



Canada's R&D Capacity and Activities in Marine Energy

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Study Overview

- In January 2008, CanmetEnergy launched an RFP to study marine energy technologies aimed at providing:
 - A detailed technical overview of tidal current and wave energy technologies being developed in Canada and the ten most promising technologies under development internationally;
 - Identification and classification of marine energy technology components where Canada could become a leader (i.e.: power take off, energy conversion, turbine control, power conditioning, and materials); and,
 - An assessment of Canada's R&D capacity
- Devine Tarbell & Associates was the successful proponent and awarded the contract in February 2008

2



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Study Overview

- **Scope modification:**
 - Determined that industry is in an immature state and identifying 'leaders' was not possible
 - Study examined which technical areas provided the greatest opportunities for advancing the marine energy industry in Canada based on a review of all Canadian technologies, representative international technologies, and Canada's R&D capacity

- **Consultation and Review Process:**
 - Kick-off meeting held in March, 2008 with NRCan and DTA
 - Formal consultation process with technology developers was held in June, 2008
 - An expert team, consisting of national and international ³ experts, provided guidance throughout the study





Perspective on the Technology Development Status

- Wave and tidal energy is at an early stage of development
- Very few of the 100+ device developers have tested their device at full-scale in real sea conditions
 - Fewer devices are ready for early adoption in commercial development projects
- No consensus on which device approach is the most promising technology to pursue

4



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Driving Considerations

- The technological considerations for marine energy technologies are based on the machine design and its interaction with the resource, and its resulting ability to extract energy at low cost
 - Deployment Location (onshore, nearshore, offshore)
 - Unit size and Economies of scale
 - Power absorption and tuning (fluid to mechanical energy conversion)
 - Power conversion
 - Power shedding ability
 - Redundancy and reliability
 - Operational considerations

5



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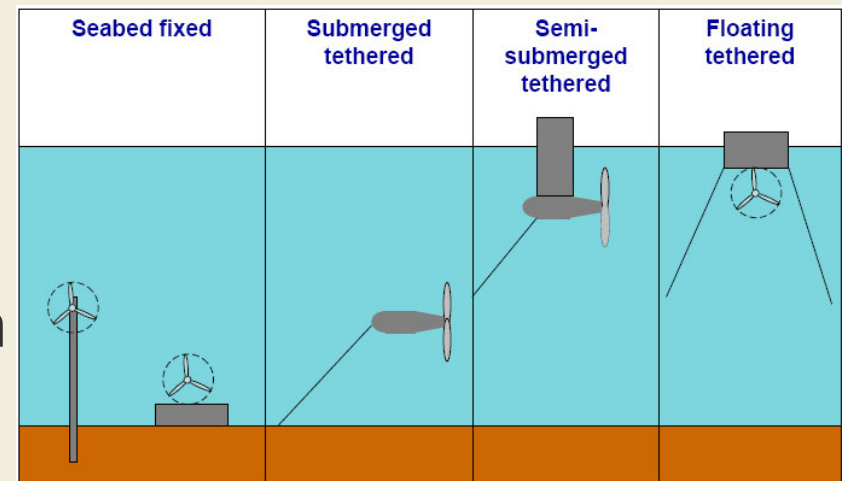
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Component Classifications

- The study focused on factors that cut across a multitude of device concepts that have promise to advance technology development and potentially lead to cost reductions within the marine energy industry
- Generic areas of research for Tidal and Wave power systems
 - Device Fabrication/materials
 - Offshore operations
 - Electrical collector system
- Wave & tidal power conversion
 - Power conversion system
 - Mooring system/foundation
 - Tuning/control system





Technology Status

7



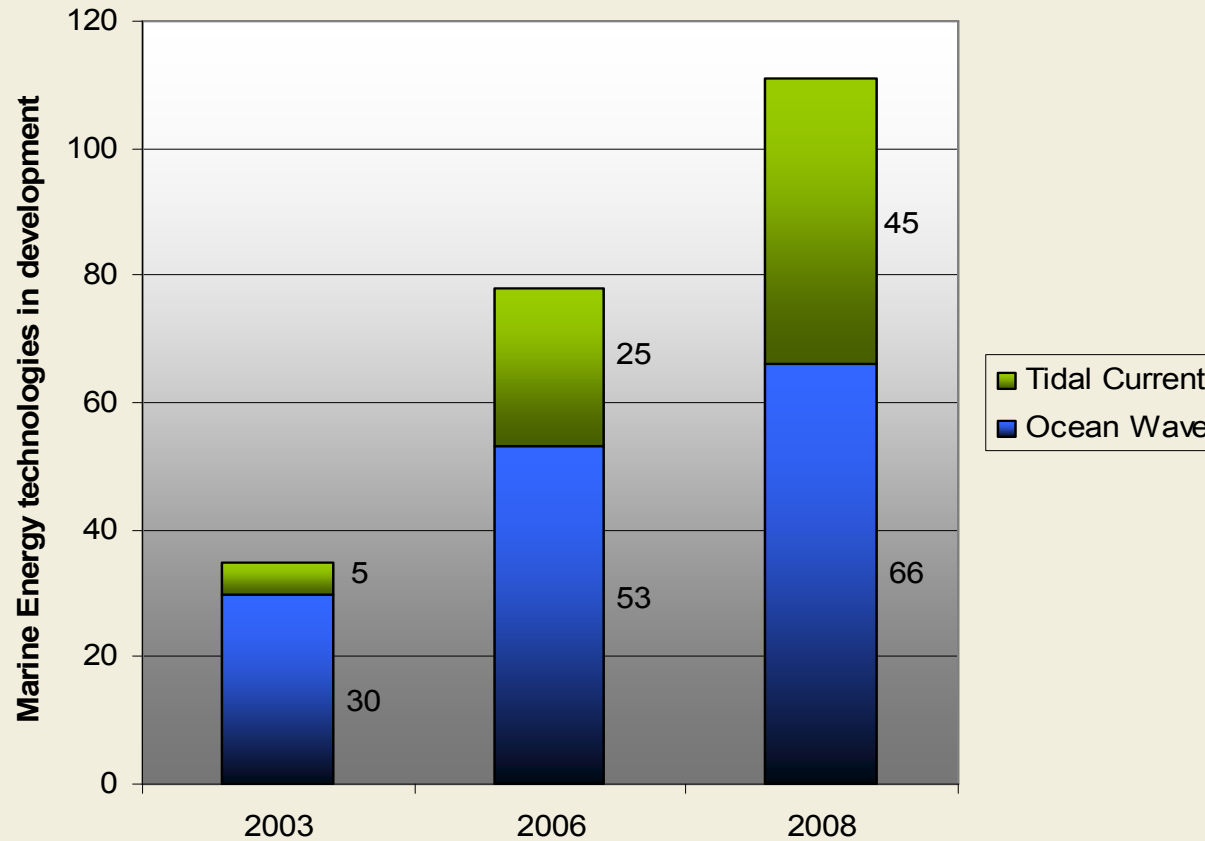
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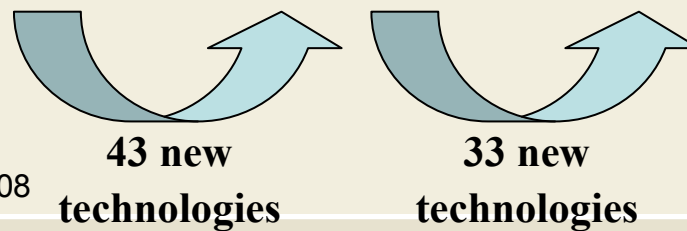
Progression of Technology Development



Sources:

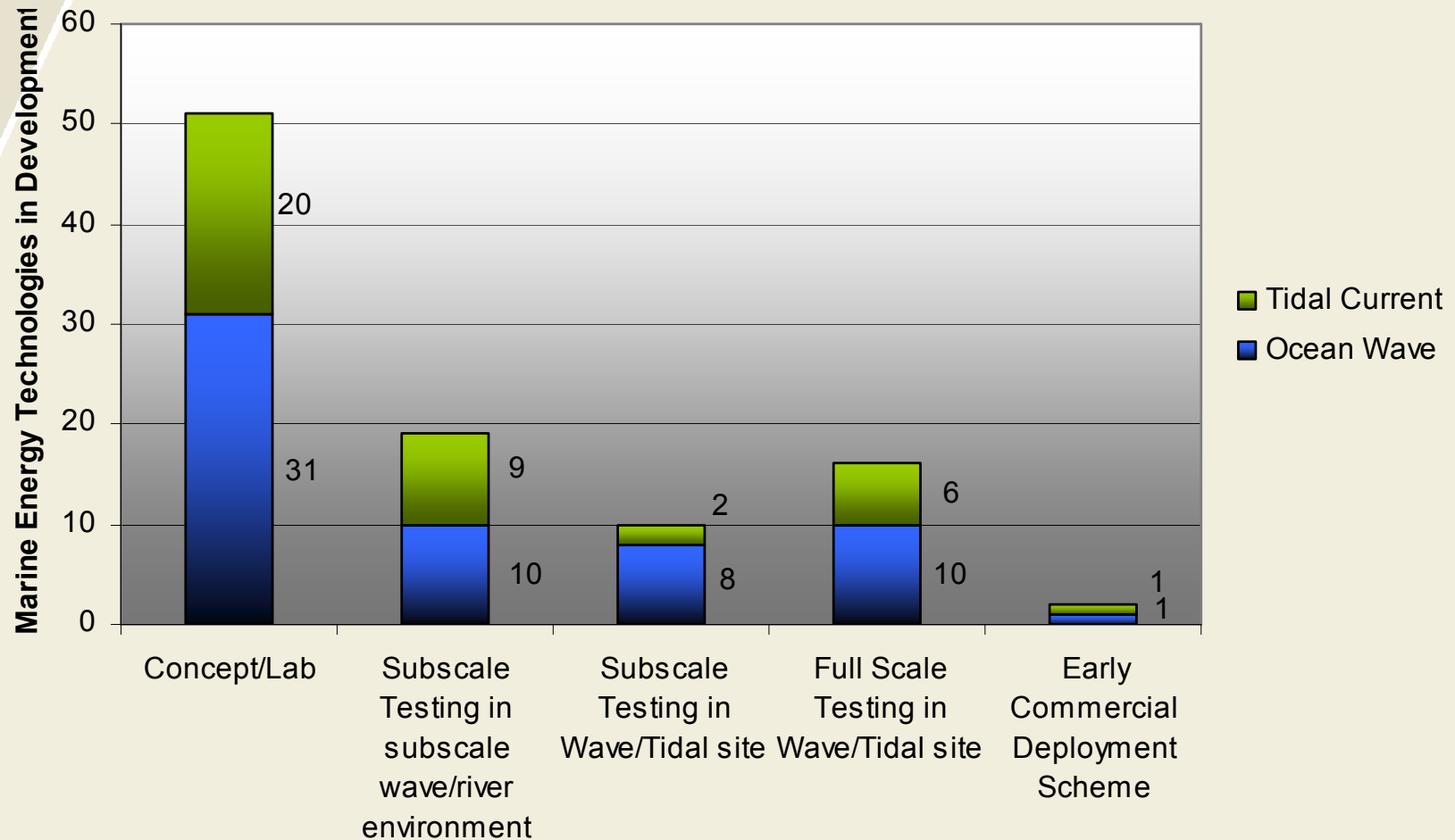
- IEA OES, 2006

- Devine Tarbell and Associates Inc, 2008





Technology Development Phase

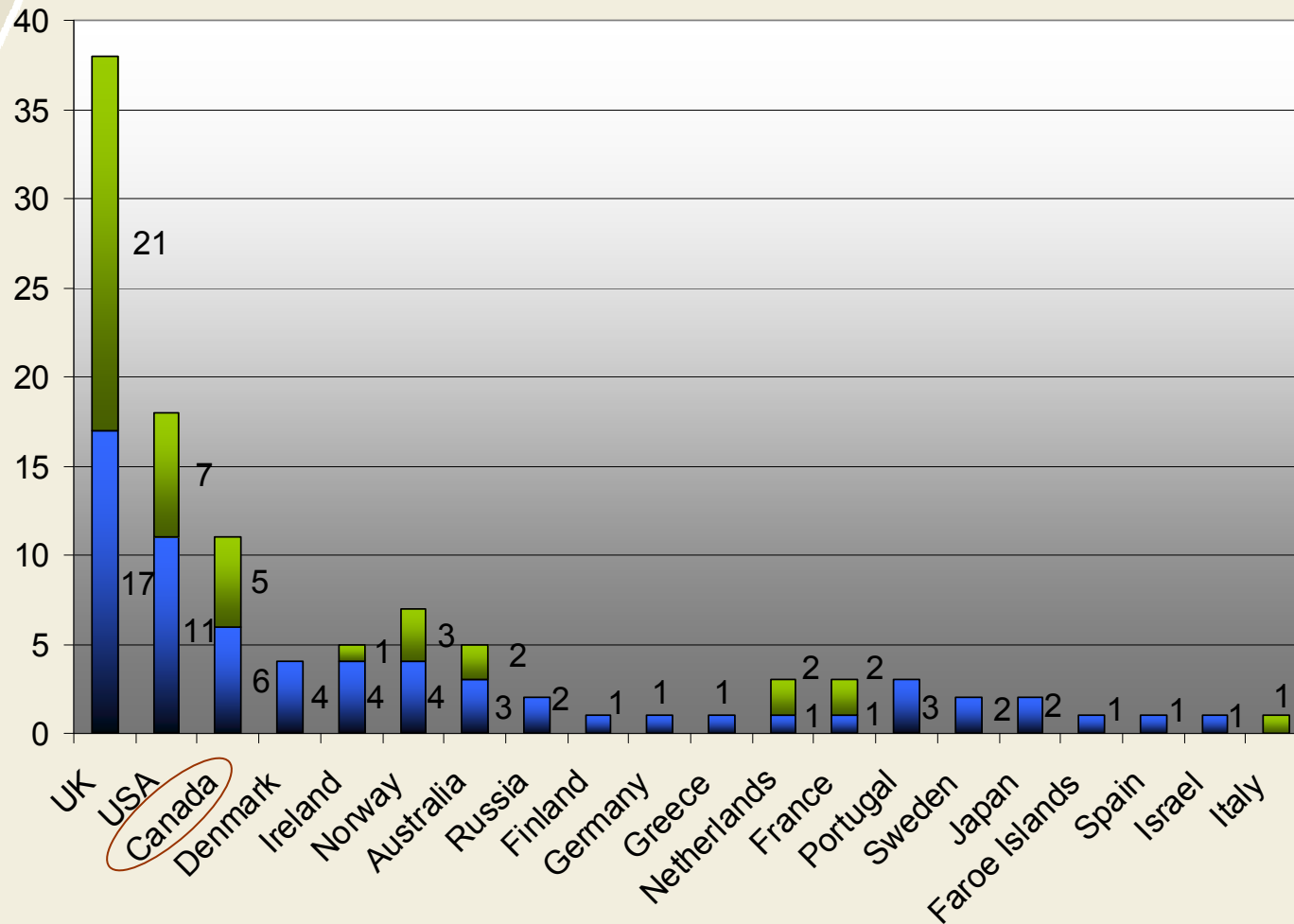


Sources: Devine Tarbell and Associates Ltd., 2008





Global Technology Development



Source: Devine Tarbell & Associates, Inc. 2008

■ Ocean Wave ■ Tidal Energy

10



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Status of Canadian Technologies

- The study includes a completed up-to-date status of Canadian technologies including a detailed description of the technology as well as listing physical aspects
- A review of the 11 Canadian companies show that many of the companies are well into the development phase, including experience with:
 - Recent tidal demonstration projects
 - Wave devices deployed in the ocean
 - Grid-connected devices

11



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Research Requirements, Capabilities, and Facilities

12



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Research Capabilities

- Canada has extensive marine energy expertise with ~30 identified research institutions and universities
- These institutions can accommodate the following research capabilities to support the advancement of the industry:
 - Theoretical modelling of wave and tidal power conversion devices
 - Sub-scale testing and validation of theoretical models
 - Full-scale testing of devices at open water test-centers
- Powertrain development and testing facilities

13



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Technology Transfer Opportunities

- Technology transfer from related industries can give a critical competitive advantage to technology development in the marine energy industry
- The following areas have been identified as well suited for technology transfer:
 - Offshore operation and maintenance
 - Offshore installation
 - Device fabrication/materials
 - Grid interconnection standards
 - Powertrain component integration
 - Interconnection costs and considerations

14



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Specific Technology Areas Requiring R&D

- Specific technology areas have been identified as those which could best benefit from targeted R&D activities:
 - Mooring and foundation designs for tidal and wave power conversion
 - Hydraulic systems – high reliability and increased efficiency at part loads
 - Riser cable for electricity transfer to seabed
 - Electrical quick connect/disconnect system
 - Direct drive generator for tidal machines
 - Site specific ice formation research
 - Economical shipping techniques for deployment

15





Developer Research Requirements

- In addition to the input the developers provided for specific technology areas requiring further R&D, the study includes a complete list of very specific research requirements, summarized into the following categories:
 - Environmental permitting and regional-specific environmental needs
 - Access to expert advice both within and outside of Canada
 - The development of protocols for maintenance in sea conditions
 - Investment in generic technologies that would benefit the industry as a whole (i.e.: mooring systems), which would not fall under core or intellectual property
 - Standardization of tools and interconnection systems

16





Opportunities for Canada

- Canada has many geographic and environmental considerations that make the region unique
 - Some of the highest power densities in North America
 - Harsh environmental conditions (i.e.: ice)
- Canada has many facilities available allowing to capitalize on the complete development cycle:
 - At the concept phase
 - Test pilot scale developers have some of the best testing tanks and flume tanks readily available in North America
 - For ocean environment testing
 - Wave developers can test in Sandy Cove in NS or Lord's Cove of Burin Peninsula in NF
 - Tidal developers can turn to the test facility at the University of Manitoba, Canoe Passage in BC, or Minas Basin in NS

17





Conclusions

- Canada is well invested in marine energy technologies and R&D:
 - One small-scale tidal developer has sold devices and has grid delivered power
 - Another tidal developer was the first to deliver power ashore, and has the potential to be in the first three at a large-scale tidal demonstration site to deliver grid power between 2009/2010
 - Two wave technology developers are well advanced with their numerical tests and scale modelling





Conclusions – cont'd

- Continued...
 - Bay of Fundy may be the first fully functional multi-module tidal plant in the world
 - Canadian-based OREG has the largest dedicated ocean energy development association in the world
 - Canadian leadership has been critical to the development of the International Energy Agency (IEA) Ocean Energy Implementing Agreement
- These attributes along with the potential for further research makes Canada one of the leaders in this emerging energy field





**A copy of the report will posted
shortly on the following website:**

www.canmetenergy.nrcan.gc.ca

20



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