



# Marine Renewable Energy

*Growing Canada's Renewable Energy Supply*

OREG 2008 Spring Symposium

April 21-22, 2008

Québec City, Québec



Presented by

Melanie Nadeau, P.Eng  
*Programme Manager – Marine  
Renewable Energy*



# Marine Renewable Energy



- Resurgence of RD&D of ocean energy technology since the 1990s - considered to be the 3<sup>rd</sup> generation of renewable energy technologies
- Financial support mechanisms and policies introduced to support the demonstration and deployment of ocean energy – more notably in countries with large ocean energy resources
- Increasing number of marine energy concepts are being researched with several devices now being demonstrated at sea, either at part or full-scale

# Growing the Renewable Energy Mix

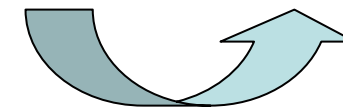
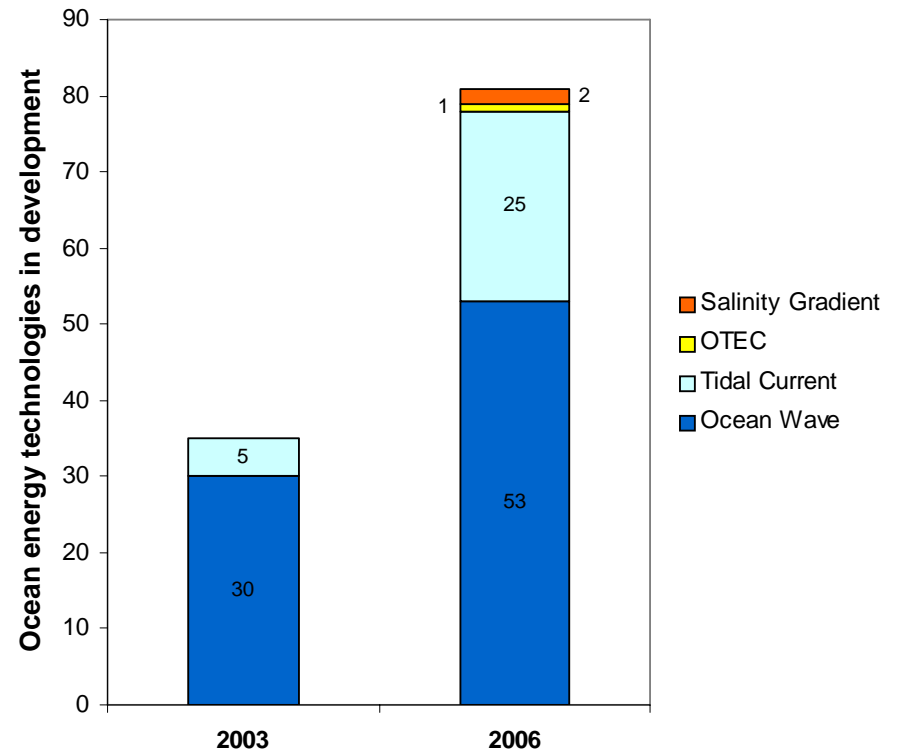
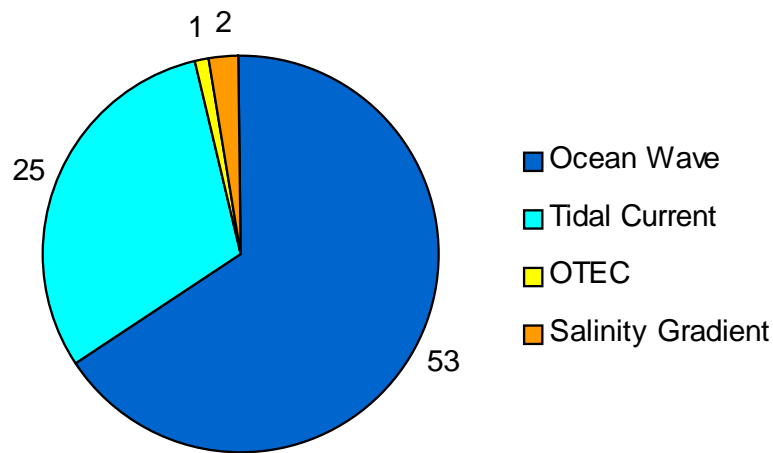


- Many energy and climate objectives are creating an environment for future ocean energy power production
  - Targets to reduce greenhouse gas emissions (GHGs) and improve air quality
  - Targets established by governments specific to ocean energy with country strategies being developed
    - 5 MW wave power by 2010 (Basque Country Spain)
    - 500 MW of ocean energy power by 2020 (Ireland)
  - Renewables Obligation – requirement for electricity suppliers to meet a certain standard of renewables as generated sources of energy (now includes wave and tidal energy)
  - Ocean energy recognized for production and investment tax credits
  - Feed-in tariffs offered at various levels throughout Europe

# Increased Technology Development



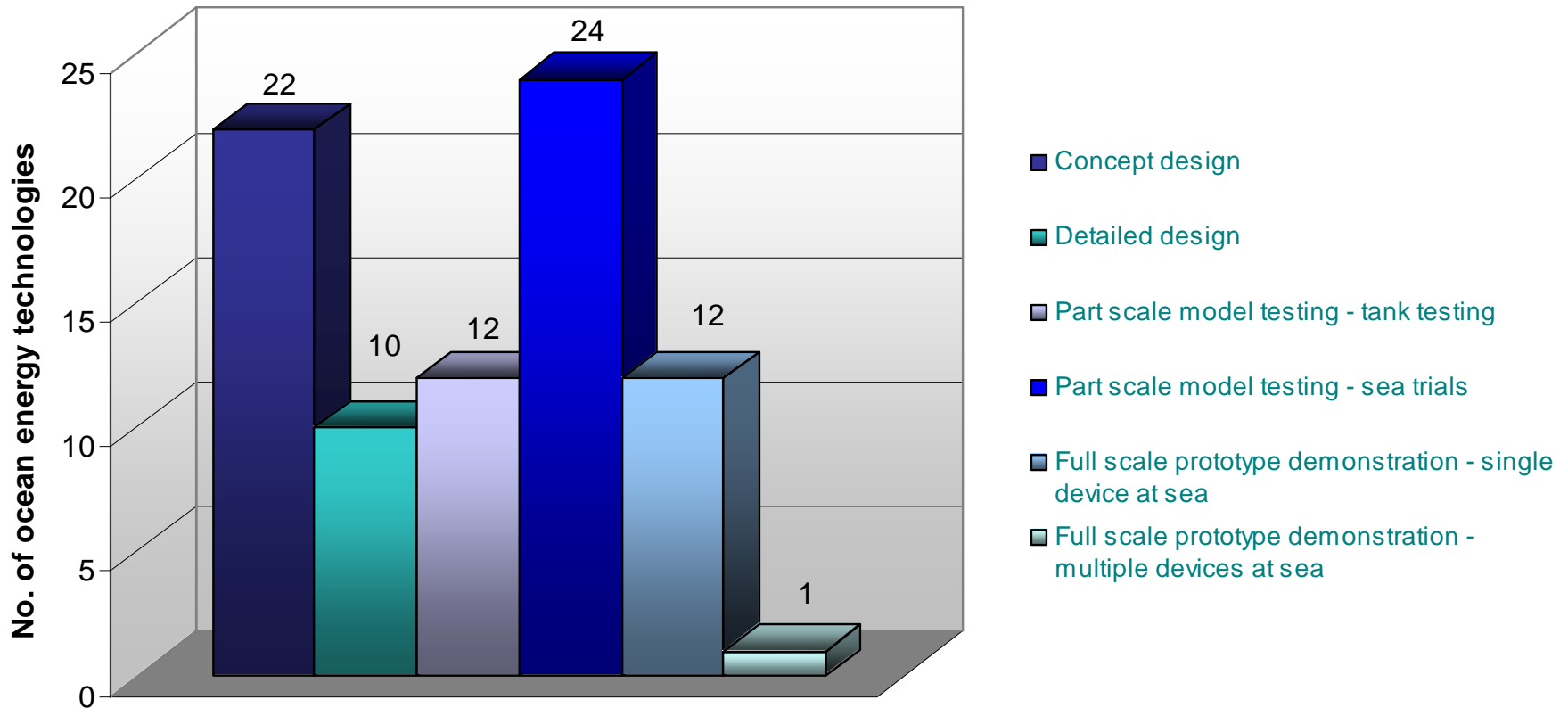
Total reported ocean energy technologies under development in 2006



**46 new technologies**

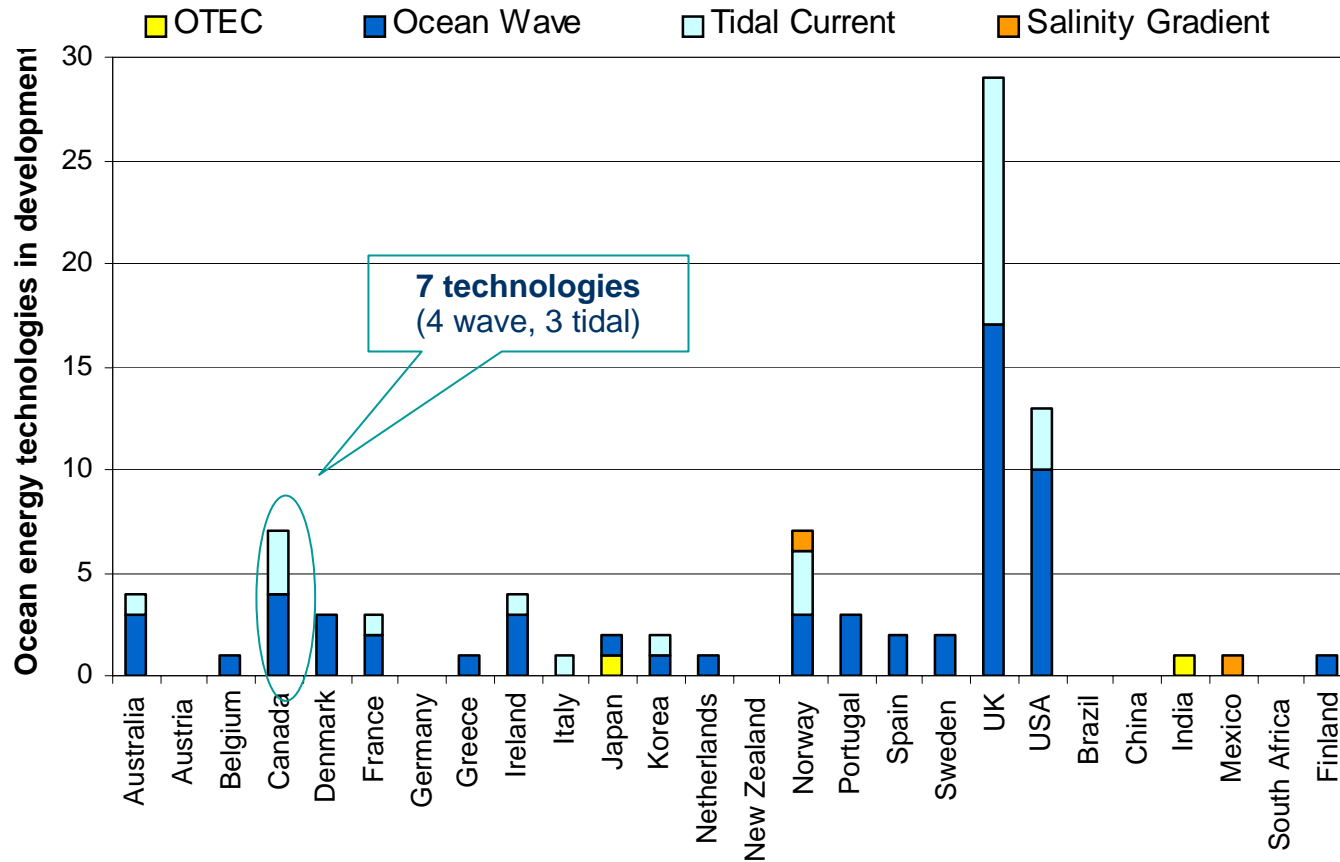
Source: IEA OES publication, 2006

# Current Status of Technologies



Source: IEA OES publication, 2006

# Technology Development – Globally

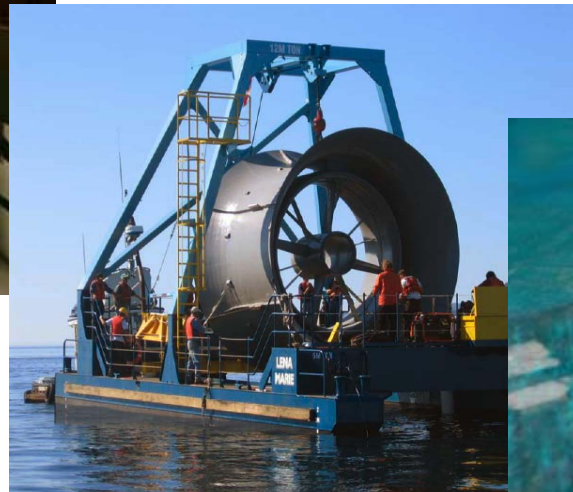


Source: IEA OES publication, 2006

# Canadian Technologies

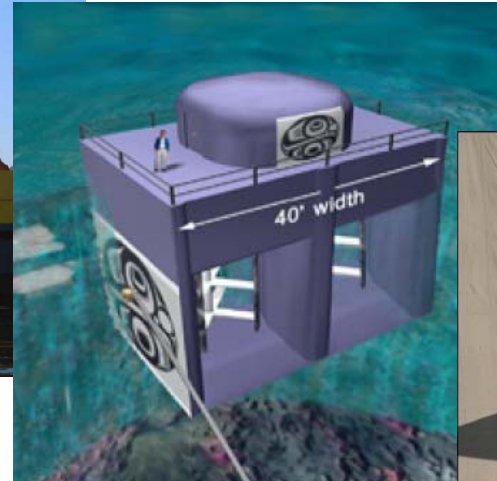


SyncWave Energy –  
Point Absorber



Clean Current Power – Bi-  
directional ducted horizontal  
axis turbine

Blue Energy – Vertical axis  
turbine



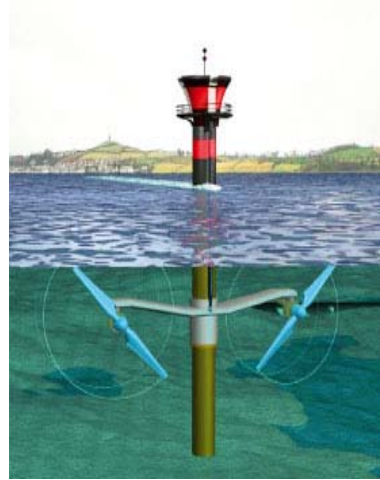
New Energy Corp –  
Vertical Axis 'EnCurrent'  
Turbine



# Technologies Developed World-Wide



OpenHydro



Marine Current Turbines



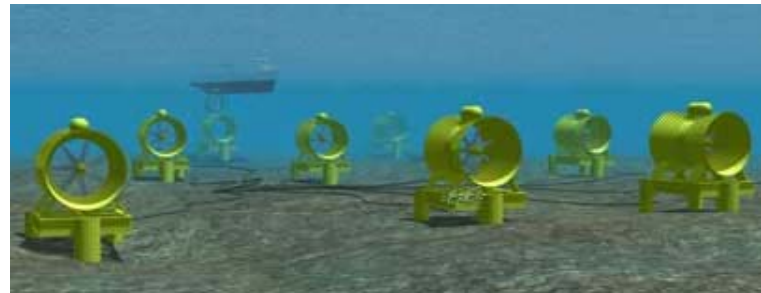
AWS



Verdant Power



Pelamis



Lunar Energy



Ocean Power Technologies

# Challenges Facing this Industry



- Insufficient demonstration of full-scale prototypes
- Demonstration of multiple full-scale prototypes in a pre-commercial farm
- Cost of grid connecting demonstration systems
- Lack of understanding of the potential environmental impacts
- Lack of understanding of the ocean energy resource
- Predicting energy production performance, metrics and design tools
- Absence of standards

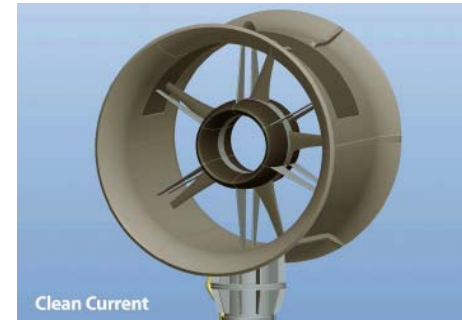


# Addressing the Challenges

# NS – Tidal Testing Facility



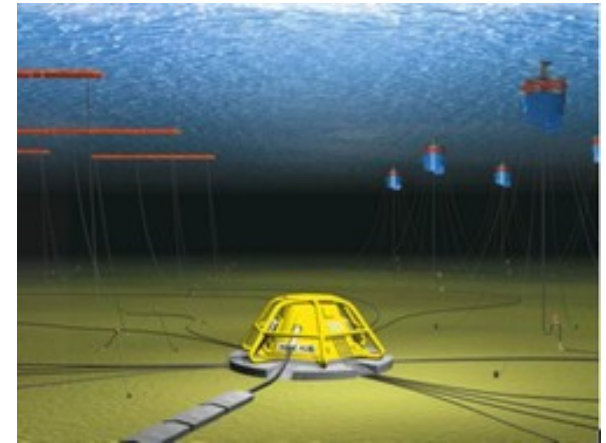
- Minas Basin Pulp and Power Co. Ltd. to build the first North American in-stream tidal testing technology centre in the Bay of Fundy
- Tidal devices would be connected to the Nova Scotia electric grid
- Demonstration of tidal devices awarded to:
  - Clean Current (using a Clean Current Mark III Turbine)
  - Minas Basin Pulp and Power Co. Ltd. (using a UEK Hydrokinetic Turbine)
  - Nova Scotia Power Inc. (using an OpenHydro Turbine)



# Wave Hub Project



- Developed by South West of England Regional Development Agency (RDA)
- First underwater system connecting Wave Energy Converters to the National grid – to be installed off the coast of South West of England
- Wave hub will include an onshore substation connected to electrical equipment on the seabed ~16 km offshore
- The Wave Hub will allow companies to test their developing wave energy technologies by plugging into the Wave Hub
- Expected to be operational in 2009





**Operating Agent:**  
Dr. Gouri Bhuyan, Powertech Labs, Canada

- A Technical Report listing potential differences and opportunities associated with integration of wave and tidal current energy plants to electrical grids, in comparison to wind energy
- A preliminary Interconnection Guideline
- A Technical Report containing dynamic characteristics of most advanced wave and tidal current conversion systems
- A Technical Report containing case studies illustrating integration of wave & tidal current energy plants to electrical grids.

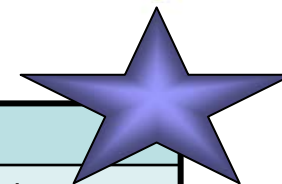
**Participating Countries:** Canada, UK, Ireland, Denmark, Portugal, and others

**Delivery Time Frame:** End of 2009



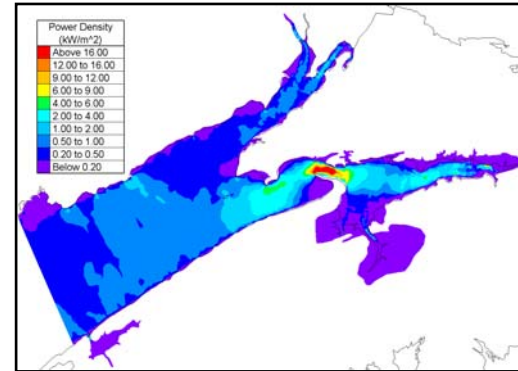
- Workshop held on October 18, 2007 in Messina, Italy – *Potential Environmental Impacts and Ocean Energy Devices*
  - Ten experts from eight countries presented information on lessons learned from other technologies/industries, wave and tidal device challenges, developer experience and strategic environmental considerations
    - Portuguese Pilot Zone
    - Project Developer Studies – Wave Dragon
    - Other organizations such as COWRIE, RAG (UK Research Advisory Group), and universities conducting research on navigation, mammal interaction, sediment processes, etc.
    - EQUIMAR Project – Equitable Testing and Evaluation of Marine energy Extraction devices in terms of Performance, Costs and Environmental Impact ---WP6: Environmental Impacts Assessment

# 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

# Resource Assessment



Tidal Current Power Density – Bay of Fundy

- Preliminary resource assessment of Canada's potential renewable energy resources off the Pacific and Atlantic Coasts completed by the National Research Council (NRC) in 2006
- Next phase of research will include a closer examination of the Bay of Fundy (tidal currents), the western shore of Vancouver Island (near shore waves) and the St. Lawrence River (river currents).
- Resource studies taking place around the world – New Zealand, UK, Ireland, Portugal, United States and many more

# Why Standards???



- Remove technical and financial risks by:
  - Establishing consensus on the resource availability
  - Identifying grid interface needs for tidal and wave energy
  - Providing a mechanism to compare wave and tidal technologies and guidance to developers
  - Ensuring technologies can enter into the international marketplace
  - Supporting requirements for the regulatory process aiming to reduce project lead times

# Codes and Standards



- Critical for moving technologies forward and providing guidelines for technology development
- IEC TC 114 formed with UK as Secretariat, Canada as Chair – inaugural meeting in May 2008
- Mirror National Committee formed, first meeting held in St. John's, Newfoundland on March 4-5, 2008
- James Taylor (NSPI) Canadian Sub-Committee Chair, Russell Stothers (Clean Current Power Systems) Vice-Chair
- Canadian standards priorities for IEC TC 114
  1. Performance Evaluation
  2. Survivability and Design
  3. Resource Characterization
  4. Power Quality
  5. Environmental Monitoring
  6. Terminology glossary



# Progressing Towards the Future



- This industry is growing in Canada and globally...
- This industry faces challenges, however....
- By pulling our resources together, we can aim to...

*Advance Canada's capacity as a developer of world-class ocean energy technologies, moving towards power production, from the deployment of the technology to the grid connection*



# Questions ???

***Melanie Nadeau, P.Eng***

Program Manager, Marine , Energy  
CANMET Energy Technology Centre

Natural Resources Canada

580 Booth St, Ottawa, Ontario

Tel. (613) 947-2370

Fax. (613) 996-9416

Email: [menadeau@nrcan.gc.ca](mailto:menadeau@nrcan.gc.ca)