Nor Aieni Haji Mokhtar, Malaysia

10th Intergovernmental Session of the IOC Sub-Commission for the Western Pacific (WESTPAC-X), 12-15 May 2015, Phuket, Thailand
Identify opportunities for promoting and linking MRET experts and establish networking among member states in the MRET field.

Promote enhancement of capacity building through a workshop, a learning network and exchange of experts.

Survey regional status on MRE in order to provide baseline information, identify challenges and share practices among member states.

Provide recommendations for policy makers.

Target for development of pilot projects.
Introduction Marine Renewable Energy

The marine renewable energy sector comprises:

- **Tidal Energy**: Energies are derived from the conversion of existing kinetic energy from water bodies to mechanical energy.
- **Wave Energy**
- **Ocean Current Energy**
- **Ocean Salinity Gradient Energy**: Energy extracted from salinity gradients through the osmotic process.
- **OTEC**: Energy is derived from temperature gradients between surface and deep-sea.
In Stream Tidal Technology Examples
Tidal Current

Verdant; Horizontal Axis; East River, NY
Gorlov Helical Vertical Axis; Merrimack River,
Hydro; Open Center Turbine; Gulf Stream
Lunar Energy, Rotech Tidal Turbine
Underwater Electric Kite; Merrimack River,
MCT SeaFlow Experimental Test
At high tide a reservoir captures water whose potential energy is released through a turbine. Similar to hydroelectric power plant.

Tidal range of at least 7 m is required for economical operation.
PELAMIS
Tidal Wave

OPD Pelamis Being Towed to EMEC For Test Trials
Horizontal Axis Turbine Prototype
Malaysian Ocean Vis-à-vis Marine Energy Concepts

- OTEC requires 20 degrees temperature difference. Deep water where large temperature difference between surface and bottom temperatures are found are far from shore – Sabah trough case
- UTM is pursuing for OTEC.
- Tidal barrage needs at least 7m difference. Maximum tidal range is only 5m. Development versus environmental damage.
## Comparison of world energy resources

<table>
<thead>
<tr>
<th>Renewable Source</th>
<th>Low Capital Cost</th>
<th>Low Running Cost</th>
<th>Minimal Environmental impact</th>
<th>Predictable</th>
<th>Minimal Visual impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
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<td>Nuclear</td>
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<td>✓</td>
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</tr>
<tr>
<td>Wave</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✔</td>
<td>✓</td>
</tr>
<tr>
<td>Marine current</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✔</td>
<td>✓</td>
</tr>
<tr>
<td>Ocean Thermal</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
## CURRENT STATUS OF MARINE RENEWABLE ENERGY TECHNOLOGIES

<table>
<thead>
<tr>
<th>Technology</th>
<th>Maturity</th>
<th>Installed capital cost (dollars per kilowatt)</th>
<th>Unit cost of electricity (dollars per kilowatt-hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tidal barrage</td>
<td>Virtually abandoned</td>
<td>1,700–2,500</td>
<td>0.08–0.15</td>
</tr>
<tr>
<td>Wave–shoreline OWC</td>
<td>Experimental</td>
<td>2,000–3,000</td>
<td>0.10–0.20</td>
</tr>
<tr>
<td>Wave–near shoreline OWC</td>
<td>Commercial 2002–05</td>
<td>1,500–2,500</td>
<td>0.08–0.15</td>
</tr>
<tr>
<td>Wave–offshore – point absorber</td>
<td>Commercial 2010 or later</td>
<td>2,500–3,000</td>
<td>0.06–0.15</td>
</tr>
<tr>
<td>Tidal current turbine</td>
<td>Commercial 2005–10</td>
<td>2,000–3,000</td>
<td>0.08–0.15</td>
</tr>
<tr>
<td>OTEC</td>
<td>Commercial 2005–10</td>
<td>Unclear</td>
<td>Unclear</td>
</tr>
</tbody>
</table>

Source: WORLD ENERGY ASSESSMENT: ENERGY AND THE CHALLENGE OF SUSTAINABILITY
Introduction Marine Renewable Energy

Existing notable MRE Plants across the globe:

La Rance in France

- Built in 1977
- Has an installed capacity of 240MW

Sihwa Lake Tidal Power Plant in South Korea

- Currently the largest tidal power installation in the world
- The construction of this plant was completed in 2011
- It has a capacity of 254 MW
Activities

Workshop on the ‘Status of Marine Renewable Energy Technology Development in the Western Pacific’ on the 16th-18th February 2012 at the Renaissance Hotel Malacca, Malaysia.

The workshop featured 4 sessions, covering a wide range of topics, ranging from a global overview of 5 types of marine renewable energy, to the ongoing national efforts in the region on marine renewable energy technologies.

Following the workshop, an MRE survey form was conducted to identify, collate and report the present state of implementation for MRE among IOC WESTPAC Member Countries.
REPORT ON THE 1ST IOC/WESTPAC WORKSHOP
16-18 February 2012, Malacca, Malaysia

THE STATUS OF THE MARINE RENEWABLE ENERGY TECHNOLOGY DEVELOPMENT
IN THE WESTERN PACIFIC

National Oceanography Directorate (NOD)
MINISTRY OF SCIENCE TECHNOLOGY AND INNOVATION,
MALAYSIA

In collaboration with
Thematic Areas

- Marine tidal power and tidal current energy development with practice in Korea; Shiwa Tidal Power Plant, Inchon TPP and Uldolmok Tidal current power plant
- Wave energy device design testing development with practice in Denmark, UK and New Zealand
- Ocean thermal Energy conversion (OTEC) and its products in Japan
- Marine Algae research for Biofuel and OTEC initiative in Malaysia
- Country presentations from China, Indonesia, Malaysia, Philippines, Fiji
- Cross cutting themes; environment impacts, law of the sea, capacity building and international framework
1ST WORKSHOP ON THE STATUS OF MARINE RENEWABLE ENERGY TECHNOLOGY DEVELOPMENT IN THE WESTERN PACIFIC

MALACCA - 16-18 FEBRUARY 2012
Invited MRETD experts
Workshop in Melaka, Malaysia (2012)

• Mr Cui Lin from Tianjin, China
• Dr Mukhtasor from Jakarta, Indonesia
• Dr Yasuyuki Ikegami from Narita, Japan
• Dr John Huckerby from Wellington, New Zealand
• Engr Loreto Carasi from Manila, Philippines
• Dr Jang Won Chae from Republic of Korea
• Mr Vu Minh Phap from Hanoi, Vietnam
• Assoc. Prof. Dr. Rafiuddin from Suva, Fiji
Speakers WESTPAC & from Malaysia

- Dr. K. Sang Byun
- Mr. Wenxi Zhu

- YB Datuk Fadillah Yusof- Deputy Minister, MOSTI,
  Chairman National Task Force Committee on Renewable Energy
- Datin Paduka Khatijah Yusof, Deputy Secretary General (science), MOSTI

- Dr. Nor Aieni Haji Mokhtar (NOD, MOSTI/UTM/UMT)
- Prof. Omar Yaacob (UTM)
- Dr. Abu Bakar Jaafar (UTM)
- Azhar Hakim Max Herriman (Sea Resources Management Sdn Bhd)
- Dr. Baharum Ismail (SIRIM)
- Dr. Yeong Hui Yin (UM)
- Dr. Lam Wei Har (UTAR)
- Dr. Chen Sen Pau (SIRIM)
- Prof. Dr. Zahari (UM/UMP)
- Assoc. Prof. Dr. Zamri (UM/T ATIUC)
- Dal Chandran (ASM)
- Dr. Muhammad Fadhli A Rahman (UMT)
Prospects of MRE R & D in WESTPAC

• Existing international collaborations around the world in harnessing different types of energy from ocean resources such as tidal (Korea), currents, waves, salinity gradient (Norway), thermal gradient (India) focus on developing advanced devices & suitable technologies specific to types of ocean-derived energy, i.e oscillating water column, overtopping devices, surge & point absorbers, tidal barrage.
China


• Main targets include
  (i) total installed capacities of marine RE in China
  (ii) number of islands powered by marine RE for residential and industrial
  (iii) number of wave and tidal technologies towards commercialization, national legislation which covers new revised renewable energy law and establishment of Administrative Center for Marine RE (ACMRE), a set up of special fund for marine RE in 5 different areas, and availability of various public funding mechanisms for marine R&D.
R & D technologies in China

3 types of marine RE;
(i) tidal barrage technology which mainly funded by industry;
(ii) tidal current technologies funded by government
(iii) wave technologies funded by government. New progress that has been made for tidal current turbine includes shrouded 3-blade axis flow 20kW tidal current turbine, 2-blade horizontal axis tidal current turbine with duct and flexible blade tidal current turbine. For wave energy, latest progress includes 10kW floating “duck” type WEC for islands and 10kW point absorber. Two marine RE projects that have been in operation in China are JiangXia Tidal power plant with installed capacity of 3.9MW and Daguan Island isolated hybrid marine energy system with capacity of 105kW.

Four on-going marine RE technologies demonstration projects are DATANG tidal current energy system in Longxudao Island (1.2kW installed capacity), CNOOC 500kW hybrid tidal current energy system in Zhaitang Island, CECEP 1MW tidal current energy system in Daishan Island and GIEC 500kW hybrid wave energy system in Danwanshan Island.
China also initiated few test sites for wave and tidal energy to survey engineering conditions and to assess wave and tidal current energy resources at these sites.
MRE development in Philippines

For the Philippines, ocean energy is at pre-development stage where 3 service contracts have been awarded with potential capacity of 170,000 W (170 kW). According to Philippines Energy Plan, the country aims to expand the capacity of ocean energy sector to 120 MW. Identified potential sites for ocean energy projects include Verde Passage, Mindoro/Tablas Strait, Balabac Strait, San Bernadino Strait, Hinatuan Passage and Basilan Strait. Resource assessment was carried out at Basiao Channel, Hinatuan Passage and San Bernadino. In 2008, detailed site assessment conducted at Tanon Strait and San Bernadino Strait. Assessment studies comprise of acoustic current doppler profiler, bathymetry studies, sea bed profiling and community profiling.
MRE in Indonesia

The National Energy Council promotes the development of ocean energy through the National Energy Policy. NEC intends to increase the role of ocean energy in the energy mix. Wave and tidal have great potential resources of energy for the country. Promotions and development of ocean energy R&D activities are being conducted by Ministry of Research and Technology and universities. The country establishes Indonesian Ocean Energy Association to foster research, development, publication and application of ocean energy. Indonesia also collaborates with few foreign countries such as Norway, Italy and Dutch to develop wave, tidal current and OTEC energy plant in Indonesia.

Mapping of ocean energy resources suggests more than 15 straits or channels have been identified as potential location for tidal current energy systems and three potential sites for OTEC system. Based on previous expedition (INOCEAN Ratification 2011), ocean energy consists of tidal, wave, and ocean thermal could produce 49GW of power (practical estimation), depending on technology maturity and market development. INOCEAN proposed to establish few pilot project of ocean energy power plant; 1 MW tidal current energy and 1MW wave energy by 2014 and OTEC power plant as part of revitalizing Indonesian ocean energy. A 6000 MW ocean energy power plant is proposed to be realized in 2030.
MRE development in Japan

The existing renewable energy is wind turbine and geothermal energy, both have great potential but conflict exists over scenery (environment). Japan has one of the world strongest ocean currents ‘Kuroshio’ and one of the world deepest oceans ‘Kuril trench’ ‘Japan trench’ and ‘Izu-Ogasawara trench’.

Coastal wind energy and wave energy resources are stable, tide and tidal current energy resources are predictive, ocean current and ocean thermal energy resources are stable but both hold technological challenges. In 2010, NEDO Japan produced ocean energy potential map for wave (potential power of 19 TWh/y), ocean current (potential power of 10TWh/y), tidal current (potential power of 6TWh/y) and ocean thermal energy conversion power (potential power of 156TWh/y).

The Basic Plan on the Ocean Policy adopted in March 2008 promotes the development of energy and mineral resources. In spring 2012, Headquarters for Ocean Policy will adopt the ‘Action Plan for the Promotion and Utilization of Offshore Renewable Energy’ that aims to set up of demonstration sites at sea and coordinate use of sea areas by local stakeholders.
MRE Development in Republic of Korea

- In Republic of Korea, ocean energy promotion is supported through National Roadmap of Renewable Energy Development and Ocean Energy R&D Programme that is anchored by Ministry of Land, Transport and Maritime Affairs and Ministry of Knowledge Economy. Ocean energy is expected to contribute 4.7% national energy demand supply from renewable resources by 2030. In 2010, government budget in ocean R&D increased to $13.5 million. Ocean technologies are classified into tidal (barrage), tidal current, wave, OTEC and hybrid system. Promotion for development of ocean energy is done in 3 stages;

- Phase 1 (2008-2012) focuses on building technologies on independent basis

- Phase 2 (2013-2020) concentrates on verification and technology advancement

- Phase 3 (2021-2030) focuses on commercial use and industrialization of ocean energy.
Estimated ocean resources from tidal, tidal current and offshore wave energy could produce more than 14,000 MW power. Tidal power plant sites in Sihwa has been in operation and 6 sites (Garolim, Incheon, Ganghwa, Saemangeum, Cheonsu, Haeju) have been identified for future development of tidal power plant sites. Few sites (Uldolmok, Jangjuk. Maenggol) have been identified for development of tidal current power plants.

New progress on technology devices for wave energy includes floating backward bent duck buoy and wave over-tipping reef. A OWC pilot plant for offshore wind energy has been installed in Yongsoo, with a power capacity of 500kW.

Similar OWC technology is scheduled to be installed in Jeju. Korea also engages in promoting technologies that will be used as a foundation to develop the industrialization of marine biofuel from sea algae. The country also plans to develop an ocean farm energy consists of the hybrid system of wind, bio energy and solar PV plant nearby Incheon airport.
MRE Development in Fiji

Fiji and other Pacific Island countries (PIC), the geographical layout of Pacific (scattered islands, high ratio of sea-area to land-area) makes ocean an attractive option for energy sources. Wave energy has good potential for electricity generation.
Assessments of wave energy potential were conducted at selected locations in Fiji and PICs. New wave energy extraction / conversion devices such as rectangular oscillating water column (OWC) and pendulor are also being developed and tested. Fiji and the rest of PIC region are working together in assessing the potential of tidal current energy of which 25 locations are identified for potential development of tidal current energy projects.
The nature of big temperature difference (more than 20 Celcius) of maritime areas in PIC region makes OTEC as an important option for source of power generation in PIC region.
MRE Development in Vietnam

Wind energy has good potential to be developed particularly at the northern and southern part of Vietnam. Wind energy power plant in Phu Quy island has installed capacity of 6MW. Wave energy has lesser potential for energy resource of which the highest energy that can be extracted 20kW/meter.

Few sites in Vietnam such as Halong Bay has potential for tidal energy project development. Lack of support policies and RE energy law, high price of RE equipment, lack of technical data and lack of expertise / capability in marine RE field impose challenge to the development of ocean energy in Vietnam.
MRE development in Australia

In Australia, current marine RE projects can be found in the southern part of the country, particularly on wind energy.

There are numbers of established developers in Australia that produce technological devices and systems in ocean energy sector, such as Atlantis (current and open tidal devices), AquaGen (floating devices for wave energy) and Oceanlix (wave energy system devices). Other companies that also engage in ocean energy sector are Tenax energy (tidal energy farming), BioPower and Waverider. Technical barriers often found are to generate interest of investors in the pre-commercialization development and technical failure in engineering capacity. Many technologies are commercially available for wave, tidal and current energy plants in Australia, except OTEC.

Potential site of OTEC in Great Barrier Reef may crate objections from various stakeholders.
MRE development in Malaysia

A comprehensive roadmap for ocean derived RE was developed in 2010. The role planning, R&D and promotion of ocean energy sector are taken up the Ministry of Science, Technology and Innovations through National Oceanography Directorate and Industry Division and Renewable Energy Research Center (RERC) of SIRIM Berhad. MOSTI has allocated some funds to explore ocean energy in two projects; assessment of Malaysia’s ocean energy resources and evaluation of ocean energy technology & devices.

Malaysia is also involve in biofuel from marine algae project where researchers explore algae cultivation for biofuel production, design & fabrication of energy devices and equipments.
Workshop Conclusion

• Marine renewable energy provides a significant potential to contribute mainly to the future sustainable energy supply, reduction of present carbon emission particularly in view that the Western Pacific, the region we are living in, is of vast social and economic importance with over 70% of the population living in and relying economically on coastal areas, approximately 54% of the world's GDP generated from the region.

• Workshop recognizes despite substantial progress on the development of MRET made in the world, the capacity of MRET R& D still remains low in the western pacific, particular SEA and pacific island countries, with various challenges being faced with, for instance, lack of sound policy environment, low level technology development, unsustainable R& D activities, conflicting use with other marine users, marketing development etc.

• With full consideration of the low capacity and ever-increasing demand for green energy, the workshop stressed the need to enhance regional cooperation in the reach and development of MRE in order to bring together regional experts, share the lessons and best practices, and further improve the capacity in the research and development of MRET.

• Decided to develop one regional status report on MRE in order to provide baseline information, identity the challenges and share practices among member states.
### Basic Ocean Data
- Ocean Energy mapping & temperature profiling
- National Oceanography Data Centre (NODC), and data sharing.

### Ocean Energy Device Development
- R&D program focus on development of MW scale ocean energy conversion devices for currents & waves
  - Development and testing of 20kw Device
  - Development and testing of 100kw Device
  - Development and testing of 0.5-2MW Device
  - Deployment of demo unit and test facilities
  - Public-Private sector partnership
  - Deployment of hybrid facilities (currents/wind/solar)

### Expertise, Skills & Training
- Government scholarship on RE Studies
- Expert exchange/Brain Gain and Post-graduate training programs on RE-O
- Collaboration among various agencies, research groups and industries

### Government Support
- National Task force/Technical committee /Working Group
- Special allocation/funding for RE-O R&D
- Include RE-O as part of Government Re policy
- Re-O as a high priority research area
- RE-O Website and media promotions on RE to public
- Education of marine renewable energy at every level

### MALAYSIAN OCEAN RENEWABLE ENERGY ROAD MAP 2010-2020
- **Current**
  - Ocean Energy mapping & temperature profiling
  - National Oceanography Data Centre (NODC), and data sharing.
- **Short term 2011-2012**
  - Development and testing of 20kw Device
- **Mid Term 2013-2015**
  - Development and testing of 100kw Device
  - Detail physical and numerical modelling of potential sites
- **Long Term 2016-2020**
  - Development and testing of 0.5-2MW Device
  - Forecast for RE-O resources and production
- **Beyond 2020**
  - R&D program focus on development of MW scale ocean energy conversion devices for currents & waves
Product

- OWC- Pilot
- Well turbine
- commercial production (near shore) 10KW
- VMT-Pilot
- Feasible sites in Malaysia
- Physical modelling and computer simulation for tidal barrage studies
- Site viability studies

Technology

- Pelamis
- Absorber
- Attenuator
- Integrator technology
- terminator technology

- Energy extraction
  - Underwater Technology, sensor, signal and image processing
  - Maritime hydraulics

- Tidal barrage
  - demo in plant
  - to produce energy with tidal range <7m
  - Ocean thermal energy converter
  - OTEC operating at 10°C T difference

- Connect to Grid by 2030

2 MW/per farm

Energy farms

100 kW

10 kW

1 kW

Baseline data South China Sea, Sulu Sea
Survey of tidal range
Horizontal marine
Vertical marine turbine – lab scale
Wells Turbine OWC -pilot 1KW
OWC lab
Initiation stage

Commercialization

Resources

- HR & skill training post/graduates programs for RE-OCEAN
- Budget
- Facilities

Programs & Projects

- Promotion program for RE ocean product awareness
- Collaborative projects such as oil & gas companies, marine industries supplying components and international organizations
- Technology adaptation Local environment
- Field trials & demonstration projects
- Investment drive for energy import for PPP

Mapping and Identification of potential sites

Address biological fouling, corrosion & other environmental impacts

Feasibility and hydraulic studies

Ocean energy conversion:
- System development & integration
- Structure design
- Technology appraisal and cost benefit analysis

Offshore Platform facilities

Physical & Numerical Modelling

Stakeholders engagement

National Technical Working Group (NTWG)

A + B = RM 65 Million

RM 150 Million

A. RM 15 Million
B. RM 50 Million

Development stage

Field trials & market testing

GRAND TOTAL = RM 215 MILLION
R& D initiatives

A number of local universities (UTM, UMT, UM and UKM) established marine centers / institute dedicated to the studies, design and development of ocean energy devices and systems. 10 potential sites for wave energy projects have been identified by SIRIM, where the highest potential wave energy in Peninsular is 150kW/meter, and 81kW/meter in East Malaysia. Sabah trough has been identified as a potential location for development of OTEC. Good tidal and strong wave near coastline would be given more priority for showcase development and that to be benefited to remote area/community.

Further exploration need to be done for offshore wind, wave (deep sea), ocean current, OTEC and salinity gradient showcase and should be supported by oil and gas company.
Marine Renewable Energy work in UTM and UMT

• OTEC in UTM – with Investment/Commercial group and experts in Korea

• MRE pilot tests at the coastal area-UMT, part of the system destroyed during coastal erosion end of 2014.

• Rebuilding for a hybrid system – Wave, current and wind at UMT as part of Green Campus Development 2016-2020
WORK AT UTM

Ocean Energy

Marine TIDAL CURRENT
Vertical Axis
Horizontal Axis

OCEAN WAVE
Oscillating Water Column

Malaysian Ocean – low current speed (0.5 m/s), low wave heights (1-1.5m), shallow water depth (15-30m)
Ocean Wave Generator in Terengganu
On balance, the survey responses demonstrate that deployment of MRE technology in the WESTPAC region is only at a preliminary stage.

The absence of specific targets for MRE power production in half of the participating countries suggests either a lack of awareness of MRE as a potential source of energy, OR a perception by governments that MRE technology is yet to be proven as a viable option for renewable energy production.
Survey Results

Theme 3: Research and Development

Healthy amount of funding among respondent countries ranging from USD16,000 to USD32 million.

One developing country noted an estimated R&D budget of USD70 million being envisaged in an ‘Ocean Technology Roadmap’, focusing on the development of MRE from the initiation stage to full commercialisation between 2010 and 2020.

Highest amount of funding, i.e. USD32.1 million as reported by a developed country was aimed at the construction of isolated island power generation systems and grid-connected power stations; industrialization for key technology; research and development for new technology; and the public service system.

Many respondents have reported an increase in the allocation/provision of funds over the years.
Most countries reported that several of their universities and institutes are researching MRE technology and are largely undertaken jointly with industry.

R&D have reportedly been conducted on the following areas:
- improving the efficiency of technology that derives power from oscillation in the water column
- detailed marine current resource assessments in strategic potential sites
- technology assessment of different ocean energy systems developed abroad for possible local application
Theme 3: Research and Development

Survey Results

One country mentioned that the MRE test site in its waters focus on:

• tidal power, for which a sixth generator unit was put into production in 2007;
• an isolated hybrid power system based on a 30 kW pendulum onshore wave power station; and
• an isolated island power system, including 300kW from wave energy and 200kW from wind turbines.

Another developing country responded that test sites have been proposed in three areas, namely in South China Sea, Straits of Johor and North of Borneo-Kudat.

One country responded that MRE technology has been imported and the development of Ocean Power Technology (OPT) & establishment of a wave energy farm are still in the initial stages.

A general absence of mature MRE technologies limits opportunities for local researchers to benchmark their designs or choice of materials, or access published sources to build upon the efforts of others.

With only one exception for tidal power, the qualitative elaboration for this question furnished no convincing evidence that countries have yet reached the stage of developing sophisticated economic models for MRE power production.
Summary of Theme 3 findings

There was no indication on the establishment of a dedicated test site at which different technology developers could utilise dedicated, purpose-built permanent mooring structures or pre-installed power-grid connection cables.

Such common-use facilities would enable developers to accelerate R&D programs. 3 responding countries acknowledged occurrence of MRE testing in their waters, but only one developed country reported the availability of a common test facility for tidal power technology that is utilised at a rate of about 20% on average.

There is a high interest in local R&D by universities and companies, suggesting that WESTPAC countries do not recognise any existing international source of proven, commercial-off-the-shelf (COTS) technology.

Absence of mature MRE technologies limits opportunities for local researchers to benchmark their designs or choice of materials, or access published sources to build upon the efforts of others.

A limited availability of proven MRE technology for import will inevitably slow development of commercial MRE power production in the region.
Survey Results

Summary of Theme 3 findings

A healthy allocation of funding support for R&D on MRE suggests good understanding of the potential for MRE technology.

The absence of supporting legislation and FIT provisions indicated in survey responses most likely reflect a conclusion that MRE technology is still in infancy and not yet a viable contributor to renewable energy production.

There is widespread interest in MRE technology in the private sector but activities to date generally remain at the level of ‘proof of concept’.

An absence of significant investment in commercial-scale MRE reinforces a belief that MRE is yet to reach the level of proven commercial viability.

The widespread interest of universities in MRE research is consistent with the broad level of MRE R&D activity also reported for the private sector. There is a strong possibility of new, emerging MRE technology, and the development of more mature MRE technology that will likely gain stronger commercial support.
Conclusion

Generally MRE is recognised by member countries as a potentially rich source of power.

Estimates of potential power production are considerable, but, at present, no MRE technology has been deployed at a fully commercial scale, with only tidal power the closest to being so in a couple of participating countries.

Strong interest in MRE R&D indicated by all survey participants and minimal imports of MRE technology suggest that MRE technology is yet to reach a commercial-off-the-shelf (COTS) stage of development anywhere in the world.

There is no current imperative need to develop detailed supporting instruments such as legislation, feed-in tariffs, EIA rules and guidelines, or financial models.
The presence of a strong offshore oil and gas industry in some IOC WESTPAC member countries has helped to prepare those countries for the operations and maintenance of MRE.

Based on the current state of MRE development and utilisation amongst the countries participating in the survey, any significant contribution by MRE to national energy capacity in WESTPAC countries would appear to remain a goal that will probably take at least until the end of the current decade to achieve.
## Proposed workplan 2015-2016

<table>
<thead>
<tr>
<th>Project /Programme</th>
<th>Activities</th>
<th>Objectives</th>
<th>Expected outputs/outcomes</th>
<th>Date and place</th>
<th>IOC</th>
</tr>
</thead>
</table>
| 1. Focus expert Working Group Meeting | To review report from MRE survey and to discuss technical status and plan for next steps for possible proposal for pilot project  
To identify experts, participating and key donor countries for MRE project  
To seek further interest from participating countries in sponsoring and constructing a pilot project | Work Plan proposal Report | March 2015  
Kuala Lumpur/ Putrajaya/ Kuala Terengganu | Travel support & per diem for WESTPAC Coordinator |
| 2. Participation in IOC/WESTPAC Intergovernmental Session | To present the proposed Work Plan for endorsement by IOC/WESTPAC  
Proposal to convene an Expert Focus Group meeting in August 2015 | Endorsement of Work Plan | 12-15th May 2015  
Phuket, Thailand  
10th Intergovernmental Session | Travel support & per diem for WG leader  
And experts identified |
| 3. Workshop on designing a proposal for pilot project | To review and support for Feasibility of a Pilot Project on MRE in WESTPAC  
To prepare Detailed Design and implementation Plan | Project design proposal, site selection  
Detailed Design & implementation Plan | 1st quarter 2016  
TBC  
2017 | Travel support & per diem for WESTPAC Coordinator |
Focus expert Working Group Meeting

To review report from MRE survey and to discuss technical status and plan for next steps for possible proposal for pilot project

To identify experts, participating and key donor countries for MRE project

To seek further interest from participating countries in sponsoring and constructing a pilot project

Date: August 2015
Venue: Universiti Malaysia Terengganu
Proposed workshop for designing a Pilot Project for WESTPAC

To review and support for Feasibility of a Pilot Project on MRE in WESTPAC

To prepare Detailed Design and implementation Plan

Project design proposal, site selection

Date: 2016
Venue: to be confirmed
Recommendations

• Shared Vision
• Creating Technology Development Platform and viable projects
• Promoting successful innovations, models and stories
• Establishing specialised Regional/National Working Groups to prepare Road Maps and Strategic Action plans
• National Plan of Action and Regional Plan of Action
• Secure Funding for R & D and Commercialisation
• Effective Regional/International Collaboration and Networking – Increasing capacities and competencies Training, R & D, Exchange Programs, Technology Transfer, Pilot project for large scale/small island communities etc.
7th WESTPAC International Scientific Symposium, 21-25 May, Sabah, Malaysia
Thank You