# Harnessing the Ocean's Energy in the Pacific Region

**Dr. John Huckerby**
**International Relations**

**Aotearoa Wave and Tidal Energy Association**

# Who is AWATEA and the Ocean Energy Systems Implementing Agreement?

- **Aotearoa Wave and Tidal Energy Association (AWATEA)**
  - Incorporated in April 2006
  - Currently 56 Corporate, Professional, Non-profit and Individual members
  - Promotes the uptake of marine energy in NZ
- **Dr. John Huckerby**
  - Founder and first Executive Officer of AWATEA
  - Current Chairman of and NZ's representative to IEA's **Ocean Energy Systems Executive (OES-IA**) – www.iea-oceans.org
  - NZ representative to IEC's Technical Committee 114, establishing electrical standards for marine energy converters – www.iec.ch
  - Lead Author of the IPCC's Special Report on Renewable Energy Sources and Climate Change Mitigation – www.ipcc.org

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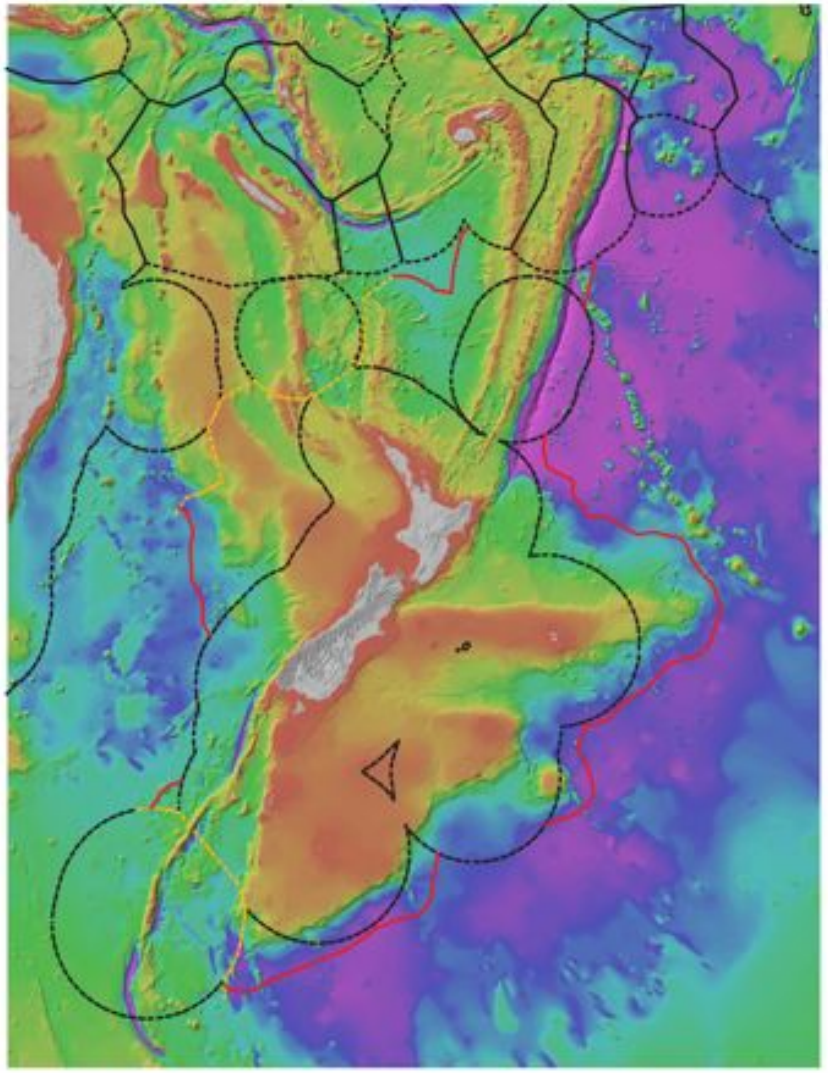
# 21st Century New Zealand

# 94%

15,200 km coastline

4th largest country in the world…



# What is Marine Energy?

**Marine Energy**

- Wave
- Tidal Rise and Fall
- Tidal/Ocean current
- OTEC/ Geothermal
- Salinity Gradient

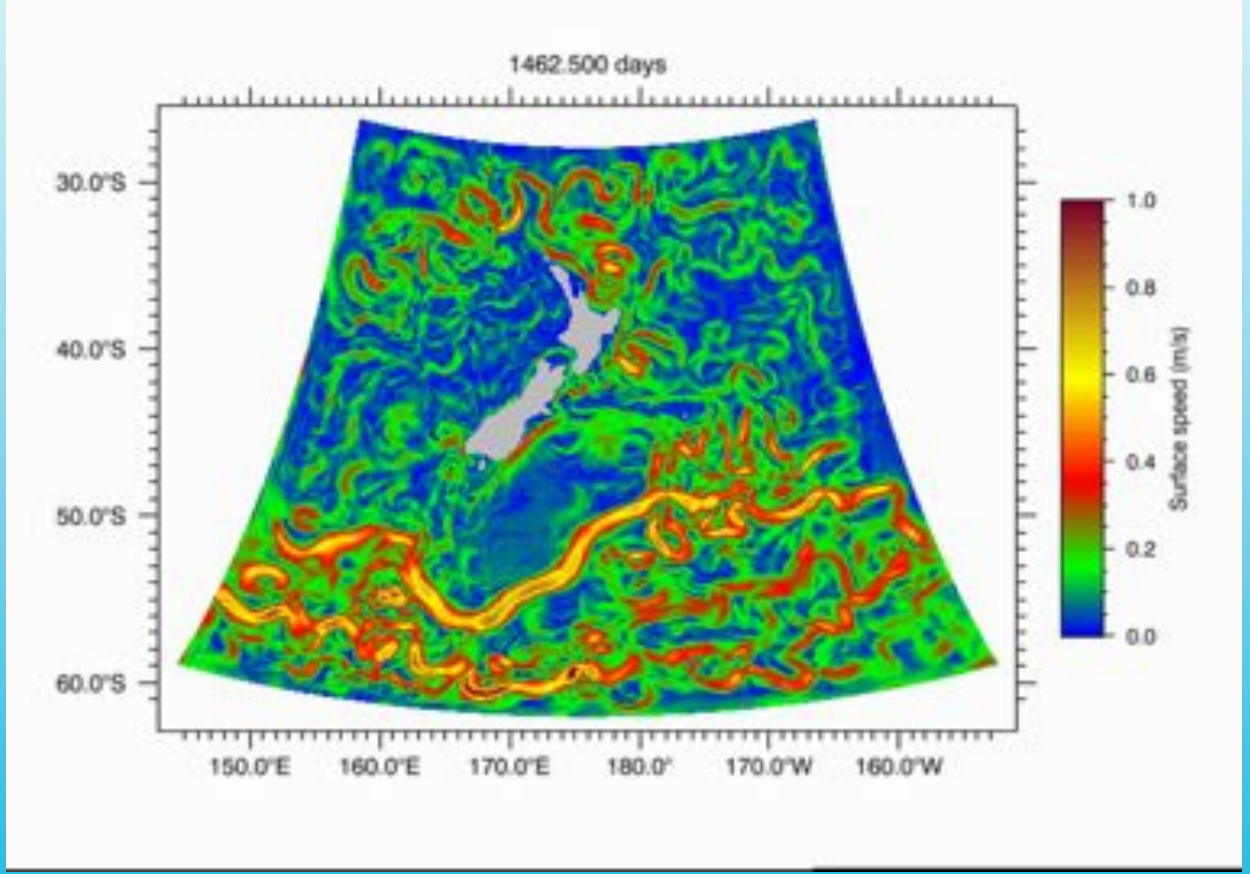





- Marine biomass and future offshore wind energy
- Products include electricity (AC & DC), hydrogen, water, heat, biofuels
- 16 PECC members have active involvement in marine energy

# Harnessing Ocean Energy

- **Resources**
  - Waves
  - Tidal rise and fall
  - Tidal and ocean currents
  - Ocean thermal energy
  - Salinity gradients
  - Marine biota (for biofuels)
- **Technologies**
  - R & D
  - Deployments
- **Projects**
- **Government Support**
- **Financing**
- **Competitively priced outputs**
  - Electricity
  - Potable water
  - Hydrogen
  - Heat
  - Biofuels

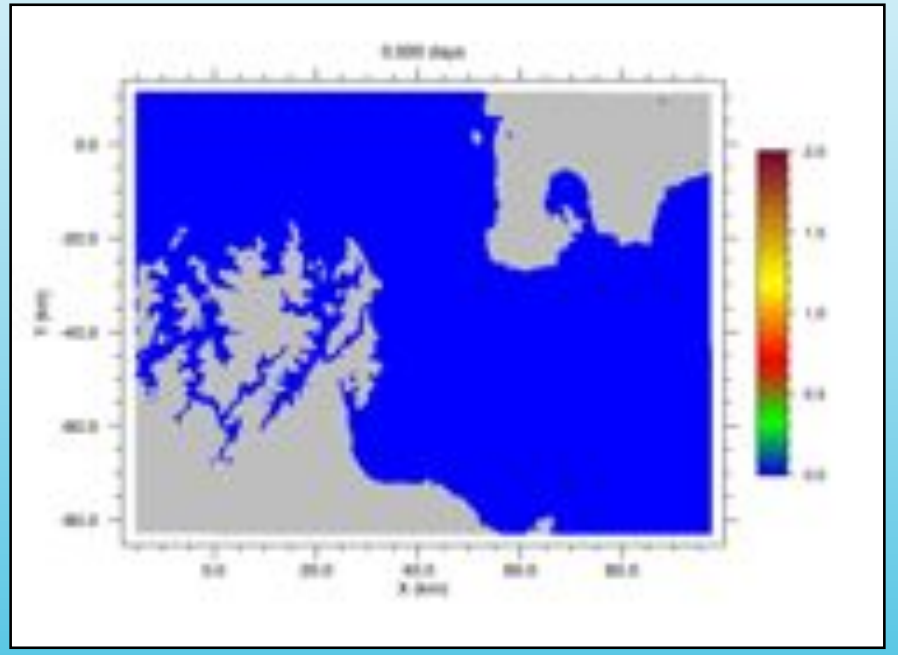



Mark Hadfield, NIWA, 2009

# Tidal Energy

Eling Mill, Southampton

Milling flour for 900 years

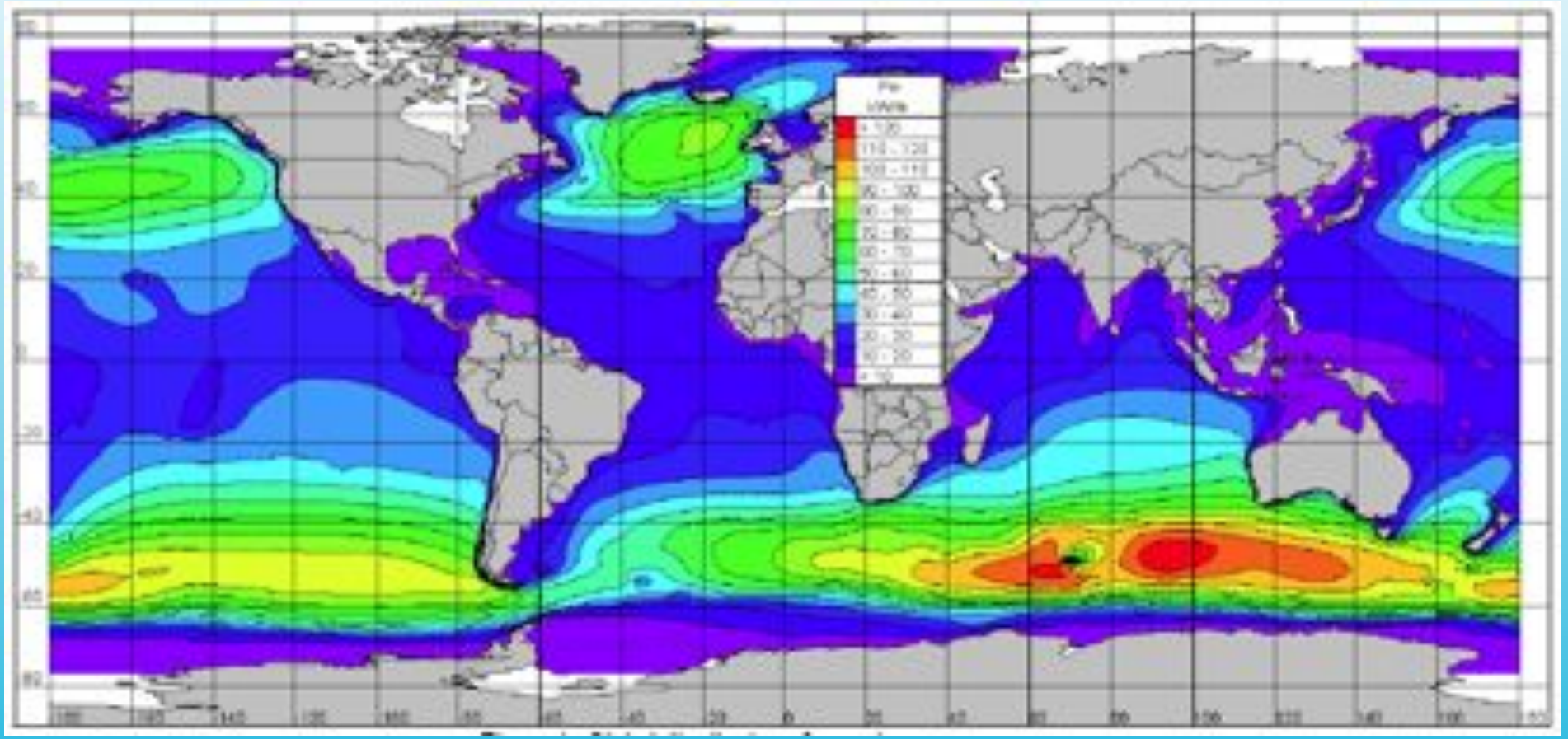


Source: NIWA, 2009

New Zealand's tides

Unused for millennia

# Global Distribution of Wave Power



*Source: Cornett, A. 2008. "A global wave energy resource assessment", ISOPE Conference 2008.*

# Ocean Thermal Energy Conversion

- OTEC resource covers an area exceeding 100 million km$^2$ across tropical oceans


- Economic feasibility: requires minimum differential temperatures of 15º between warm surface seawater and deep cold seawater; warm surface seawater is between 25 – 29º; deep cold seawater remains stable at 4 – 5º; 20º difference in temperature between the two is potentially viable
- Favourable OTEC regions are for the most part far offshore from any land (best sites: tropical locations with steep bathymetries)
- OTEC produces stable baseload power; good for security of supply

# Osmotic Power Potential:
## Key indicators

- Osmotic Power potential requires availability of both saline and fresh water
- Major river estuaries are thus key potential sites
- Energy potential from osmotic power depends on freshwater flow:


Statkraft's Osmotic Power Prototype, Oslo
Operational since October 2009

| River | Average flow, m3/s | Power Production, GWh |
|---|---|---|
| Small local stream | 10 | 88 |
| Namsen (Norway) | 290 | 2560 |
| Rhine (Germany) | 2200 | 19520 |
| Mississippi (USA) | 18000 | 160000 |

Source: UN Atlas of the Oceans

# Wave Energy Conversion

## Australasian Devices

Oceanlinx OWC, Port Kembla, Australia, 2007

WET-NZ Point Absorber, Christchurch, December 2009

# China: 40 kW Tidal Power Plant
## "Wanxiang-II"


- This experimental plant has two VAHT under water and rests on seabed of a strait of Daishan, Zhejiang Province.
- Capacity: 40kW; size: 7.6 x 7.6 x 5 m,; weight in air: 60 tonnes

# Korea: Tidal Energy
## Barrages and Turbines


### Sihwa Barrage – 254 MW

- SE of Seoul
- Retrofitted on existing barrage
- Built with CDM support
- Nearing completion – operational in 2010
- Two more >250 barrages planned


### Woolmoldog – 1 MW tidal prototype

- 100 kW test facility – 2003
- 1 MW device installed in 2009
- Max current speed 5.5 m/sec!

# Wave Energy Conversion
## Hawaii

OPT: PowerBuoy point absorber


COURTESY PHOTO
A plan announced yesterday would place three wave energy platforms, similar to this one in Australian waters, off the coast of Maui.

- OPT has been testing PowerBuoys for the US Navy at Kaneohe for more than 10 years
- Oceanlinx proposes to deploy three devices offshore at Pauwela Point, Maui (2.7 MW)
- US DoE has nominated Hawaii as a Marine Energy Testing Centre and there are a number of DoE-funded research projects on Ocean Thermal Energy Conversion in progress

# Canada's Potential Offshore Wave Energy Resources

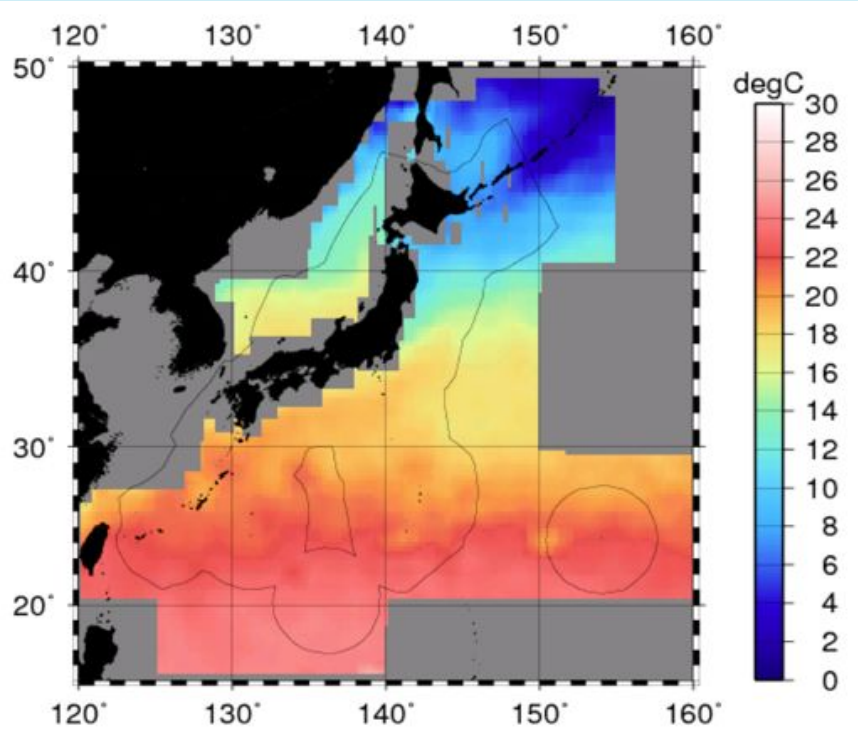
| | | |
|---|---|---|
| **Pacific Ocean (200 mile limit)** | 50.7 kW/m | 54,300 MW/yr |
| **Atlantic Ocean (200 mile limit)** | 34.5 kW/m | 161,955 MW/yr |

- Canada's Electricity Consumption about 70,000 MW/annum
- Nearshore wave energy in the Atlantic is considerably smaller than in the offshore

# Canada Potential Tidal Current Sites (by Province)

| Province | Potential Tidal Current Energy (MW) | Number of Sites (-) | Average Size (MW) |
|---|---|---|---|
| Northwest Territories | 35 | 4 | 9 |
| British Columbia | 4,015 | 89 | 45 |
| Quebec | 4,288 | 16 | 268 |
| Nunavut | 30,567 | 34 | 899 |
| New Brunswick | 636 | 14 | 45 |
| PEI | 33 | 4 | 8 |
| Nova Scotia | 2,122 | 15 | 141 |
| Newfoundland | 544 | 15 | 36 |
| **TOTAL** | **42,240** | **191** | **221** |

# Japan: OTEC
## Resource and Test Facility




**Temperature Diff. (Surface – WD 1,000m)**

- Most of northern Japan too cold
- Areas of S. Japan have potential for OTEC

**SAGA University – 30 kW Pilot OTEC**

- Ammonia – water system

# Fresh Water from Ocean Energy

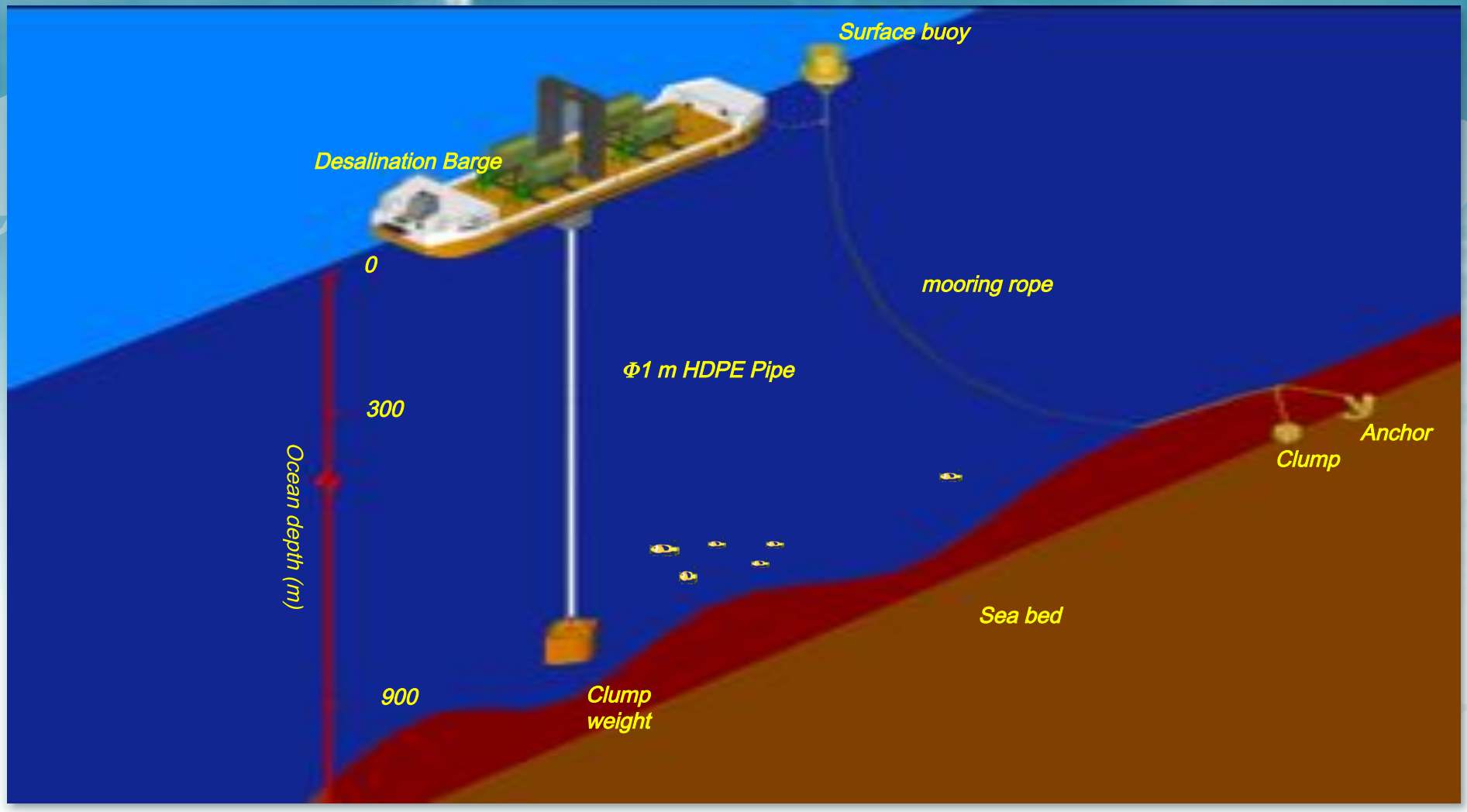
- 'Free' renewable energy for desalination
- Zero greenhouse gas emissions
- Can be located up to 5 km offshore
- Located close and scaled to market demand
- Minimal requirement for pipelines – ideal for remote sites
- Residual brine disposed at site
- Small footprint due to ocean energy density
- Substitute power production in the rainy season

Projects in Australia, US, Mexico and India

Indian Ocean: Floating LTTD Plant

IEA | OES
Ocean Energy Systems

# Barge: Desalination 1 M l/d Capacity Plant



# Role of Governments

- **Supportive policies and strategies**
  - Targets: installed capacity and generation
  - Resource allocation and permitting regimes
  - Integration of onshore and marine estate regulation
  - Infrastructure support (OE centres and testing facilities)
  - Standards and protocols
  - ‘First nation’ considerations
- **Funding/co-funding – from model to money**
  - R & D grants (most countries)
  - Deployment capital grants (UK and NZ)
  - Feed-in tariffs & renewables obligation certificates (NW Europe)
  - Competitive prizes (Scotland)
- **Climate change & sustainability**
  - Emissions reductions & trading regimes
  - Legislative promotion of renewables

# International Connections

- **IEA: Ocean Energy Systems**
  - Intergovernmental organization working on ocean energy
  - Canada has been long-standing member and past Chair
  - Annex IV: Environmental Impacts of Marine Energy Converters
  - www.iea.oceans.org: Annex reports, annual reports, newsletters

- **IEC Technical Committee 114**
  - International standards setting agency for electrical devices
  - Has established standards for wind turbines
  - TC114 proposed in August 2007 to establish standards for marine energy converters
  - Ms. Melanie Nadeau of Natural Resources Canada is Chair
  - Canada, US, UK and NZ leading tech. specification work groups

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# Ocean Energy Systems IA

**Members**

Membership is Governmental only, membership is by invitation from IEA

Member Governments may represent themselves or nominate other parties to nominate them

**Representatives**

Member government departments (US, UK), government agencies (Canada, Ireland), national energy agencies (Spain, Sweden) industry associations (EU, NZ), device/project developers (Australia, Norway, Italy), research organizations (Portugal, Denmark, Germany) and universities (Japan, Belgium, Mexico) and the European Commission

**Key Strengths**

Collaborative efforts between countries, pooled capital, resources and effort

Wide reach and range over issues; transfer of experience and knowledge

Range of representatives means wide range of interests, desires and directions

# IEA:OES-IA Mission & Vision

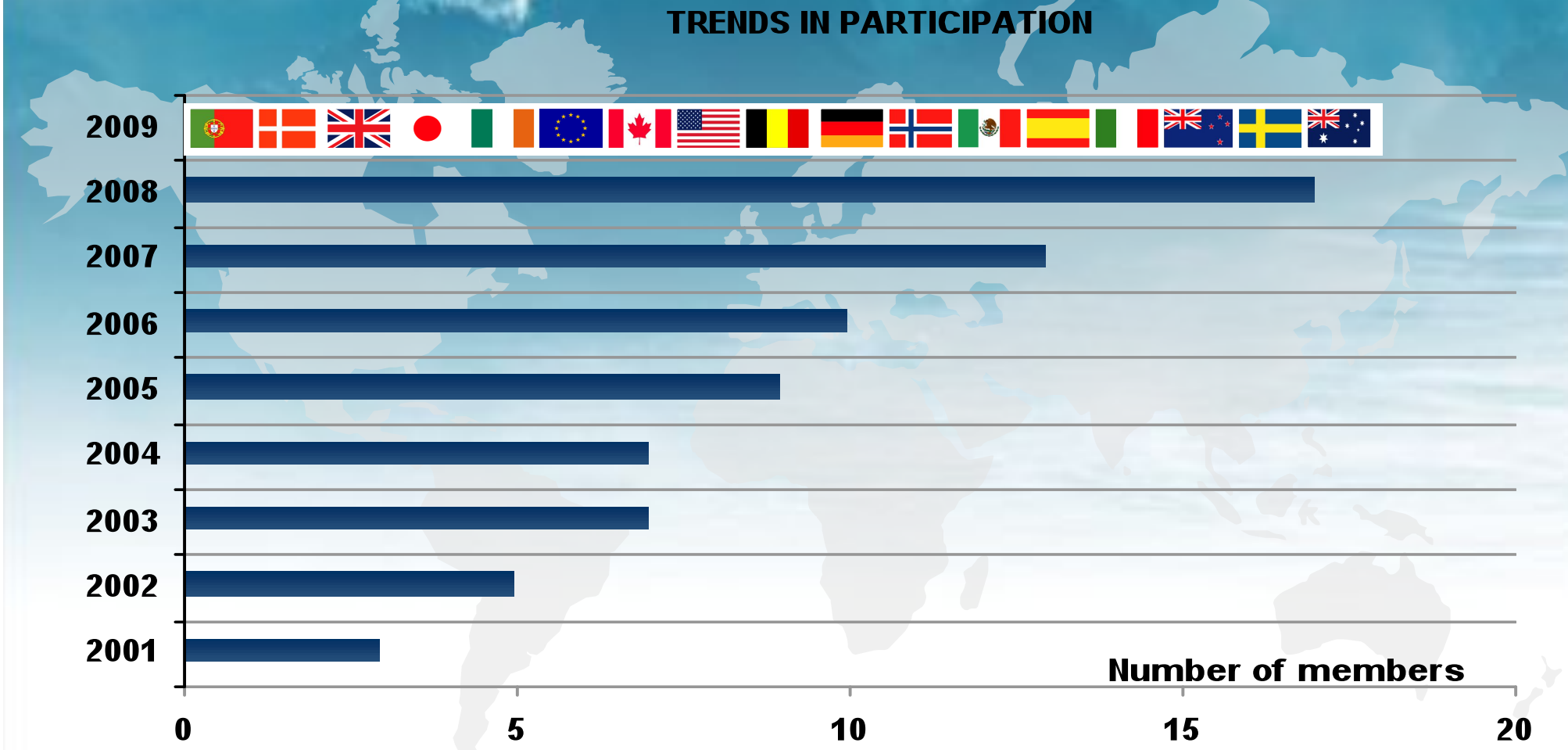
## Vision

To realise, by 2020, the use of cost-competitive, environmentally sound ocean energy on a sustainable basis to provide a significant contribution to meeting future energy demands

## Mission

To facilitate and co-ordinate ocean energy research, development and demonstration through international co-operation and information exchange, leading to the deployment and commercialisation of sustainable, efficient, reliable, cost-competitive and environmentally sound ocean energy technologies

# Present Membership




IEA | OES
Ocean Energy Systems

# Potential New Members


**Countries invited to join the IEA-OES**

**Countries that are completing the process for joining**

IEA | OES
Ocean Energy Systems

# IEA:OES-IA Objectives

## 5 Year Strategic Plan (2007 – 2011)

1. To actively encourage and support the development of networks of participants involved in R, D & D, prototype testing and deployment, policy development and facilitate networking opportunities
2. To promote and facilitate collaborative research, development, and demonstration to identify and address barriers to, and opportunities for, the development and deployment of ocean energy technologies
3. To promote the harmonization of standards, methodologies, terminologies, and procedures, where such harmonization will facilitate the development of ocean energy
4. To become a trusted source of objective information and be effective in disseminating such information to ocean energy stakeholders, policymakers and the public
5. To promote policies and procedures consistent with sustainable development

# Ocean Energy Themes

## Recent and Present Trends

1. **Early R & D, deployments and supportive policies**
   Initial interest/investment in Portugal, UK, Denmark and Ireland
   More recent developments in N. America and Australasia
   Feed-in tariffs and marine supply obligations in most advanced countries

2. **Proliferation of Testing Centres**
   EMEC operational in 2004
   More than 11 testing centres under development

3. **Utility-scale Investors & GW-scale Investments**
   Voith Hydro and RWE Innogy – JV for tidal energy
   Aquamarine Power and Airtricity – 1 GW proposed

4. **Expectations Met and Promised Delivered?**
   Early developments have promised much…
   Need for extended deployments to demonstrate capacity factors, O & M costs and commerciality
   RAB report (2008) and Saltire Prize

# Harnessing Ocean Energy

- **Resources**
  - Resource measurement
  - Continuous mapping
  - International standards
- **Projects**
  - “Devices in the water”
  - Deployment technologies
- **Government Support**
  - R & D & Deployment -> commercialization
  - Gov’t policies to promote renewables
  - Policies and regulation
- **Financing**
  - Willing investors
  - Niche applications
- **Wave Technologies**
  - Point absorbers
  - Attenuators
  - OWCs
- **Tidal/ocean Technologies**
  - HA tidal turbines
  - VA tidal turbines
  - Fences
- **Tidal Rise and Fall**
  - Barrages
  - Impoundments
- **Ocean Thermal Energy**
- **Salinity gradients**
- **Marine biomass**

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# If you have been, thank you for listening!

For more on the IEA's Ocean Renewable Energy Systems Implementing Agreement, to go:

**www.iea-oceans.org**

or on New Zealand's potential, go to:

**www.awatea.org.nz**

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