MARINE ENERGY is one of the largest unexploited sources of renewable energy. Strong growth is forecast for the industry, but as yet only a small number of international and local projects exist. Most of these are at research-and-development stage and have yet to be commercialised. An opportunity therefore exists for New Zealand to develop its own R&D structure, and become a major player in the marine energy industry. The creation of an R&D centre would bring a number of strategic benefits, including the potential to develop a high-value marine export industry and a network of marine energy sites that could become an additional source of “clean” electricity for the national grid.
NEW ZEALAND has the potential to produce energy from tidal and wave forces.

These technologies are at an early stage of development, and are a more relevant option for New Zealand than marine energy sources based on more mature technologies. Analysis of the global marine energy industry suggests that there is the potential for New Zealand to develop a competitive advantage. This country could learn from other international renewable energy centres and incorporate key factors into its own marine R&D structure. Doing so would enable it to enhance its R&D position, leading to strategic benefits for the country once these projects reach commercialisation stages, and opening up the possibility of marketing the technologies internationally.

Global and national outlook

According to International Energy Agency (IEA) data, by the end of 2010 a total of 2MW of wave energy and 4MW of tidal-stream energy generating capacity had been installed worldwide (the figure does not include plants using tidal barrage technology). This energy capacity includes demonstration and testing prototypes, with only a few programmes close to commercialisation. A major issue preventing the rapid development of marine energy is cost. In 2010, the IEA found that the construction costs for wave and tidal energy were much greater than for other types of renewable and conventional energy, mainly due to their significantly higher operational and maintenance costs.

A number of growth forecasts have been made and comparisons to the wind energy industry are common as the technologies have similar characteristics. For example, both energy sources require the development of high-technology devices and for both the path to commercially viable electricity generation is long and expensive. The IEA has predicted high growth for marine energy similar to that enjoyed by onshore wind energy for the past 20 years.

Some countries have successfully developed marine energy projects. England and Scotland are at the forefront of marine energy development, with their Wave Hub and European Marine Energy Centre (EMEC) projects providing large-scale testing facilities. Recently, the United States also improved its position by establishing the Water Power Program—a US$59 million project that promotes R&D activities for hydropower, wave and tidal technologies. Canada is also in the advanced stages of marine energy development, with the establishment of the Fundy Ocean Research Centre for Energy (FORCE) and a regional tidal energy test site.

In New Zealand, marine energy is less developed, but its potential is almost unlimited. In 2008, Power Projects estimated that, on an aggregate scale, the total amount of commercially viable marine energy is around 8,000 MW. The areas in New Zealand with the greatest potential for harvesting wave power are on the southwest tip of the South Island, but almost the entire western and southern coast also has potential. The most suitable sites for tidal power generation include Cape Reinga, Cook Strait, Foveaux Strait and the southern side of Stewart Island. Of these, Cook Strait is the most attractive, since it has good current speeds and is close to an urban area.

In 2008, Power Projects estimated that, on an aggregate scale, the total amount of commercially viable marine energy is around 8,000 MW.
Cornwall Wave Hub layout

Crest Energy. WET-NZ established a partnership with a US company, Northwest Energy Innovations, after submitting a bid to the US Department of Energy and receiving US$1.8 million of funding to further develop and test a half-scale device at the University of Oregon and in waters off the Pacific coast. Once the project is completed, WET-NZ will be at an advanced stage of development for the deployment of a full-scale pre-commercial prototype.

Neptune Power, another important New Zealand marine energy company, has gained consent for a 1MW tidal-stream prototype to be deployed off the south coast of Wellington. Neptune Power is currently seeking $600,000 in seed funding to install a test unit. This will enable the company to work toward its goal of a full-scale turbine installation by mid-2013 and to develop a 900MW commercial project by 2015. Another organisation, Auckland-based Crest Energy, is looking to develop a 200MW tidal stream project to be deployed in the Kaipara Harbour. Changes in the project proposal and opposition from local Maori hapū, Kaipara residents and the Department of Conservation delayed the consent process for about five years. A consent was finally approved in 2011.

Government support for this sector is scarce. Between 2007 and 2011 it allocated $4 million in grants for marine projects, but this initiative has not been continued. Among the strategic goals set in the New Zealand Energy Strategy 2011-2021, one subsection is dedicated to promoting R&D in the renewable energy sector. Though no specific technologies appear to be excluded, the government strategy focuses on attracting R&D investments in geothermal and bioenergy sources. A brief mention is made of developing marine energy, though without the promise of major funding.

International Practices in Renewable Energy Technologies

TO DETERMINE best practice regarding marine energy development we have identified four international cases that stand as good exemplars for New Zealand.

Israel NEWTech

Israel has developed pioneering programmes aimed at creating a technological centre of expertise. In 2006, Israel NEWTech, a government technology initiative, was created to enhance the country’s water efficiency and renewable energies R&D programmes. It is a consortium of industry sector representatives, financial companies and academia that aims to evaluate and guide the implementation of new projects. The government aids the consortium by matching its financial needs with potential investors. The consortium assists entrepreneurs to develop renewable, energy-related R&D projects through the entire process, from conception and testing to commercialisation and export.

Canadian and Danish Projects

In 2008, The Fundy Ocean Research Centre for Energy (FORCE), a non-profit institute supported by both public and private funding, was established to test in-stream tidal turbines in Canada’s Bay of Fundy, a location renowned for having the world’s greatest tidal range. FORCE provides shared infrastructure and monitoring, pre-approved sites, academic research, data sharing and strategic environmental assessment. It is an industry pioneer, deploying and testing North America’s first commercial-scale in-stream tidal device.

Another important testing facility for tidal energy was developed in 1998, within the Danish Wave Energy Programme. It comprises five stages, with projects typically scaled up as the level of technological readiness increases, resulting in minimal investment risk. Stage 1, which lasted five years, was run by a panel of university and industry experts and funded by the Danish government. The programme created a 1:4.5 scale power plant prototype that was extensively tested in the sea and, most importantly, it developed a procedure for evaluating wave energy projects. More recently, the program assisted the development of up to half-scale size wave turbine prototypes and the government has announced DKK25 million ($5.3 million) in funding to further develop marine energy. The projects are yet to reach the commercialisation stage.

Cornwall Wave Hub

Cornwall is home to an English marine energy cluster, at the centre of which is Wave Hub, an electrical hub where firms can “plug in” and test new marine energy technology. Figure 1 shows how Wave Hub is set out, with four offshore berths available for lease. The berths are all connected to an onshore substation via underground cables so that power can be supplied to the local grid. Wave Hub provides an excellent ocean testing ground for wave energy technology as companies can focus capital and knowledge on developing the actual marine technology. Wave Hub has been funded by several organisations, including the now defunct South West Regional Development Agency, the European Regional Development Fund Convergence Programme for Cornwall and the Isles of Scilly, and the UK government.

One of the key factors contributing to the development of this cluster is the proximity of complementary facilities. Wave Hub now has the necessary infrastructure for firms to test their technology without having to build their own testing facilities. It is linked closely to Peninsula Research Institute for Marine Renewable Energy (PRImARE). PRImARE supports innovation and growth through research and technology transfer in the marine energy sector and has links to local universities and other EU organisations.
Developing a Marine R&D Cluster in New Zealand

MARINE CENTRE OF EXPERTISE

To enable New Zealand to be a leader in marine energy we propose the establishment of a Marine Centre of Expertise to harness the country’s natural resources and technical capabilities. What the marine industry needs is a structure to support domestic companies and at the same time attract international companies to locate marine energy R&D activities in New Zealand. This will require both financial incentives and practical actions. Figure 2 outlines the primary activities of the proposed Marine Centre of Expertise. Its main goal will be to test technology with the potential for commercialisation. Some of the activities noted in Figure 2 are already performed by various companies and the intention is not to undermine their efforts, but to aggregate them for the benefit of the industry. Aotearoa Wave and Tidal Energy Association (AWATEA) also supports the development of the marine energy industry in New Zealand and can play an active role in the Centre of Expertise.

Project evaluation

The core capability that the Marine Centre of Expertise will add is the evaluation of new projects and the testing of marine and tidal devices. A procedure to evaluate and test small-scale tidal and marine turbine prototypes is a crucial step in determining whether a new technology can be developed to a commercial stage.

Finding international partners

In order to gain an international reputation and quick access to leading intangible knowledge regarding marine and tidal energy, it is crucial for the Centre of Expertise to forge alliances with the key marine R&D sectors in Canada, the UK and the EU. FORCE has benefited from this strategy by joining efforts with the European Marine Energy Centre (EMEC) to create an alliance to coordinate and share research efforts. The main motivation for establishing international links is to source funding, but as shown by WET-NZ, such links can also help secure market access.

Given that New Zealand has a high proportion of small companies that lack resources, capital and market reach, establishing international relationships and distribution channels would be an important focus in the development of an Auckland cluster.

Testing facilities

Currently there are no publicly known testing facilities for tank scale devices in New Zealand. A testing facility would lower the entry barriers for new companies, both domestic and international, to develop their devices.

Developing industry standards

As a member of two important global networks—the IEA Ocean Energy Systems Implementing Agreement (IEA OES-IA) and the IEC Technical Committee 114 for marine energy: wave, tidal and other water current converters—New Zealand has an opportunity to be actively involved in the creation of standards. Currently Dr. John Huckerby, the executive officer of AWATEA, is the IEA OES-IA Chair. These international contacts must be integrated into the Centre of Expertise to ensure information flow because whatever happens in terms of the development of international standards will need to be communicated effectively to the local industry. Active participation in these organisations also offers the possibility of influencing the standards, so they are favourable to the local industry.

Siting and permitting sea tests

Projects looking to deploy devices in the water need to be able to calculate data regarding power output to estimate the price of power. Though NIWA hosts baseline data on wave heights and tidal currents, little additional information is currently available. Prior to full-scale commercialisation, additional data would be required, including information regarding optimal placement of power generation sites.

Dealing with a variety of stakeholders and applying for the necessary permits and consents for testing and power station sites can be a time consuming process. The government can aid this process through regulatory interventions—for example by reducing permit requirements. Marine energy centres such as Wave Hub, have a “blanket” consent that allows the leasing of a berth. Companies then need only submit information specific to their technology, rather than having to go through the entire consent process. When applying for a site in New Zealand, companies must apply for consent under the Resource Management Act 1992. Mechanisms to evaluate a marine project applicant’s suitability are yet to be developed.

What the marine industry needs is a structure to support domestic companies and at the same time attract international companies to locate marine energy R&D activities in New Zealand.

Figure 2

MARINE CENTRE OF EXPERTISE

Business Competence

Technological Competence

Testing facilities

New Zealand Marine Centre of Expertise

Develop industry standards

Help in siting and permitting

Find international partners

Concerned parties feedback

Project evaluation

Link to investors
Developing Regional Clusters

Wellington marine energy cluster

WELLINGTON LIES next to Cook Strait, an area which provides an excellent location for tidal energy testing. SKM Consulting has estimated that the tidal currents in Cook Strait have the potential to generate up to 1,000 MW of power. The two largest marine energy projects in New Zealand—those of WET-NZ and Neptune Power—have identified specific areas in Cook Strait as the best locations for their testing facilities.

One of the primary hurdles facing developers of renewable energy is a lack of access to transmission networks. This vital infrastructure is available in Wellington, making it a cost-efficient testing location for tidal/ocean turbine prototypes.

Furthermore, Wellington is home to key businesses networks, industry experts and supporting facilities essential to fast track R&D activities in the marine sector. AWATEA is located there and could assist marine projects by utilising its existing networks. WET-NZ, also in Wellington, could provide important know-how and business links to help secure funding with international partners.

Locating the Centre in Wellington would enable companies to monitor permit and consent applications and ensure a smooth flow of information to central government agencies. Crest Energy’s Kaipara Harbour project permits and consents took more than seven years to be approved. Neptune Power, on the other hand, was awarded a consent to undertake R&D activities by Greater Wellington Regional Council six months after submitting a consent application as they had undertaken a due diligence consultation processes with various industry representatives.

Auckland marine energy cluster

LOCATED ON a narrow isthmus, Auckland has ready access to sites with potential for tidal and wave technology, including the Kaipara Harbour. Auckland also has a deep skills base, especially in science and human resources, and the city is home to some of the country’s top universities. The University of Auckland’s commercialisation arm, UniServices, provides a valuable link to academia. UniServices is the largest organisation of its kind in the Southern Hemisphere and is involved in a variety of projects ranging from medicine and education to clean technology.

What Auckland, and New Zealand as a whole, lacks is infrastructure. The country has no facilities similar to Cornwall’s Wave Hub where companies can trial marine technology. Nonetheless, testing facilities could readily be built in Auckland. And The University of Auckland has an existing Yacht Research Unit with equipment and competence in computational fluid dynamics, which could be used for marine energy applications. Indeed, WET-NZ used wave tank facilities at the university to test its 1/100 scale turbine prototype.

To summarise, Auckland and Wellington both have technical, natural, business and infrastructure attributes, which make the development of a Marine Centre of Expertise feasible. Both cities are located close to marine energy sites that companies have already utilised, and both have access to human resources and expertise. While Auckland has the human capital needed to undertake R&D activities in
Marine energy is one of the world's largest untapped sources of renewable energy and is forecast to follow the same growth curve as wind energy.

New Zealand has the natural resources and technical capabilities needed to take a leading role in the industry.

Creating a Marine Centre of Expertise would support domestic marine energy pioneers, attract international R&D and potentially lay the foundations for an export industry.