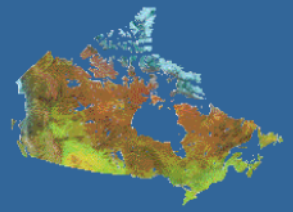
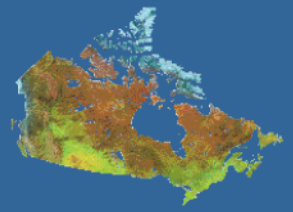


Potential Environmental Impacts of Ocean Energy Devices IEA-OES Experts Meeting Summary

Global Marine Renewable Energy Conference
April 17-18, 2008

Presented by
Melanie Nadeau
IEA – OES



Presentation Overview

- Environmental Experts Meeting
  - Meeting Purpose
  - Participants
  - Environmental Issues
  - Organizational Issues
  - Accelerating the Learning Curve
  - Conclusions and Recommendations
  - IEA – OES Next Steps

Meeting Background

- International Energy Agency Implementing Agreement on Ocean Energy Systems (IEA-OES) in meeting strategic objectives aims to address barriers that could impede the pace of deployment of ocean energy devices

- The *Understanding of Environmental Impacts* identified as a key R&D priority in IEA-OES Strategic Plan, proposed action

  hold experts meeting on environmental impacts from ocean energy development and promote collaborative research in the area resulting in outcomes targeted to policy makers and agencies responsible for consent

- Workshop held on October 18, 2007 in Messina, Italy – *Potential Environmental Impacts and Ocean Energy Devices*

Invited Experts

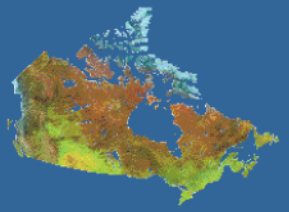
- Ten experts from eight countries presented information on lessons learned from other technologies, wave and tidal device challenges, developer experience and strategic environmental considerations

Oregon Wave Energy Trust (OWET)

Minerals Management Service

UPPSALA UNIVERSITET

Ocean Energy Devices Deployed



Ecological

Environmental Issues

- Ecological energy balance
- Disturbance to seabed
- Disturbance to water
- Disturbance to shoreline
- Behavioral changes
- Contamination of water
- Wildlife entanglement
- Underwater and air noise
- GHG emissions

Receptors

- Geology
- Sediment
- Sea Mammals
- Seascape
- Atmosphere

Socio-Economic

- Visual impacts
- Local air quality
- Interference with communication
- Waste minimization
- Navigation

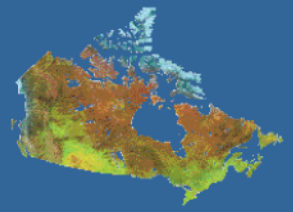
- Fish
- Commercial Fishing

Management

- Suitability in local environment
- Timing of activities
- Accidents

- Protected Species
- Local economy
- Seabirds

Source: EMEC 2005



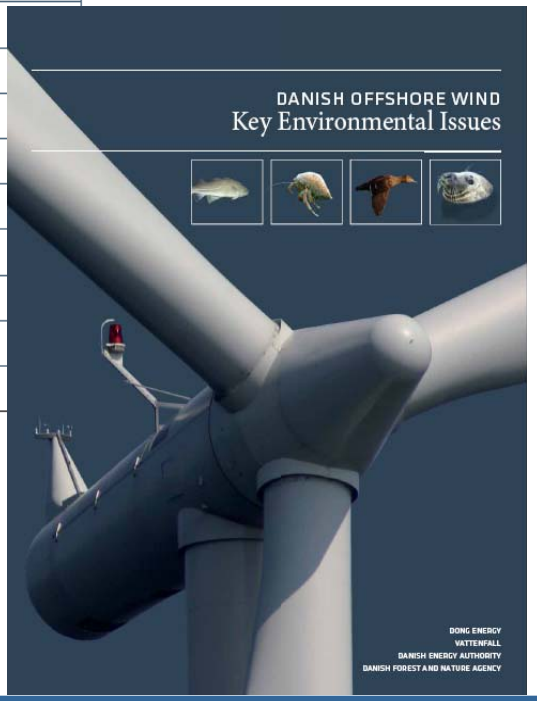
Decentralized knowledge

Facts	Possible consequences	Action
Different legislation Different administrative processes	Benefits for certain countries Regulators implement monitoring programs that are overly prescriptive	Propose common legislation Monitoring Guidelines Standards
Some environmental impacts unknown -Lack of research -Early stage of development	Risks Projects could get stopped	Link research groups from different countries to join efforts
Lack of public knowledge	Opposition to development	Public education
Lack of experience	Best practices are not followed, nor established	Phased projects – Pilot zone
Common and differing characteristics between wave and tidal not well-identified	Lack of dedicated funding Efforts spread too thin	Promote via workshop where efforts are worthwhile

Lessons Learned – Offshore Wind

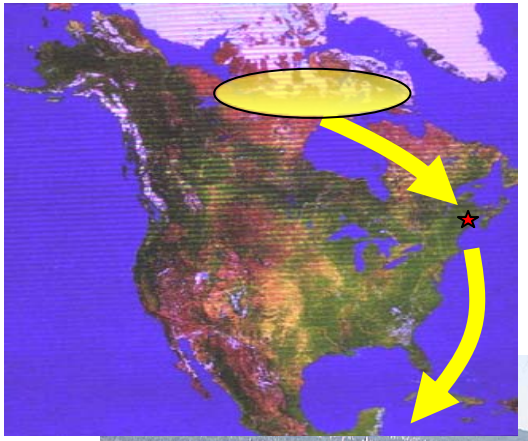
	1999	2000	2001	2002	2003	2004	2005	2006
Visualisation and socio-economic investigations	●●	●●			●●	●●		
Hydrography	●							
Hydrography and coastal morphology	●	●		●	●	●		
Benthic fauna and flora along 132 kV cable	●	●	●	●	●	●		
Benthic fauna and flora in the farm area	●●	●	●●		●	●	●●	
Fish in the farm area	●●	●		●				
Fish, sand eel				●		●		
Electromagnetic fields and possible effect on fish			●	●	●	●		
Monitoring of harbour porpoises	●	●	●●	●●	●●	●●	●●	
Monitoring of seals	●●			●●	●●	●●	●●	
Monitoring of birds	●●	●●	●●	●●	●●	●●	●●	
Development of new habitats					●●	●●	●●	

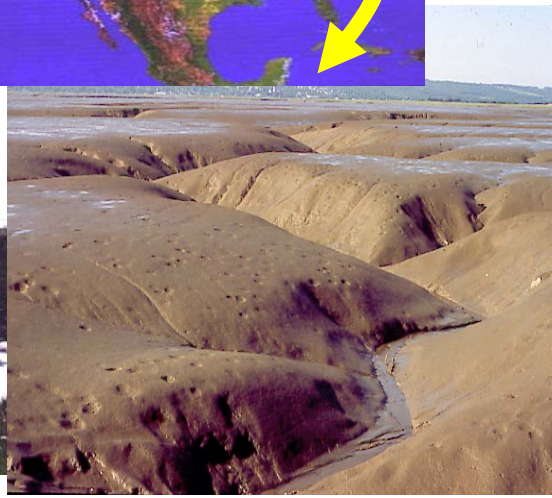
Figure 9: Environmental studies carried out at Horns Rev Offshore Wind Farm (●) and Nysted Offshore Wind Farm (●).



Lessons Learned – Tidal Power

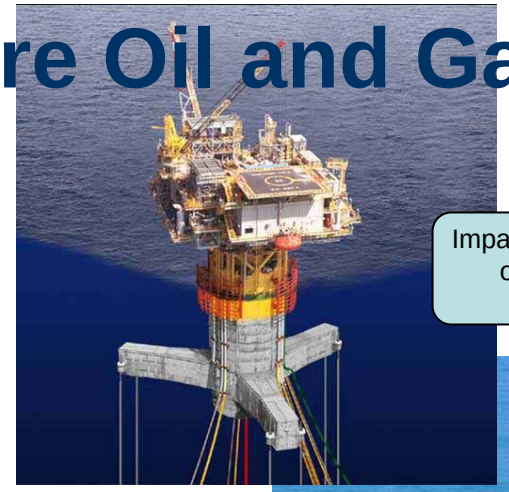
- Tidal Barrages – Annapolis Royal (1984 – present)
  - Bay of Fundy's (Nova Scotia) Biological Connections
  - Issues - fish passage, fish population effects, salinization of farmland, shoreline and marsh erosion, sedimentation

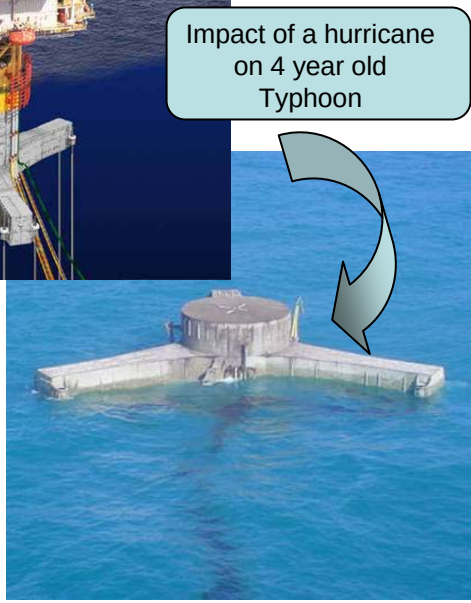




Lessons Learned – Offshore Oil and Gas

- Never underestimate Mother Nature
- Always an element of uncertainty with dealing weather forces such as a hurricane
- Failure investigations are very helpful for understanding appropriate levels of safety and verifying design criteria
- Need to constantly update design guidelines and regulations





Design for Environmental Conditions

- Wind
- Waves
- Current
- Seismic
- Snow & Ice

Extreme environmental event in selected return period with other associated environmental events

- Minimum levels of safety (probability of exceedance) need to be established

Environmental Research Projects

- Portuguese Pilot Zone
  - Stages demo, pre-commercial and commercial
  - Baseline studies, monitoring program and mitigation measures
- Project Developer Studies – Wave Dragon
  - Navigation studies, visual impacts, landfall, important fishery, changes in waves
- Other organizations such as COWRIE, RAG (UK Research Advisory Group), and universities conducting research on navigation, mammal interaction, sediment processes, etc.

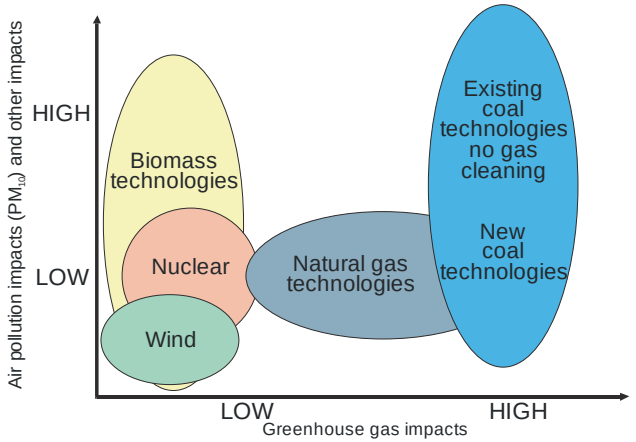
EQUIMAR

- EQUIMAR Project – Equitable Testing and Evaluation of Marine energy Extraction devices in terms of Performance, Costs and Environmental Impact
  - WP6: Environmental Impacts Assessment
    - Discussion of common legislation baselines
    - Scientific protocols
    - Risk for large vertebrates and other crucial uncertainties
    - Lifecycle analysis approach
    - Environmental analysis of existing and future scenarios

SEVENTH FRAMEWORK PROGRAMME

Risk Assessment for Ocean Energy

- Risk Management – decisions made based on expected risk; stakeholder inputs, feedback loop with monitoring
- Uncertainty – limited experience, complex systems
- Why risk assessment for ocean energy?
  - Goes beyond impact analyses
  - Specifics on probability and consequence
  - Allows comparison of impacts, including ecological, social and human
  - Includes an analysis of uncertainty
  - Logic structure is linked to management systems
  - Sets priorities for research

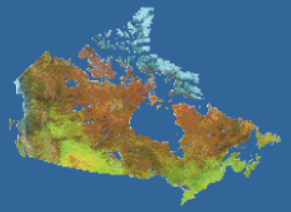


Comparative Effects and GHGs

Conclusions/Recommendations

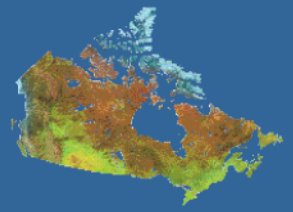
- IEA – OES can play a role in alleviating some of the potential environmentally related barriers facing ocean energy technology penetration

RECOMMENDATIONS		
	Review of existing documentation	Number of studies produced providing information on environmental impacts for offshore renewables – Collation of studies required that can be used as a tool for regulators and stakeholders
	Case Studies	Series of cases studies on well documented ocean energy projects – possible benchmark for future projects
	Public education	Ensure accurate information is available to the public through website, newsletters, public forums, etc.
	Environmental Monitoring Guideline	Overly prescriptive monitoring programs are becoming a financial burden for project developers, international guideline on recommended environmental monitoring methods and practices would serve as a benchmark



IEA – OES Next Steps

- Discussion of Messina workshop at April 2008 ExCO Meeting
- Decision on formation of new Annex under IEA – OES Implementing Agreement
- Identification of Operating Agent for New Annex and participating countries
- Development of work programme – proposed start date in early 2009



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