12-Mile-Zone**
  - Permissions by Federal States
  - on the Basis of the Federal Environmental Impact Law
- **In the EEZ**
  - Permission by the Federal Government
  - through Federal Authority for Shipping and Hydrography (BSH)
  - Permission has to be granted if the safety of shipping and the environment is not impaired

Building Permissions

- 2001 Permission for pilot phase in the EEZ
- 2002 Permission for cable connection
- 2002 Permission for first research platform, construction and erection contract awarded

Contents



Conclusions

- There is enormous potential
- There are even more projects
- The anticipated wind turbines (5MW) are not available yet
- A controlled growth needs an extension of the REL (2006)
- Insurance companies are hesitant to move offshore because of major losses in the onshore market
- The land-based infrastructure needs major investments
- The elections in fall will determine the future directions in wind energy (onshore and offshore)

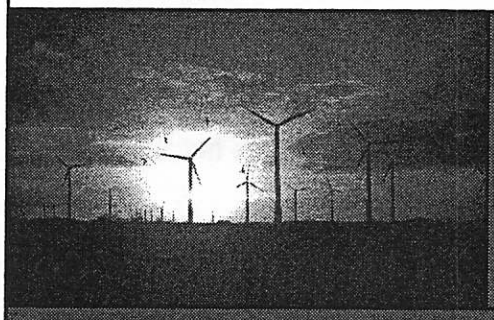
Considering the conclusions
and the restrictions in onshore locations

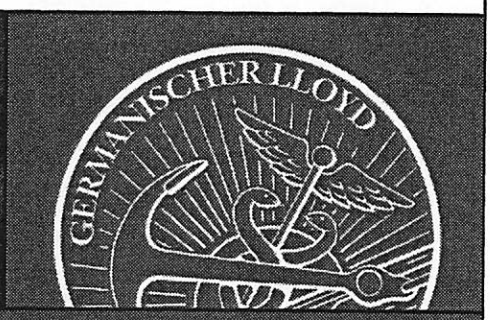
OFFHORE WIND ENERGY

may be one of Germany's best options
for an environmentally friendly energy supply

Thank You for Your Attention

Christian Nath
Germanischer Lloyd WindEnergie GmbH
www.gl-wind.org





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24.09.2002

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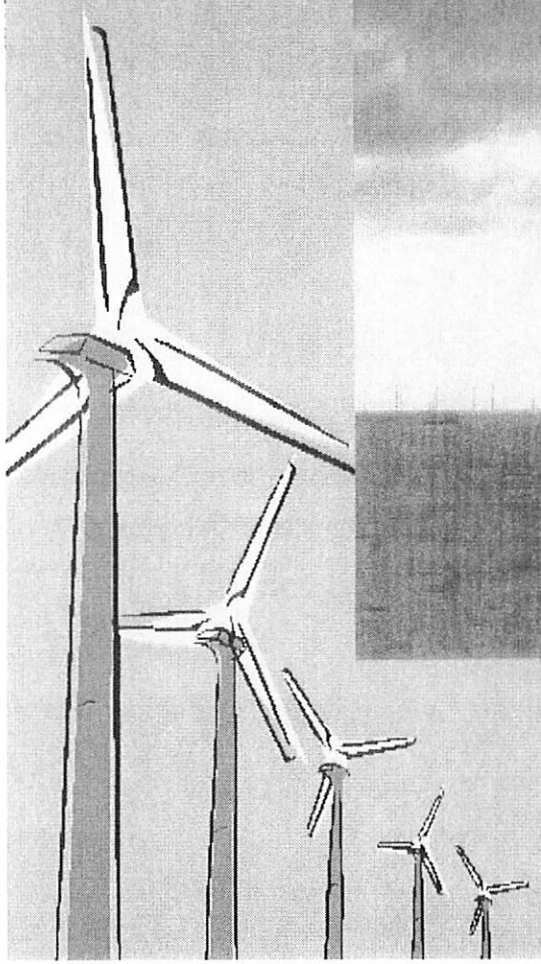
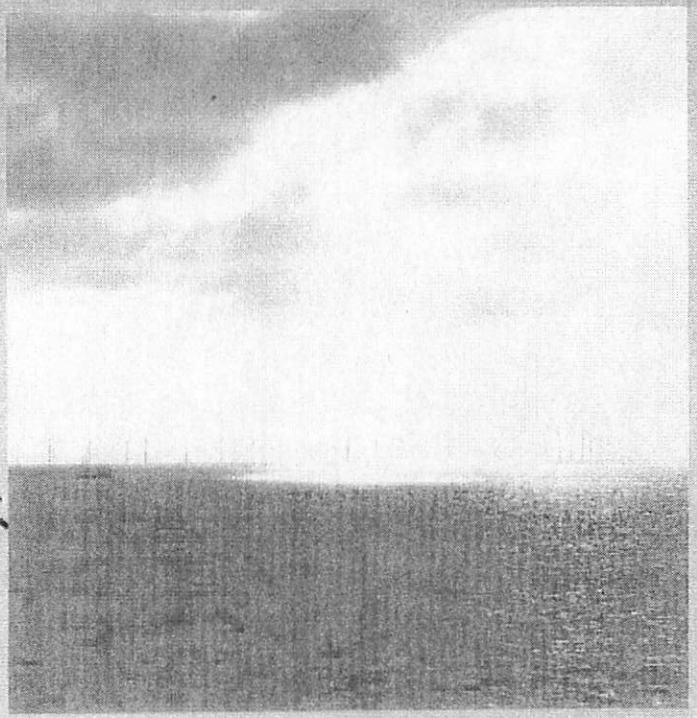
Horns Rev Offshore Project

EIA Review and Monitoring Programme





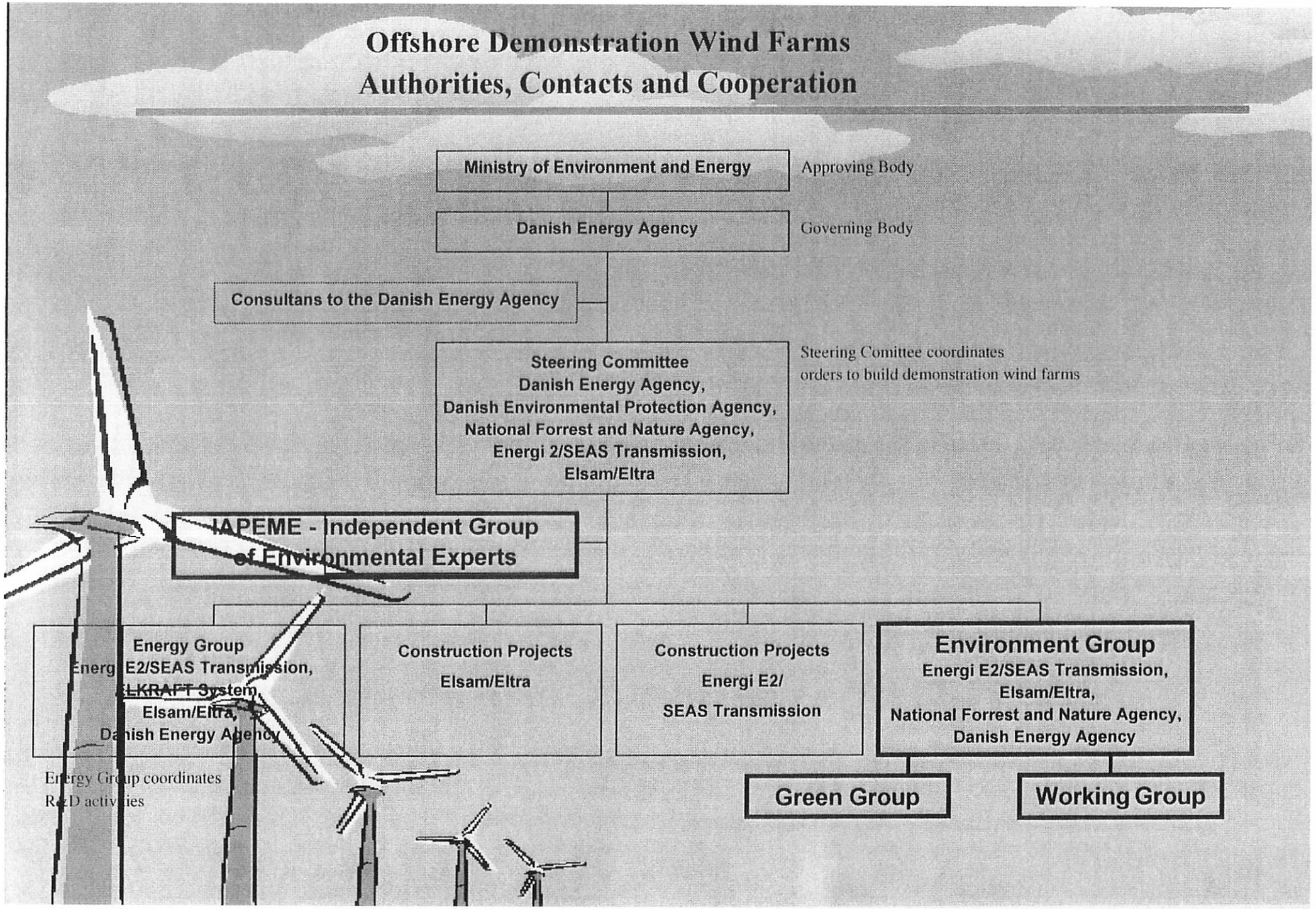
Jette I. Kjær Gaarde

Dipl. Ing.

Tech-wise A/S

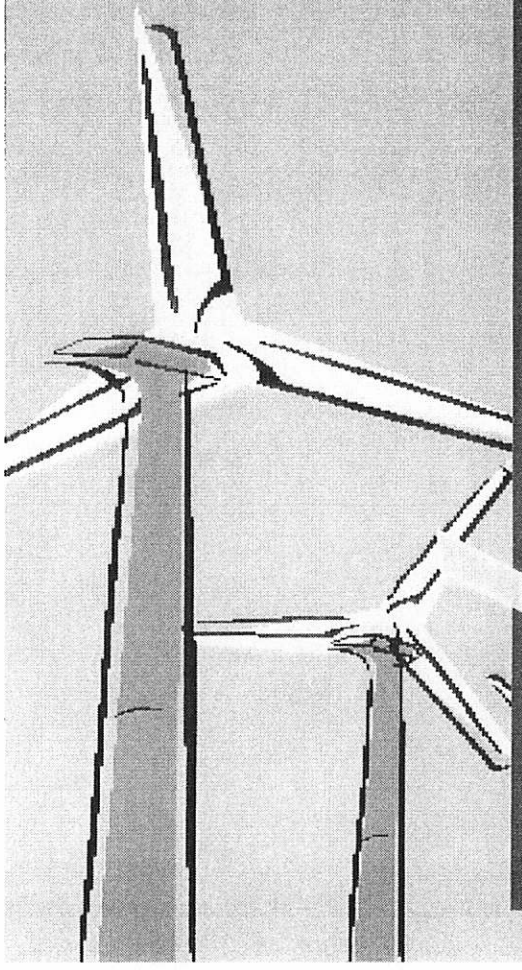
Visit www.hornsrev.dk

Offshore Demonstration Wind Farms
Authorities, Contacts and Cooperation



Planning Process

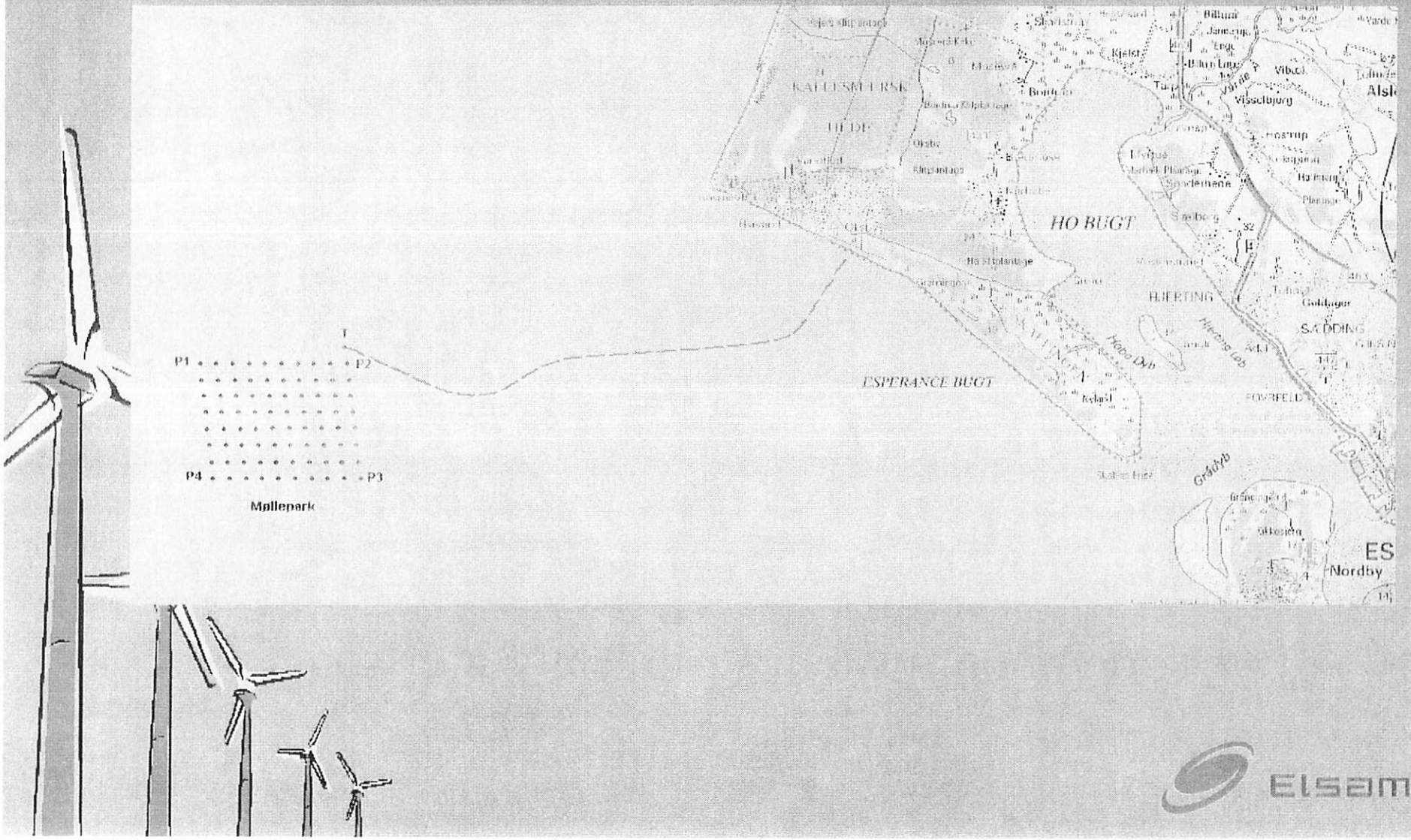
Possible Sites for Demonstration Farms

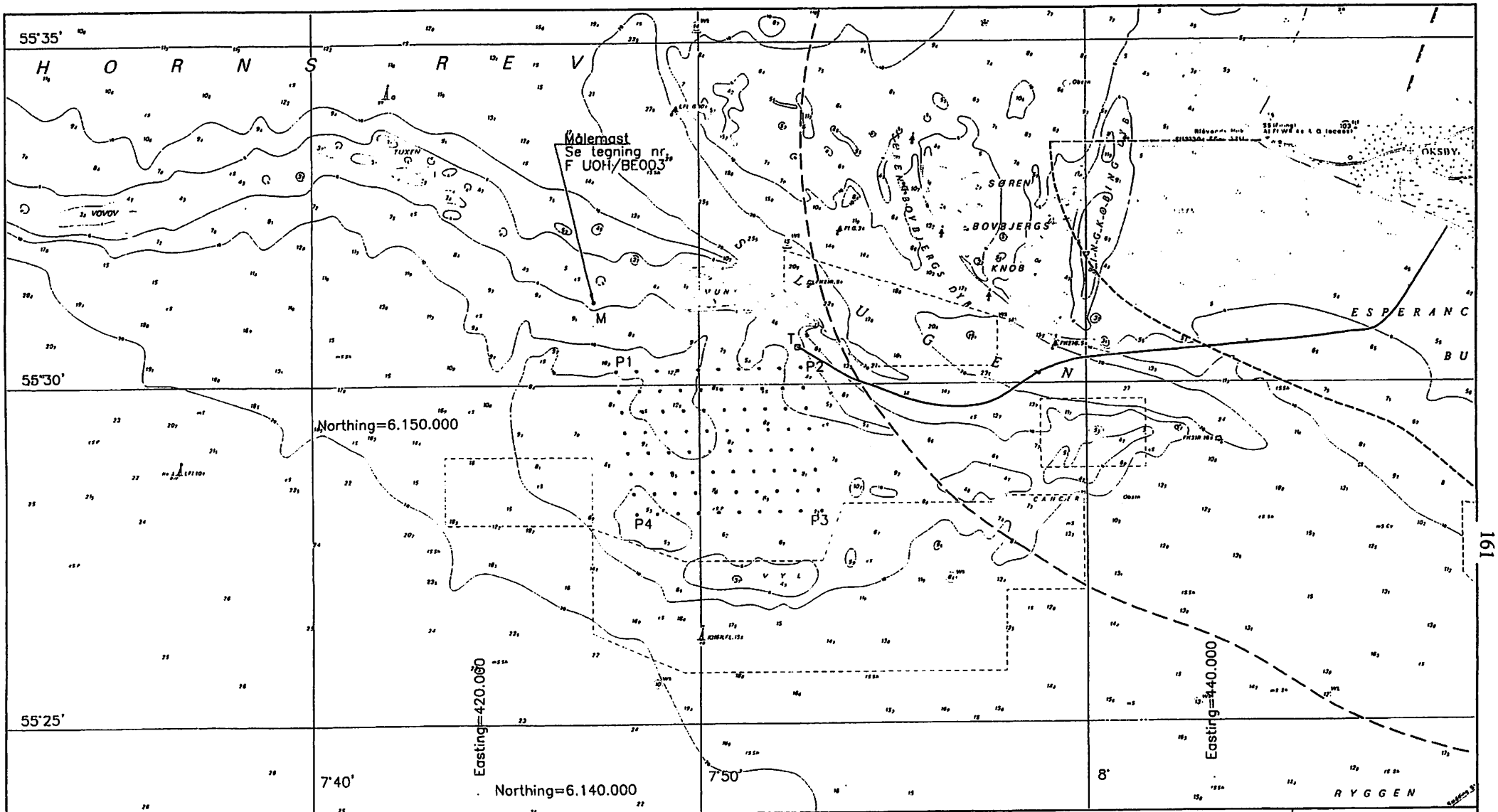


1. Horns rev
2. South of Læsø
3. Omø Stålgrunde
4. Rødsand / Gedser

EIA-Report

Location of Offshore Wind Farm and Cable to Shore





Koordinater i system UTM32/WGS84		
Punkt	Easting (x)	Northing (y)
P1	423.974	6.151.447
P2	429.014	6.151.447
P3	429.492	6.147.556
P4	424.452	6.147.556
T	428.946	6.152.003
M	423.412	6.153.342

Opstillingsområde
Kabeltracé
Anbefalet afstand til kystlinie (12,5 km)
Ramsarområde

index	dato	kontr.	godk.	Projekt-grup.
b	190900	KAH	ERA	tegningen udsendes til

udgave

ELSAMPROJEKT

tegnet	160200	LIJ	målestok ca. 1:100000
kontr.	160200	ERA	
godk.	160200	JP	

ELSAM A/S HAVMØLLER
HORNS REV
SITUATIONSPLAN

EP117460
F UOH/
BE001 b

FILNAVN: FUOH_BE001b

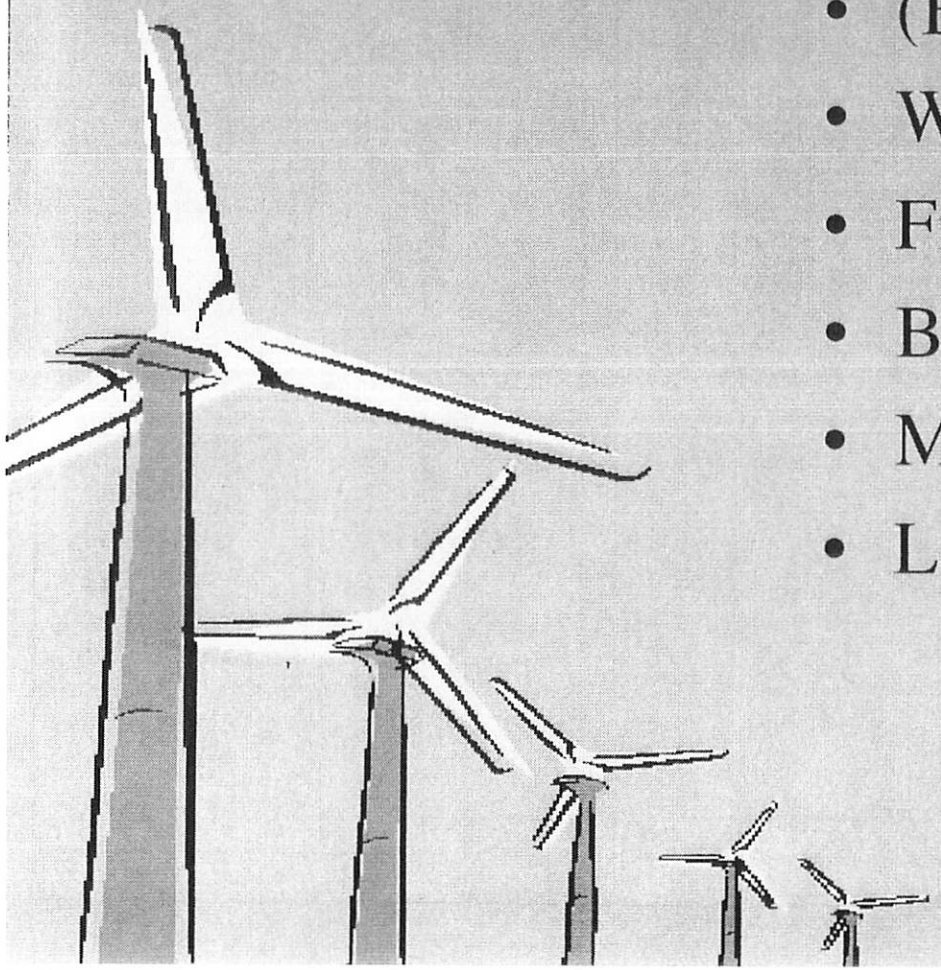
KATALOG:

Kraftværksvej 53 DK-7000 Fredericia Denmark Tel: +45 7923 3333 Fax: +45 7556 4477 E-mail: ep@elsamprojekt.dk Reg.nr. 159481 Giro 8 63 43 35

Environmental Parameters investigated

Screening

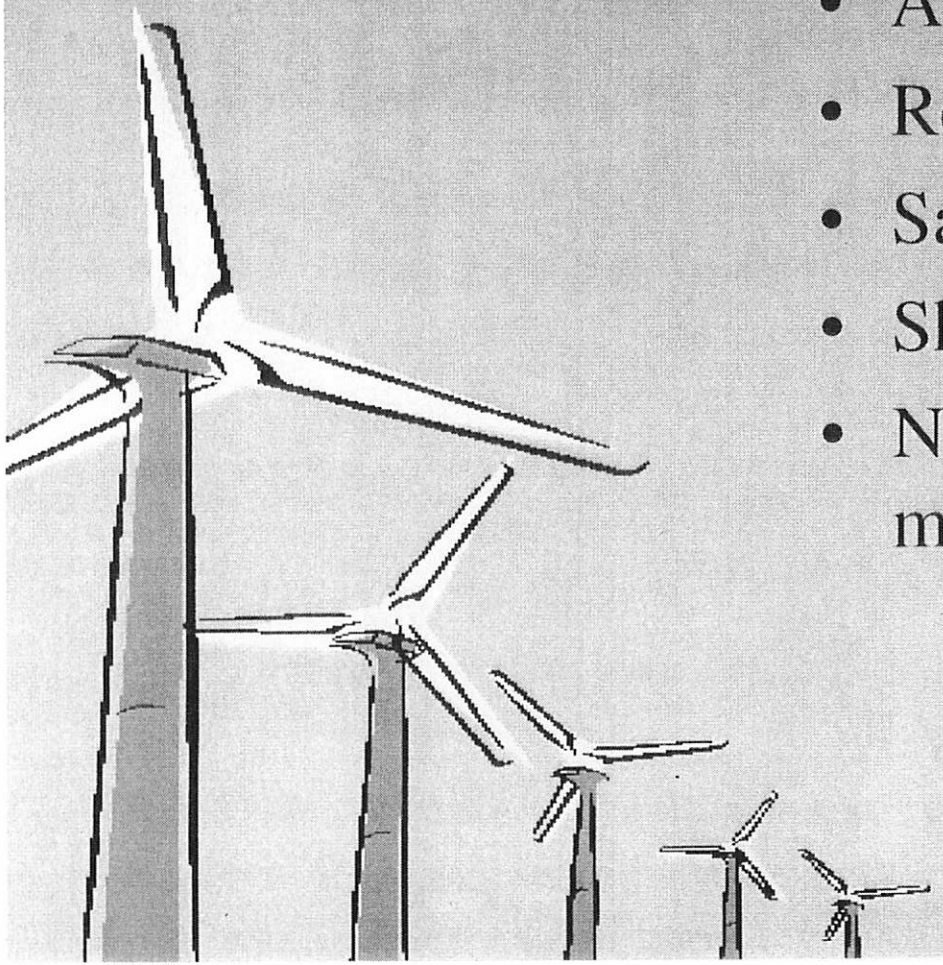
- Hydrography
- (Bottom)flora and fauna
- Water quality
- Fish and fishing
- Birds
- Marine mammals
- Landscape aspects



Environmental Parameters Investigated

Screening

- Raw materials
- Archaeology
- Recreational interests
- Sailing
- Ship collision risks
- Nature preservation and protective measures



EIA Investigations

Hydrography

Purpose

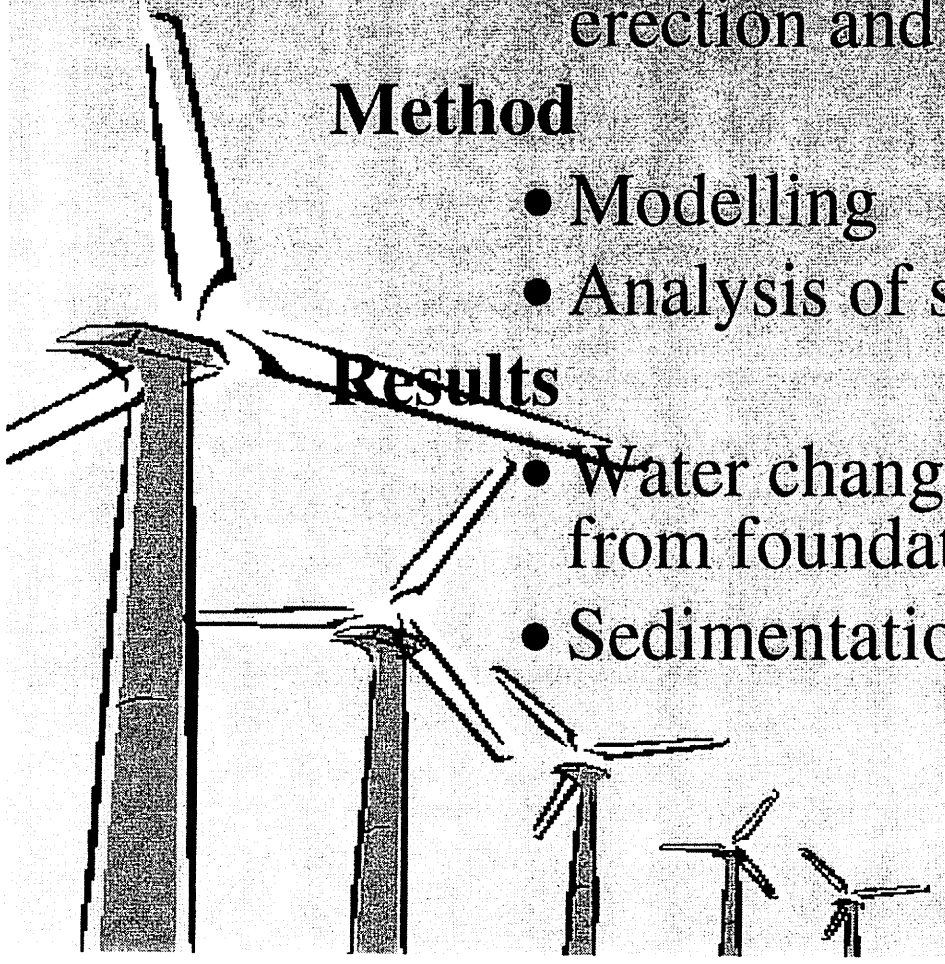
- Sedimentation and change of water during erection and operation.

Method

- Modelling
- Analysis of sediment samples

Results

- Water change reduced by less than 15% 5 m from foundation
- Sedimentation as background level



EIA Investigations

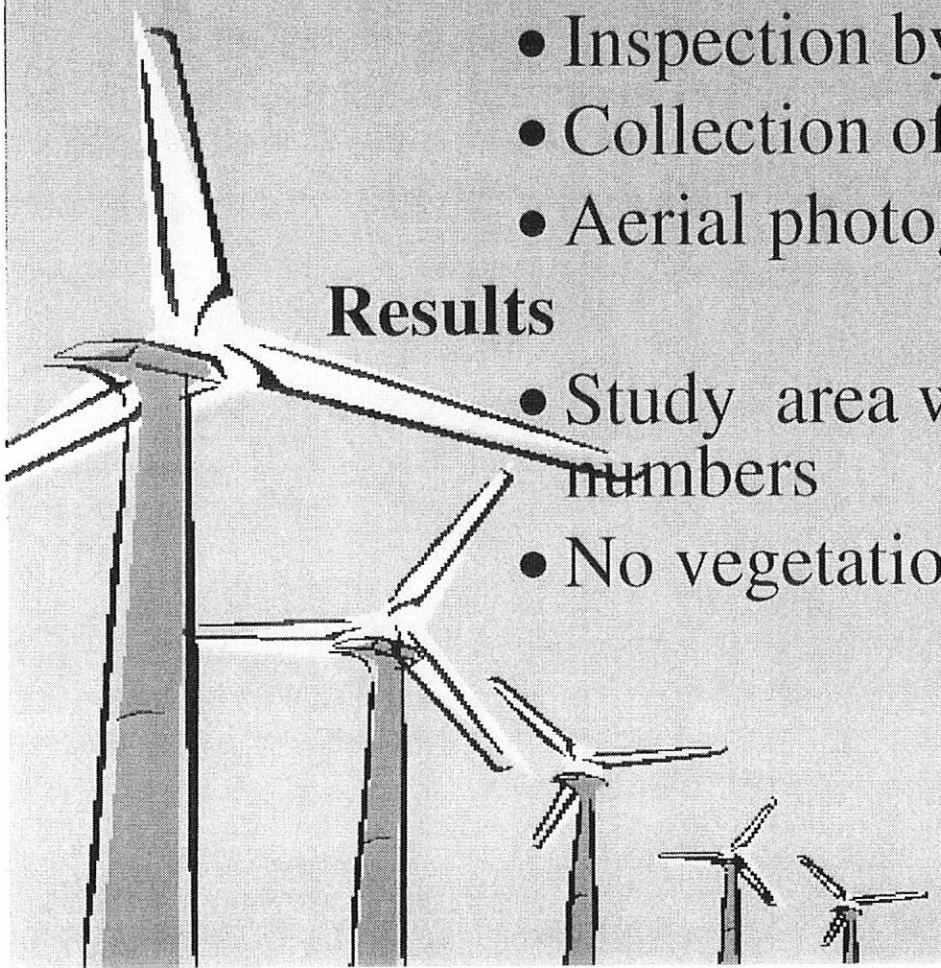
Bottom Flora and Fauna

Method

- Inspection by divers
- Collection of seabed samples from 40 stations
- Aerial photography of area

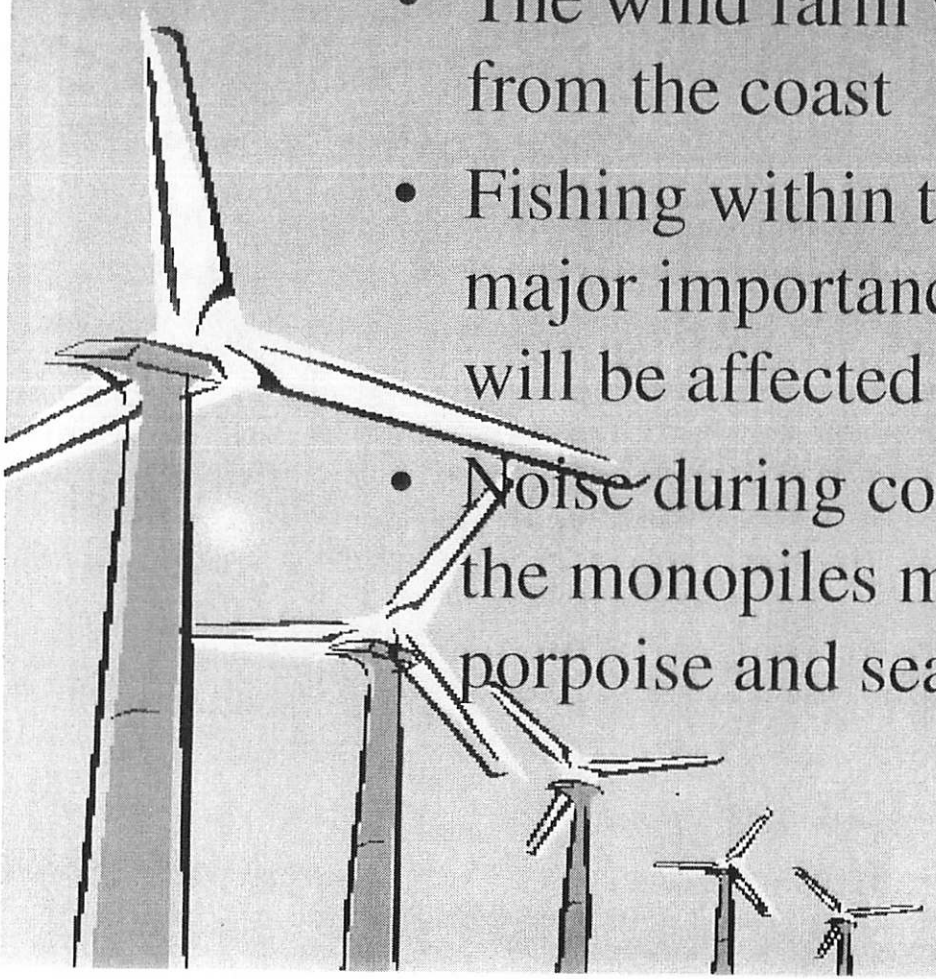
Results

- Study area with few animal species and low numbers
- No vegetation is found



EIA Conclusions

Human Activities



- The wind farm will be visible a few days a year from the coast
- Fishing within the wind farm site will have no major importance. Shrimp fishing along the coast will be affected due to fishing ban.
- Noise during construction due to the ramming of the monopiles may be hazardous to common porpoise and seal

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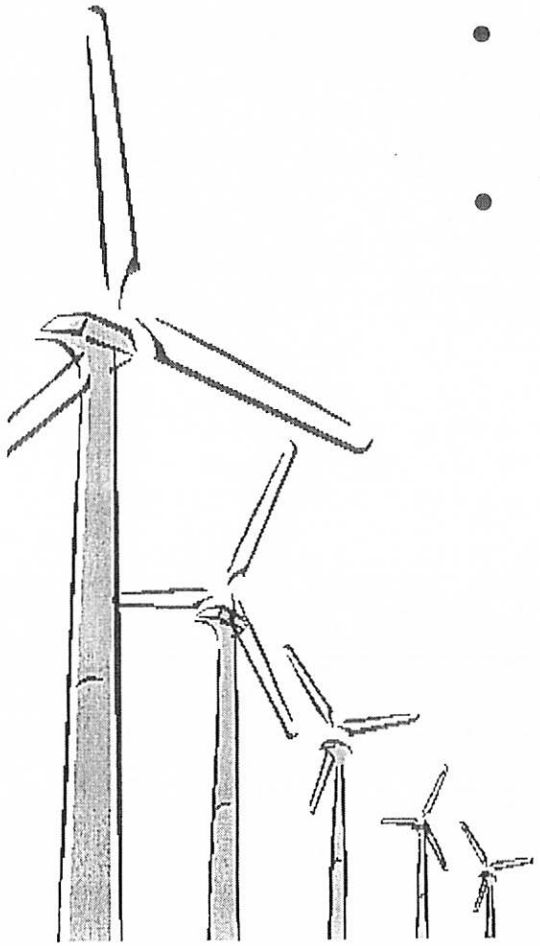
Visual effects



- Off shore wind farms will be seen on large distances
- Landscape effects regarding aeronautical lighting

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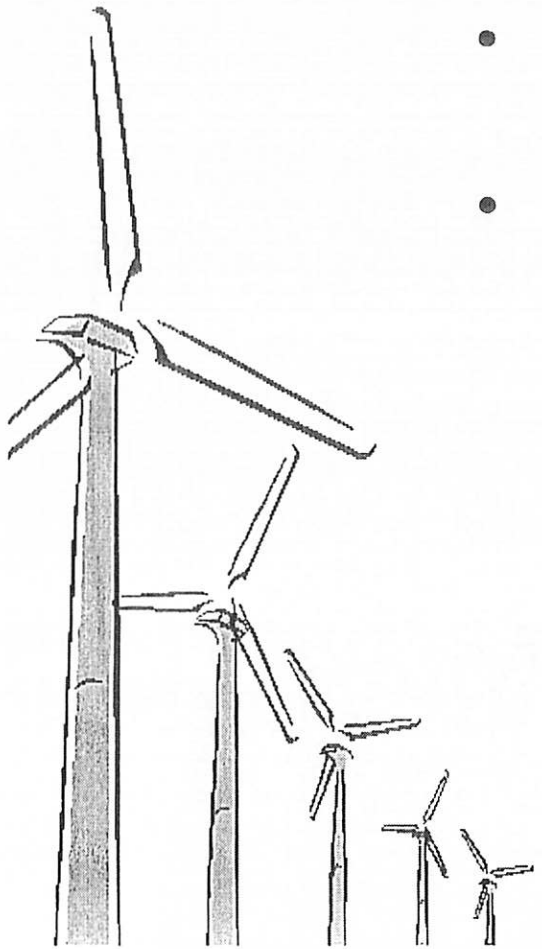
Defence arrangement - aeronautical lighting



- Visibility under or = 5 km, light intensity 2000 cd
- Visibility more than 5 km, light intensity can be reduced to 32 cd

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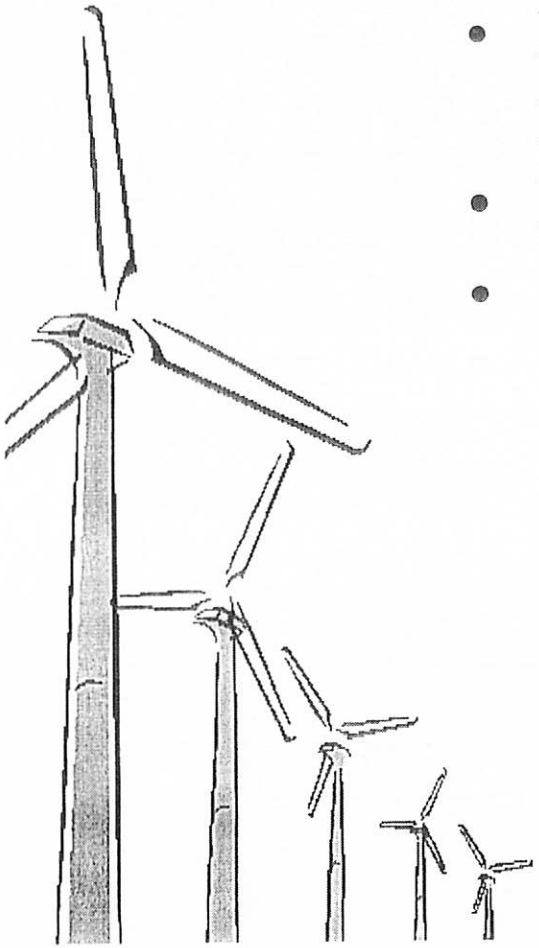
Noise During Construction



- Noise from ships, helicopter, working procedures
- Noise from ramming proces
- Damages on common porpoises and seals

Ramming of Monopiles Horns Rev

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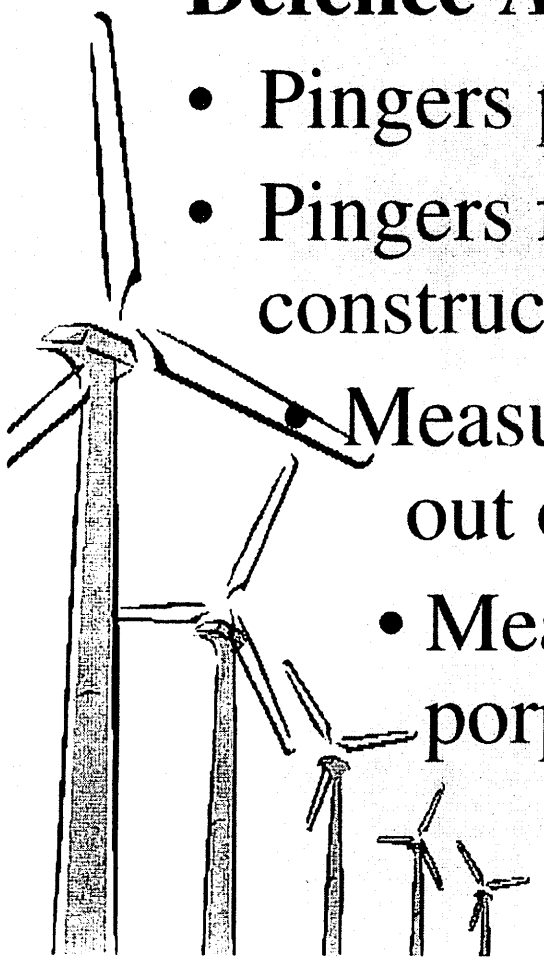


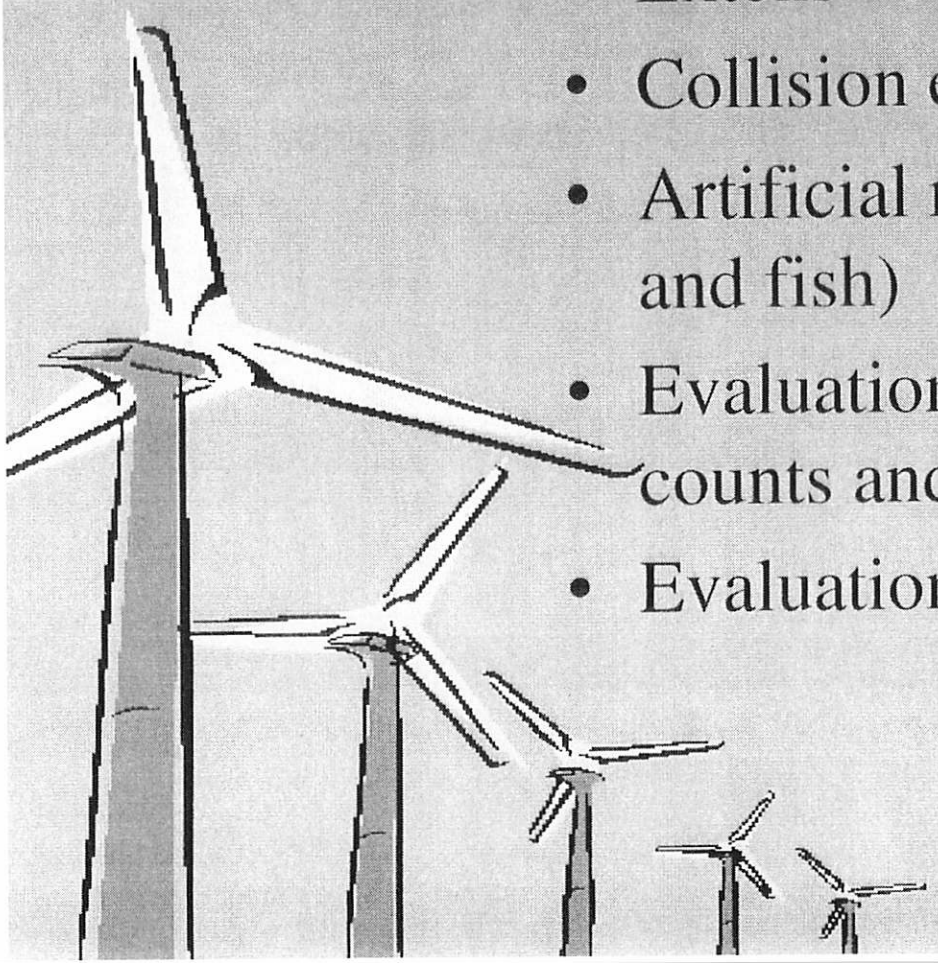
Defence Arrangements

- Pingers put down during ramming
- Pingers fastened to the anchors of all construction vessels (2-6 per vessel)
- Measuring program of the noise level, also out of consideration for divers
- Measuring program of the reactions of the porpoises during the construction period

EIA

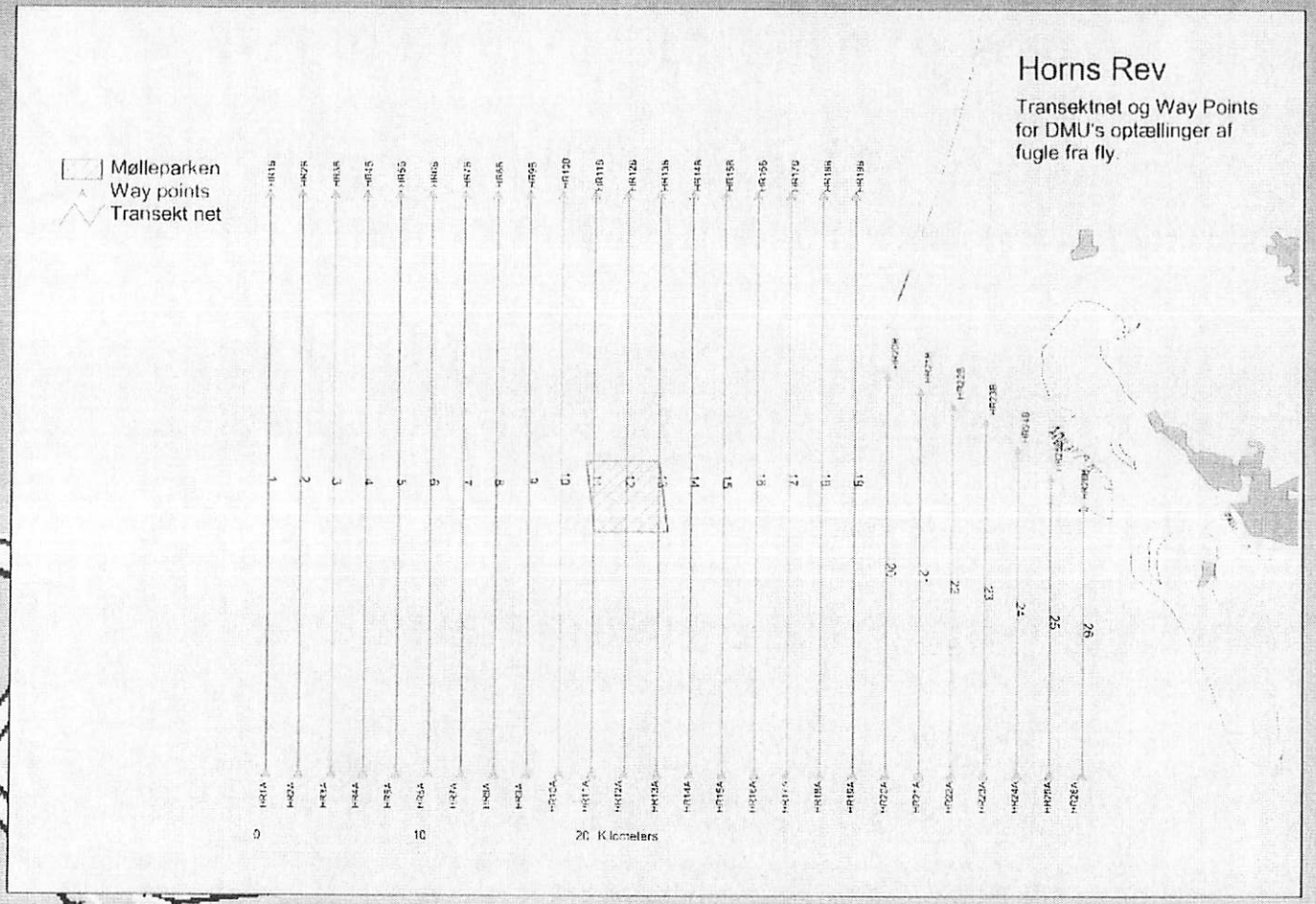
Monitoring Programmes

- Extensive monitoring of bird species
- Collision evaluation during operation
- Artificial reef effects (bottom flora & fauna and fish)
- Evaluation of importance to porpoise - ship counts and use of PODS
- Evaluation of presence of seal



EIA Investigations

Birds



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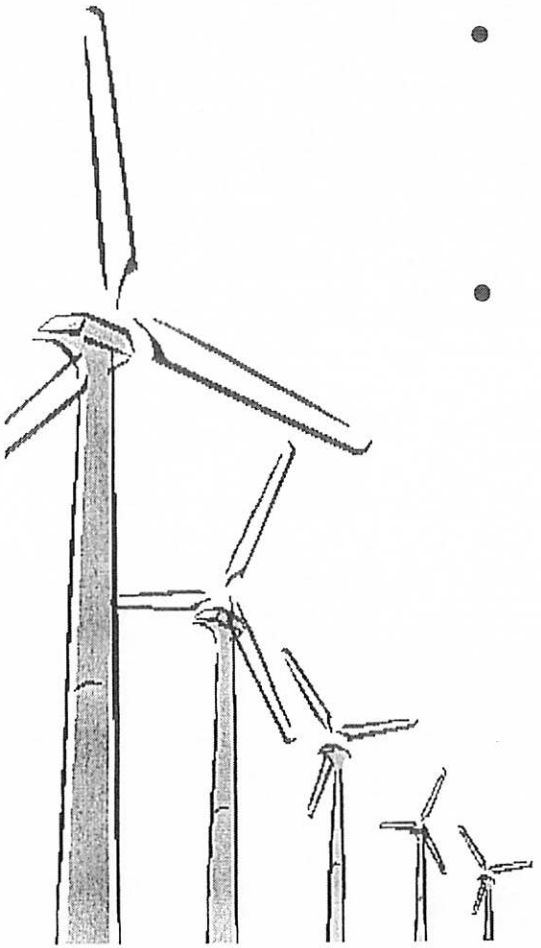
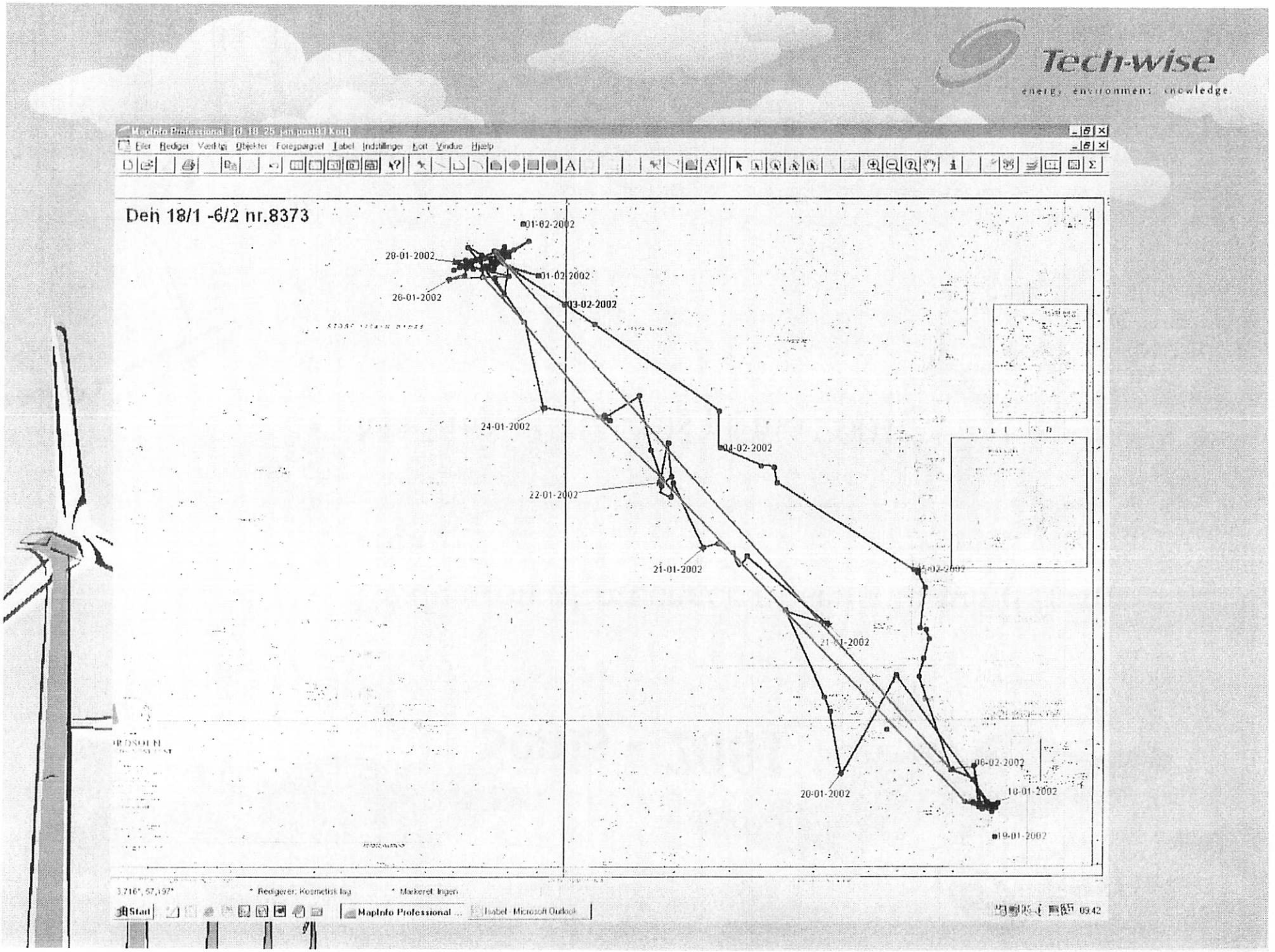
Seals - 2001



- Evaluation of precence of seals in wind farm area
- Marking of 10 seals primo 2001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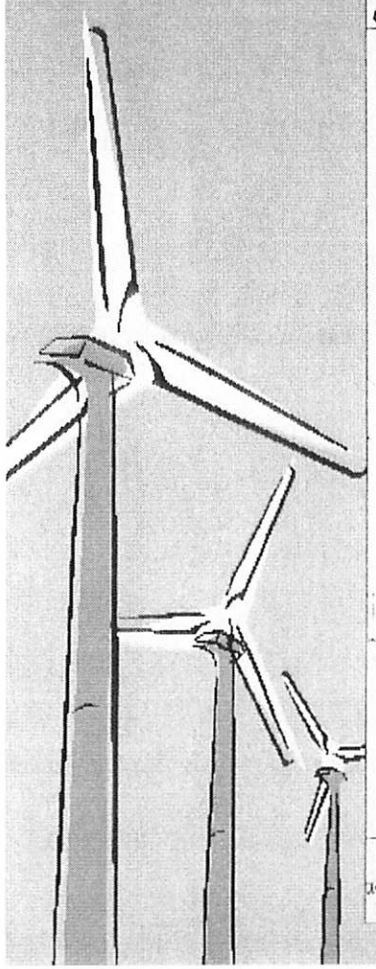

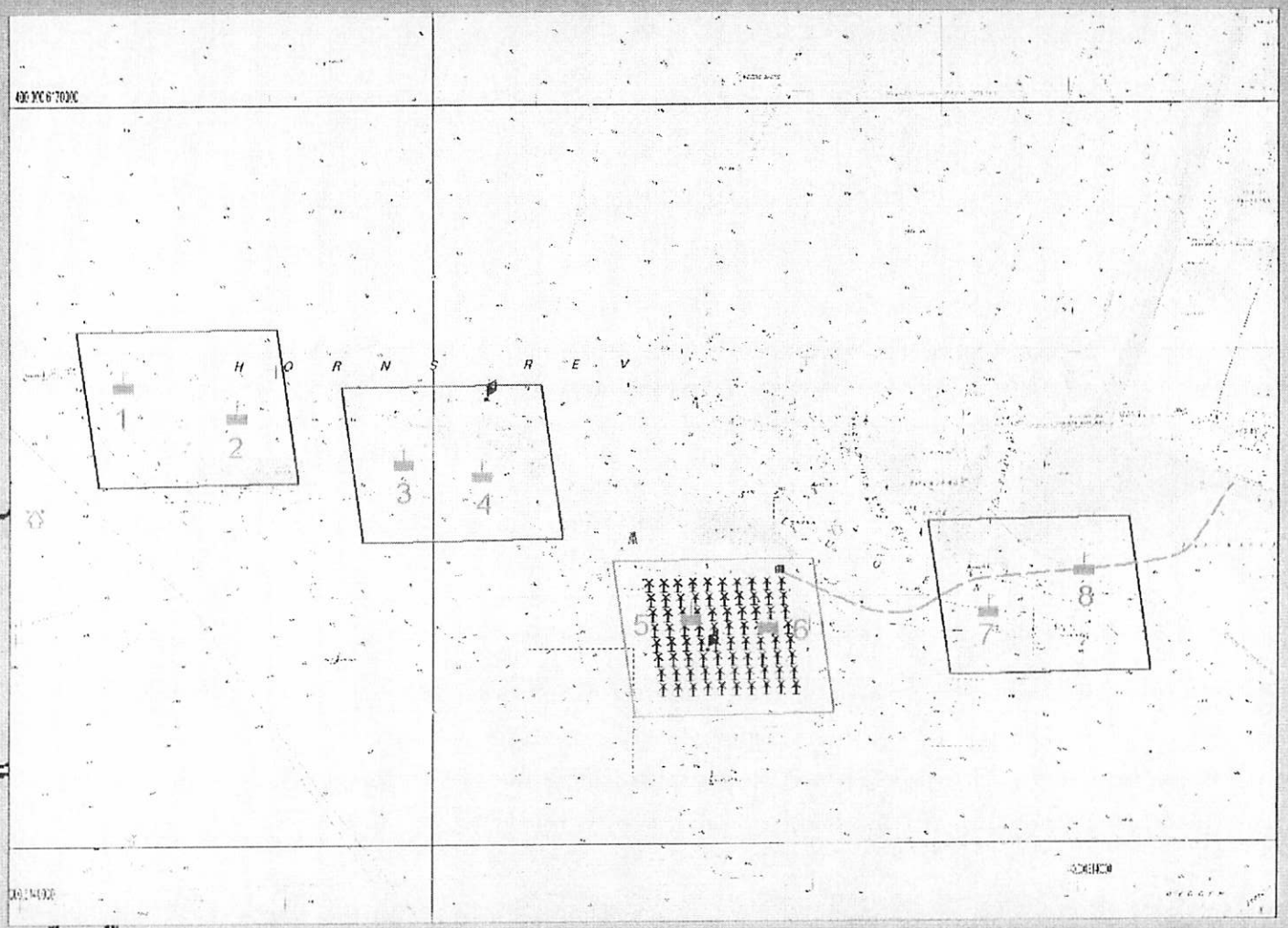

Summary of IEA R&D Wind - Topical Expert Meeting #40

Environmental issues of offshore wind farms

23rd and 24th of September 2002, Husum, Germany

Elke Bruns, Annika Andersson, Sven-Erik Thor

1 Background

In recent years many countries in Europe have announced plans for installation of wind farms offshore. A survey published in the German Wind Kraft Journal 3/2001 lists more than 10 000 MW of planned installations.

In Sweden, Denmark, the Netherlands and the UK wind farms have been installed offshore. In these as well as other European countries many more will follow in the next few years.

Placing wind farms offshore eliminates some of the obstacles encountered when siting wind farms on shore like visual influence on the landscape, annoyance to inhabitants from noise and flickering light, conflicts with other planning interests etc, etc.

Other challenges remain - like influence on birds – and new are added like influence on marine life, hydrography and marine traffic.

While there are now 20 years of experience in assessing and meeting environmental challenges associated with land based wind installations little is known of the effects of offshore wind installations.

The planning and approval procedure for each offshore wind farm installed so far has been on a case-by-case basis as have the demands for environmental surveys prior to installation and monitoring programs during construction and operation.

2 Summary

The meeting gathered 24 people from five different countries. Participants came from government agencies, energy agencies (or suppliers) universities and research institutes (both ecological and technical).

The aim of the meeting was to make an inventory of the already existing and available information on environmental aspects of offshore wind energy. Another aim was to give recommendations to the COD-project (Concerted action for Offshore wind energy Deployment) on how to proceed within the work package regarding:

- Collection of information on activities (projects) of participating countries, including at least birds, benthic flora and fauna, sub-sea noise, visual intrusion, and coastal impacts
- Composition of a coherent overview with identification of white spots

The meeting mainly focused on

- National programs to enforce offshore wind energy
- Studies and experiences of influence on birds and sea mammals
- Experience and application of Environmental Impact Assessment

One outcome of the COD-project will be a database of environmental issues. At the end of the meeting it was discussed, what kind of information this database should contain:

1. Base line data
2. Methods for investigating biological data
3. Methods for the evaluation of data
4. Procedures EIA (Environmental Impact Assessment) and other assessments

The meeting agreed to propose the COD project to handle these questions.

After the meeting it was decided to develop a preliminary questionnaire (form) which can be used by the COD-project.

3 Summary of Presentations

3.1 Introductory note

The introductory note was presented by Elke Bruns. She pointed out the challenges for deployment offshore. The objective of the meeting is to exchange information among the participants and also to interact with the European Union COD project. *"The objective of COD is to speed up the responsible deployment of offshore wind energy in the EC by early identification and possibly removing non-technical barriers: legal, administrative, policy, environmental and infrastructure issues, by co-ordination between energy agencies of 7 North/Baltic seas countries (NL, DK, UK, DE, SE, PO, and IRE) representing >90% of the technical Offshore potential in the EU".*

3.2 National programs

The presentations given by Cornelia Viertl (Germany), Lars Bo Hansen (Denmark) and Jim Green (USA) gave background information on plans for deployment and national programs for evaluation of environmental effects. German and Danish programs are extensive and have budgets in the order of tens of millions of Euro. There is a common understanding that there is a great potential offshore and that environmental aspects have to be considered.

The latter will be achieved by requesting that Environmental Impact Assessment (EIA) studies must precede building projects.

Danish rules states that wind farms have to be erected at least 7 km from the shore (preferably 12 km) at water depths between 6 and 15 m. Single turbines are not allowed, turbines must be grouped in farms. The Danish potential is 28000 MW, with at theoretical limit of 12500 MW. Two wind farms are included in a national offshore and environmental monitoring programme (Horns Rev and Nysted (previously named Rødsand)) financed by the national government and energy companies.

US activities offshore are quite limited presently. Jim Green and Skip Brennan showed that the interest is focused on the east coasts of USA, where water depths are suitable. Long Island and Nantucket Sound are areas of interest. Proposed installation effect is 425 MW in Nantucket Sound. On the west-coast waters are too deep for utilisation of wind energy.

German plans include a four-step program. At the end of the fourth step there will be 20 to 25 GW installed. These wind turbines are expected to produce 7-10 TWh of electricity annually. Danish plans include 1500 MW year 2005, with 200 MW of them being offshore. The Netherlands plans to erect 1200 MW to year 2010. A large national program has started in order to find suitable and unsuitable areas for offshore wind farms. The program is financed by the state and the results will be used as base line material for companies when they will seek permits.

YEAR	German targets (minimum - possible)	Danish targets	Dutch goals
2005		200	
2006	500		
2010	2 000-3 000		1 200
2020			6 000
2030	20 000-25 000	4 000	

Table: Targets and goals for different countries (MW)

3.3 Specific studies and experience of influence on marine life

3.3.1 Birds

No less than five presentations were given by Ib Clausager, Johnny Kahlert, Jan Pettersson, Chris Westra, Ommo Hüppop on the interaction between birds and wind energy. Tracking bird movement is a time consuming task. Methods incorporate surveying by aeroplane, radar, thermography and visual observations from platforms. The effect on the birds was summarised as:

- physical change of the habitat (i.e. resting areas)
- disturbance /avoidance effect (effects on foraging of sea birds)
- collision risk

Ib Clausager (DK) presented the results of studies (finished in 2000) on migrating birds and resting birds. The presentation was given as a contribution to the EIA assessment of Horns Rev. A plan was used to ensure the necessary overview on the large areas (planning area, impact area and reference area). Further studies will be made two years after erection.

Johnny Kahlert (DK) presented the results of a preliminary study at Nysted/Rødsand. This project will also be undergoing a monitoring program. He pointed out that long-living species with low reproduction are most sensitive to collision. The highest probability is during periods with low visibility (darkness, fog, heavy rain). He also showed that tailwind elevates flight altitude and migration intensity.

Jan Petterson (SW) presented the results of radar surveying the flight of eiders at Utgrunden. It could be shown that the eiders avoided the wind turbines not only during the day, but also at night by flying up to 300 m to the sides. During nights with very bad sight conditions the eiders didn't change direction and flew directly over the turbines. As flying altitudes can not be recorded by radar, it could not be found out, whether the eiders changed altitude to evade the turbines.

Chirs Westra (NL) pointed out the costs of monitoring by permanent video surveillance. He proposed a combination of acoustic and visual methods for detection if and to which extent

bird collisions happen. The collision would be detected by microphones; the collision sound would then immediately start a camera. It was criticised that the method would not work during periods of bad visibility, as it is not intended to use infrared cameras.

Ommo Hüppop (DE) described a preliminary method for evaluating bird impact, called Wind Energy Sensitivity Index. Every bird species is evaluated by a bundle of criteria, which refers to the sensitivity. By knowing their preferred or mainly frequented breeding and foraging habitats, areas which are candidates for protection (tabu-zones) can be identified. He pointed out that there are available atlases, which show the migrating routes for birds. A common database exists, which is manage by Scotland.

In the discussion it was mentioned that lethal effects could be in the order of 10 birds per wind turbine per year. This is a preliminary figure related to eiders, other figures may occur for other species. It was also mentioned, that huge numbers of migrating birds could be affected under bad flight and visibility conditions, also if it might only happen once a year (see Öresund bridge).

Bats are treated like birds.

3.3.2 Marine mammals

In the EIA studies of Rødsand /Nysted and Horns Rev the behaviour of harbour porpoise and seal was also investigated. By tracking the migration movements of seal, their main routes could be studied. Grey seals travels larger distances, one went to Sweden while the Harbour seals stayed in the local area.

Adolf Kellermann: Effects on sea mammals: how do they react on noise. In a project (MINOS) Harbour porpoise distribution in the North Sea and Baltic Sea (EEZ) will be studied. Detailed studies will be carried out locally like behaviour, habituation, curiosity and avoidance.

3.3.3 Below the sea surface

Rainer Knust (DE) gave a presentation on the expected changes of sediment structure by turbine foundations. The effects of wind farms can be:

- changes in the hydrodynamic system
- changes of the sediment characteristics
- changes of the benthos composition (increase of epibenthos)
- changes of the fish fauna with possible implication to fisheries

They have made a model, which describes risks and their possible impacts on the environment. The project is financed by the government (BEOFINO).

It was discussed, what relevance the changes in sedimentation will have in decision making processes. Changes leading to an increase of species (diversity), are judged differently.

3.4 Environmental Impact Assessment

Due to the European Directive on EIA, which had to be transformed into national law of every European country, the building offshore requires an EIA study as a part of the licensing process. The levels of investigation and applied methods of assessments are apparently different from one country to another.

Pernilla Holm Skyt, Jette Kjær Gaarde and Annika Andersson reported from such EIA activities at the Nysted site, Horns Rev and the Karlskrona wind farms. The Danish studies reported on a number of sub-studies ranging from movement of seals to bird migration and lobster behaviour. These studies were performed before the farm was erected and serves as background material for future comparisons.

3.5 Miscellaneous

Christian Nath (DE) gave an overview of the extensive German offshore plans and the research which is related to that. The program is called MINOS (Marine Warmblueter in Nord and Ost See) and is divided into technical and biological aspects of building offshore.

There was an observation that most of the presentations/discussions at the meeting dealt with possible impact on birds, demersal[1] and benthic[2] system. Other subjects, such as visual intrusion, risk of ship collisions, sub-sea noise, interaction with outdoor recreational life and other interests were mentioned but not covered, but they may be of equal importance when building offshore.

4 Discussion

At the finalising discussion the group discussed the need for a database of background information. The content of such a database could be:

1. Base line data (both studies on affected parts of the ecosystem/marine life and studies on offshore-wind-turbine-specific impacts and their reach / intensity)
2. Methods for evaluation of data
3. Procedures for EIA (Environmental Impact Assessment) and Habitats Assessment
4. List of interesting reports

The main task is to exchange data, reports and standardised procedures for different aspects in EIA. It was noted that EIA is carried out in different ways in different countries. A unified approach is essential. It would be of great help if a unified list of treated aspects was made available.

The meeting agreed to propose the COD project to handle these questions. After the meeting it was decided to develop a preliminary questionnaire (form) which can/may be used by the COD project.

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[1] Demersal = found in deep water or on the bottom of stream pools, or the ocean

[2] Benthos = the whole assemblage of plants or animals living on the sea bottom

5 Useful links

Country	Project	Link
USA	Cape Cod	http://www.capewind.org/
USA	Long Island	http://www.lipower.org/projects/windmills.html
Sweden	Kalmarsund	http://www.havsvind.nu/main.html
EU	Offshore Windenergy in Europe	http://www.offshorewindenergy.org/
Denmark	Horns Rev	http://www.hornsrev.dk/Engelsk/default_ie.htm
Denmark	Middelgrunden	http://www.middelgrunden.dk/MG_UK/ukindex.htm
Denmark	Rødsand/Nysted Offshore Wind Farm	http://www.seas.dk/cm94.asp?d=1
Denmark	EIA-report Nysted	http://www.seas.dk/cm378.asp?d=1
UK	Offshore wind farms	http://www.offshorewindfarms.co.uk/
UK	Offshore wind energy network	http://www.owen.eru.rl.ac.uk/
Denmark	SEAS company	http://www.seas.dk/cm4.asp?d=1
Germany	General info offshore	http://www.offshore-wind.de/
Germany	FINO - Research Platforms in North and Balticseas	http://www.fino-offshore.de/
Germany	MINOS – Marine Warmblueter in Nord and Ost See	http://www.minos-info.de/
Germany	Data base – CONTIS	http://www.bsh.de

A Swedish database on environmental aspects of offshore wind energy has been developed by Elforsk (a utility research organisation). The database can be found at http://www.elforsk.se/varme/varm-miljodatabas.html (unfortunately in Swedish)

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IEA R&D Wind Annex XI Topical Expert Meeting
Environmental issues of offshore wind farms
September 23 24, Husum, Germany

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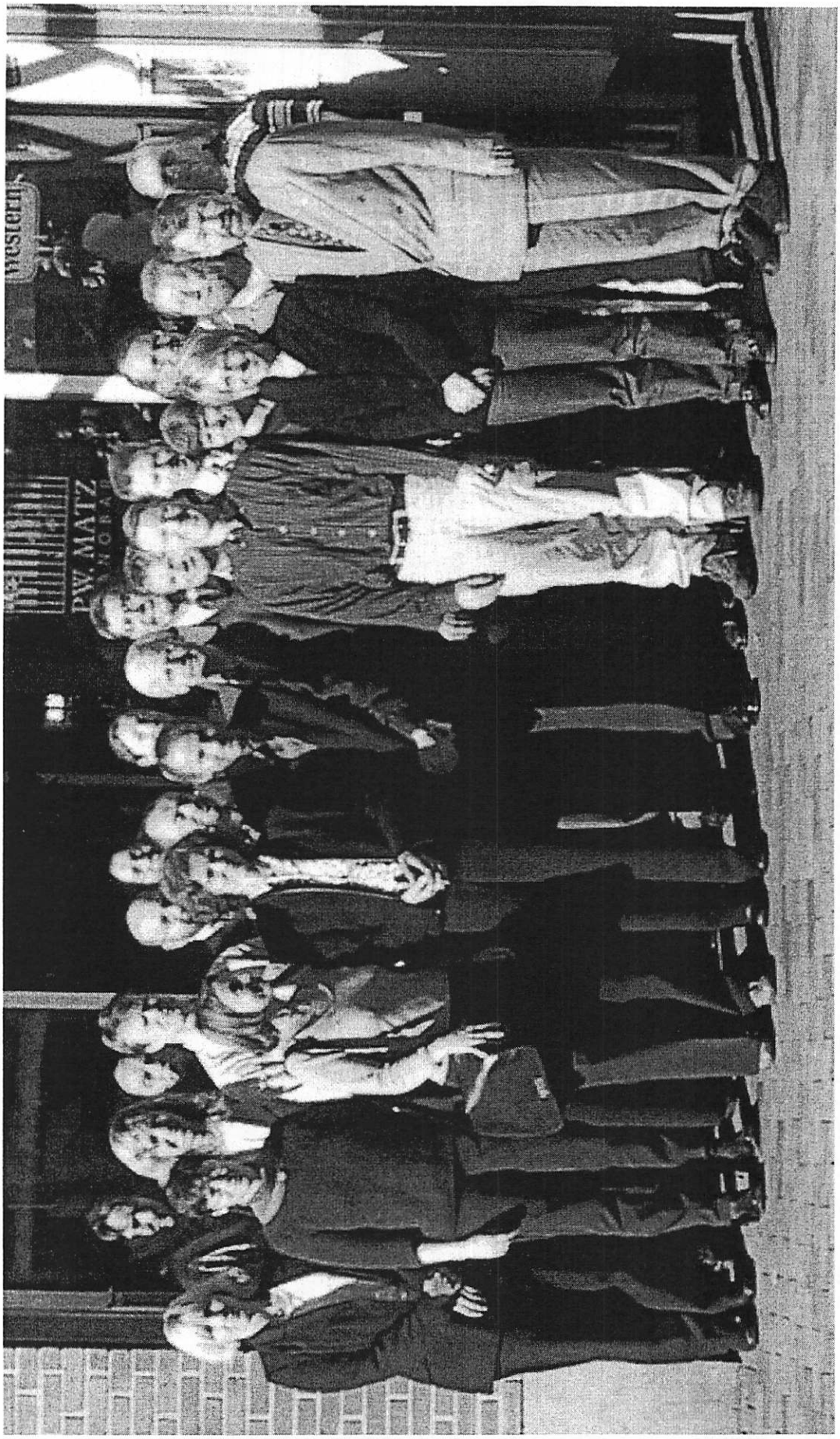

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