# OFFSHORE WIND

**A NEW ENERGY OPPORTUNITY FOR TARANAKI**

**DISCUSSION PAPER**

TARANAKI like no other

Elemental Group

venture TARANAKI Te Puna Umanga

# FOREWORD

New Zealand is at a turning point when it comes to powering our nation's future. Targets of a transition to a low-emissions economy are gaining momentum and present us with opportunities to investigate and innovate when it comes to the renewable resources that New Zealand is blessed with.

New Zealand is already well advanced when it comes to harnessing hydro-electric generation, and geothermal generation, and has an established but still relatively small wind generation sector. But if we are to realise our low-emissions energy goals, and meet our future energy needs, we will need to look beyond current efforts.

As an island nation, we are increasingly turning our gaze beyond our expansive coastline. Wave energy is being explored in Taranaki, and could offer part of the solution. Using offshore wind generation could add to this and help create the renewable energy supply our growing economy will need.

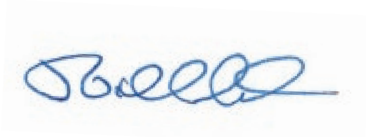
Offshore wind generation is a technology already in effect internationally but which hasn't been fully explored in a New Zealand context. That could be about to change.

As generations of Taranaki surfers, windsurfers and kiteboarders will attest, Taranaki's coastline offers a world-class wind resource. Couple this with the offshore geography of our region – particularly south Taranaki – plus our skills in offshore operations and we have a substantial low-emissions energy resource that has the potential to form a valuable component of our future energy equation.

This discussion paper lays the foundation to consider offshore wind, as part of our energy future.

As Taranaki's regional development and promotion agency, Venture Taranaki recognises the significant potential for offshore wind; economically, in the creation of high-value jobs, in the generation of renewable energy, and as an opportunity to help our region – and our nation – transition to the low-emissions economy of the future.

There will be wide-ranging responses to the idea of wind generation off our coastline, and many steps are required before any developments are progressed. This discussion paper has been prepared as the first of those steps and supports the Energy Pathway Action Plan for Taranaki 2050. I hope this paper will encourage valuable discussion on the potential opportunity for offshore wind.



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## UNITS

- kW, MW, GW and TW are progressively larger units of power being produced or used at a specific point in time. One MW is equivalent to the power produced by 10 100kW small car engines.
- kWh, MWh, GWh and TWh are progressively larger measures of the amount of energy produced or used continuously for an hour. For example a 2kW heater run for an hour will use 2 kWh of electricity.

## CAPACITY

- A wind farm with 100MW capacity will produce less than 100MWh as the wind resource is variable. New Zealand wind farms typically produce about 40% of their capacity.[1]

1 *www.windenergy.org.nz*

## NEW ZEALAND NEEDS MORE CLEAN ELECTRICITY

To help address projected significant demand for energy, while addressing greenhouse gas emissions, we will need to develop more low-emissions electricity generation.

In 2018, Transpower forecast that electricity demand will grow from 43 TWh/yr to 88 TWh/yr by 2050[2]. This is driven by assumptions that over the next 30 years the energy system will become more efficient while at the same time the transport fleet, as well as some industrial process heat, will be electrified.

Some of the required supply of additional low emissions electricity is expected to be met using new generation sources of the existing large-scale methods such as hydro, geothermal and onshore wind. However, there is opportunity for new methods of low-emissions electricity generation to be utilised at scale in New Zealand provided they stack up well against the alternatives on economic, social and environmental grounds. There is expected to be continued increase in solar while the potential of wave energy is already being explored in Taranaki. Another form of electricity generation used internationally that may be considered in New Zealand is offshore wind.

The first offshore wind turbines were installed in Denmark in 1991. More than 18 GW of offshore wind turbines are now operating internationally, mostly in the seas surrounding northern Europe. The largest operating offshore wind farm is the 659 MW Walney Extension in the UK although larger projects are under development. China has set big growth targets for offshore wind and developments are being explored in south-east Asia and Australia.

New Zealand has had commercial onshore wind farms since the installation of the Hau Nui wind farm near Martinborough in 1996. Since then, 17 onshore windfarms have been developed with a capacity of 690 MW (around 6% of New Zealand's generation capacity). New onshore wind farms are being developed including the 133MW Waipipi farm at Waverley in South Taranaki (with 31 4.3MW turbines). Several other onshore sites are consented[3]. However, some proposed onshore wind developments in New Zealand have been challenged because of their landscape effects. Similarly, it has become increasingly difficult for further hydro schemes to gain consent.

There is now increasing recognition by a wide range of parties of the potential for offshore wind energy in New Zealand:

- The Interim Climate Change Committee (ICCC) noted in a recent report[4] that accelerated electrification is needed to reduce New Zealand's greenhouse gas emissions. Their report noted that there is potential for other technologies to show rapid cost reductions and enter the generation mix – the example they gave was offshore wind.
- The ICCC referenced a study on offshore wind in South Taranaki waters, completed out of the University of Canterbury[5]; which suggested the area had considerable potential.
- In May 2019 the Prime Minister noted, when announcing funding for the National New Energy Development Centre, that *"The Centre will look at the full range of emerging clean energy options such as offshore wind, solar batteries, hydrogen and new forms of energy storage"*[6].
- In September 2019, Greenpeace publicly supported exploration of offshore wind in Taranaki waters[7].

### HOW DOES OFFSHORE WIND ENERGY WORK?

Onshore and offshore wind turbines both generate electricity in exactly the same way. Wind turns the blades of the turbine, which in turn spins a generator and creates electricity.

The design and size of the blades is a key factor in how much electricity is generated. Offshore turbines are generally larger than onshore turbines. The relatively high cost of installation and maintenance for offshore wind projects encourages larger turbines. While the greater distance between offshore developments and where people are living also provides opportunity for larger turbines.

The consistency of the wind in the right range of wind speeds is another important factor favouring offshore wind. There needs to be sufficient wind but not too much wind for turbines to work efficiently. Offshore sites often have more consistent wind resources than onshore sites meaning more of their potential generation capacity can be harnessed.

Most offshore wind turbine foundations are driven directly into the seafloor and can be installed in waters up to 50m depth. Floating turbines have recently been developed which are tethered by chains to the seafloor. These floating turbines can operate in much deeper water.

Specialised vessels and offshore support services are required for installing and maintaining offshore wind turbines.

Both onshore and offshore wind turbines are normally organised as wind farms involving multiple turbines connected to common infrastructure for transmission.



2 *Te Mauri Hiko – Energy Futures, Transpower June 2018*

3 *The New Zealand Wind Energy Association website lists 10 consented wind farms where development has not yet begun. Total capacity of these sites is around 2 GW*

4 *Interim Climate Change Committee (2019). Accelerated Electrification. Available from www.iccc.mfe.govt.nz.*

5 *Ishwar C.A., Jan 2019, Assessment of the Potential for Offshore Wind in New Zealand. University of Canterbury and also Ishwar C.A. and I.G. Mason, Offshore Wind for New Zealand, EEA Conference Paper 2019.*

6 *Government invests in clean energy centre to help power New Zealand's economy, 9 May 2019, Retrieved from www.beehive.govt.nz/release/government-invests-clean-energy-centre-help-power-new-zealand%E2%80%99s-economy*

7 *www.stuff.co.nz/taranaki-daily-news/opinion/115915475/offshore-wind-could-play-a-role-in-taranakis-just-transition*

The photo on this page shows part of a wind farm off the coast of the Netherlands.

The electricity from offshore wind farms is transmitted via undersea cables back to shore. Most offshore wind farms operating internationally are within 40 km of the coast. This minimises transmission losses from the high voltage alternating current cables normally used. One North Sea wind farm is 100 km offshore and utilises a high voltage direct current cable (like New Zealand's inter-island link) which is more efficient over longer distances.

Once onshore the electricity is then usually connected to the country's transmission infrastructure in exactly the same way as onshore electricity generation. It is also possible for the electricity generated to be supplied directly to a specific end-user, such as a large-scale industrial plant, bypassing a grid connection.

## THE TARANAKI OPPORTUNITY

The waters off Taranaki are a promising area for generating electricity from offshore wind.

The recent study completed via the University of Canterbury investigated the potential for offshore wind in New Zealand with a focus on the waters off South Taranaki and concluded that *"offshore South Taranaki has an exceptional wind resource and has sufficient suitable area from a bathymetric (water depth) perspective"* (see Figure 1).

Offshore Taranaki has a significant area of water of less than 50m depth along with a relatively flat sea floor suitable for fixed turbines. Floating wind turbines can be deployed in deeper water[8] and there is also potential for these to be deployed in Taranaki waters.

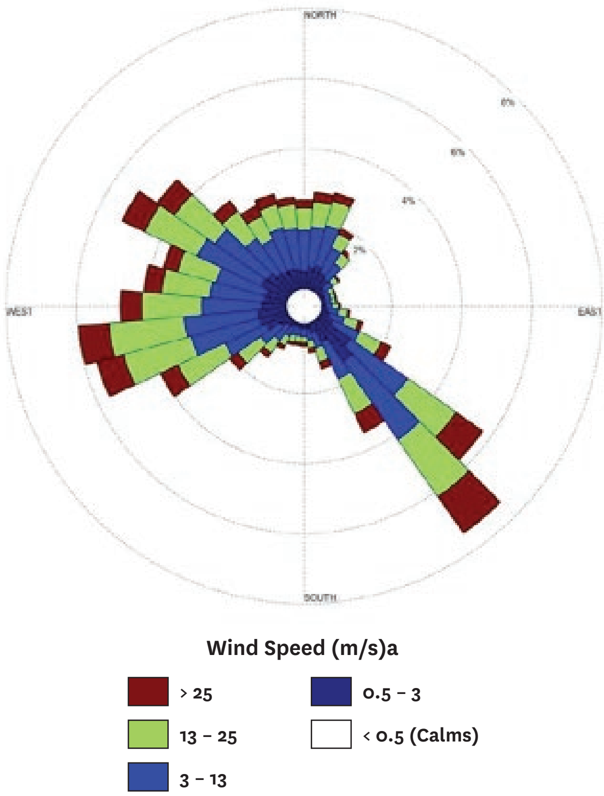
### FIGURE 1: OFFSHORE TARANAKI'S BROAD AND RELATIVELY SHALLOW SHELF (THE 50M CONTOUR IS HIGHLIGHTED IN RED)[9]


The prevailing winds in offshore Taranaki tend to be westerlies from the Tasman Sea complemented by southeasterlies through Cook Strait (see Figure 2). The average wind speeds for South Taranaki and North Taranaki waters are estimated to be 10.1 m/s (36 km/h) and 8.5 m/s (31 km/h) respectively, both being commercially viable values for offshore wind development.

Two matters that will need investigating for any proposals in Taranaki waters will be:

- The engineering issues associated with fixing turbine foundations into the volcanic rock of the sea floor
- The impact of strong swells on foundations and on support vessels during construction and maintenance.

### FIGURE 2: WIND ROSE FOR SOUTH TARANAKI, COMPILED USING DATA FROM THE MAUI PLATFORM.[10]




As well as describing the challenges and opportunities of offshore wind, two indicative development scenarios were explored by Elemental Group when preparing this paper – potential offshore wind farms of 200 and 800 MW installed wind turbine capacity[11]. The scenarios assumed individual turbines of 7-8 MW – though larger turbines are being developed and will likely be available in the development horizon for Taranaki offshore wind.

The 200 and 800 MW scenarios would occupy 30 $km^2$ and 120 $km^2$ respectively. These two scenarios were explored in both South and North Taranaki waters.

Figure 3 shows the area of Taranaki waters that initial investigations suggest have potential for offshore wind development. The areas in green are shallower waters (<50m) that have potential for installing fixed foundation wind turbines while the area in yellow are deeper waters (100-150m) that have potential for installing floating wind turbines. These technologies are discussed further below.

Figure 3 also shows the indicative relative size of wind farms of 200 MW (in orange) and 800MW (in blue) that are possible using the most widely deployed fixed foundation turbine technology.



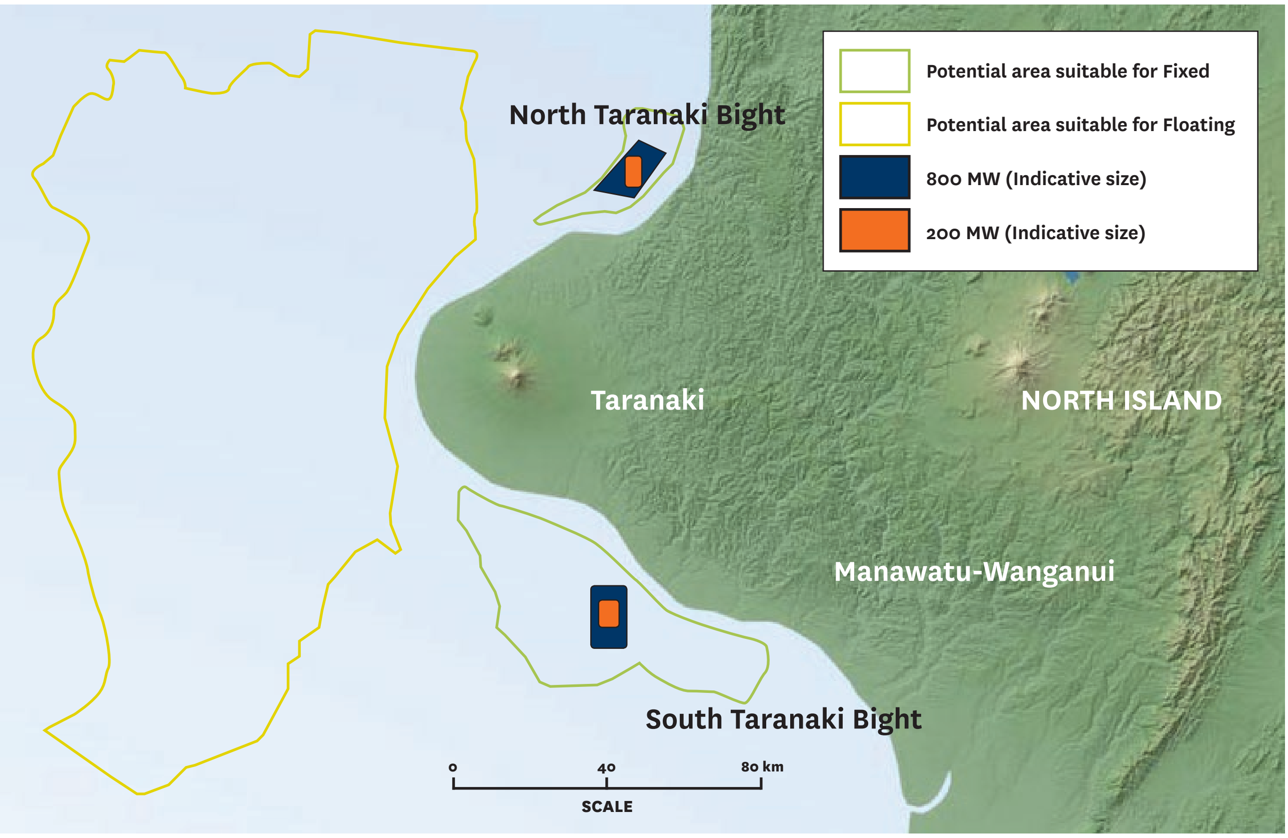
8 *See the section below on "Technology implementation" for more detail on the different types of turbine platforms.*

9 *From New Zealand Regional Bathymetry, NIWA (2016)*

10 *Data provided by Shell Todd Oil Services, former operators of the Maui platform*

11 *A 200 MW windfarm is indicative of a minimum viable size which could likely be developed and connected directly to the New Zealand electricity grid. A 800MW windfarm is indicative of what could be developed in association with a large-scale industrial customer e.g. a green hydrogen production plant.*

**FIGURE 3: AREAS WITH OFFSHORE WIND POTENTIAL IN TARANAKI WATERS FOR BOTH FIXED AND FLOATING TURBINES. ALSO SHOWN IS THE INDICATIVE SIZE OF 200 MW AND 800 MW WIND FARMS IN OFFSHORE NORTH AND SOUTH TARANAKI.**






Initial analysis suggests the areas potentially suitable for offshore wind utilising fixed turbines in South and North Taranaki waters are 1,800 km² and 370 km² respectively (the areas in green in Figure 3). If fully developed these areas could deliver 12 GW and 2.4 GW respectively, and would double New Zealand's current electricity supply.

If floating wind turbines are to be considered then another 14,000 km² of suitable area developed could deliver an additional 90 GW into the New Zealand grid. This is considerably greater than the energy supply that New Zealand is likely to need in 2050. Such large-scale development could create opportunity for significant energy exports (e.g. in the form of green hydrogen produced by using renewable electricity to electrolyse or split water) while also reducing global emissions.

The total potential offshore wind resource in Taranaki waters is considerably larger than the energy currently extracted on an annual basis from Taranaki's existing oil and gas fields. It is an energy resource that has the potential to be globally significant.

In the long-term, there is an opportunity to grow offshore wind as a renewable energy resource that could provide large quantities of clean energy while using many of the complementary skills and resources that service the existing energy sector in Taranaki.

Just as the development of New Zealand's offshore petroleum industry has been partly reliant on infrastructure such as drilling rigs and specialised support vessels sourced from other countries, the specialised logistics of any offshore wind development in New Zealand will require international resources.

Most of these resources are currently located in Europe. Offshore wind developments occurring in China, South-East Asia and potentially Australia will bring these resources into the Asia-Pacific region and improve the economics of offshore wind developments in New Zealand.

If large scale developments occur in New Zealand there is potential to create a largely self-sufficient local offshore wind industry.

## THE STAR OF THE SOUTH

An Australian company is planning the country's first offshore wind farm. The "Star of the South" wind farm is planned to have a capacity of up to 2000 MW from 250 turbines. It will be located 10-25 km offshore from Gippsland in Eastern Victoria[12]. The project has recently been given an exploration permit by the Australian Government to explore the seabed in the proposed area. It is being developed by Australian parties including Melbourne's Offshore Energy Pty Ltd partnered internationally with Copenhagen Infrastructure Partners and Copenhagen Offshore Partners. The multi-billion dollar project is planned to use existing transmission infrastructure which previously supported a (now defunct) coal-fired power plant. As this project progresses, it will be helpful for New Zealand to draw from any knowledge and expertise relating to the development of a new supply chain and related logistics in Australasia.

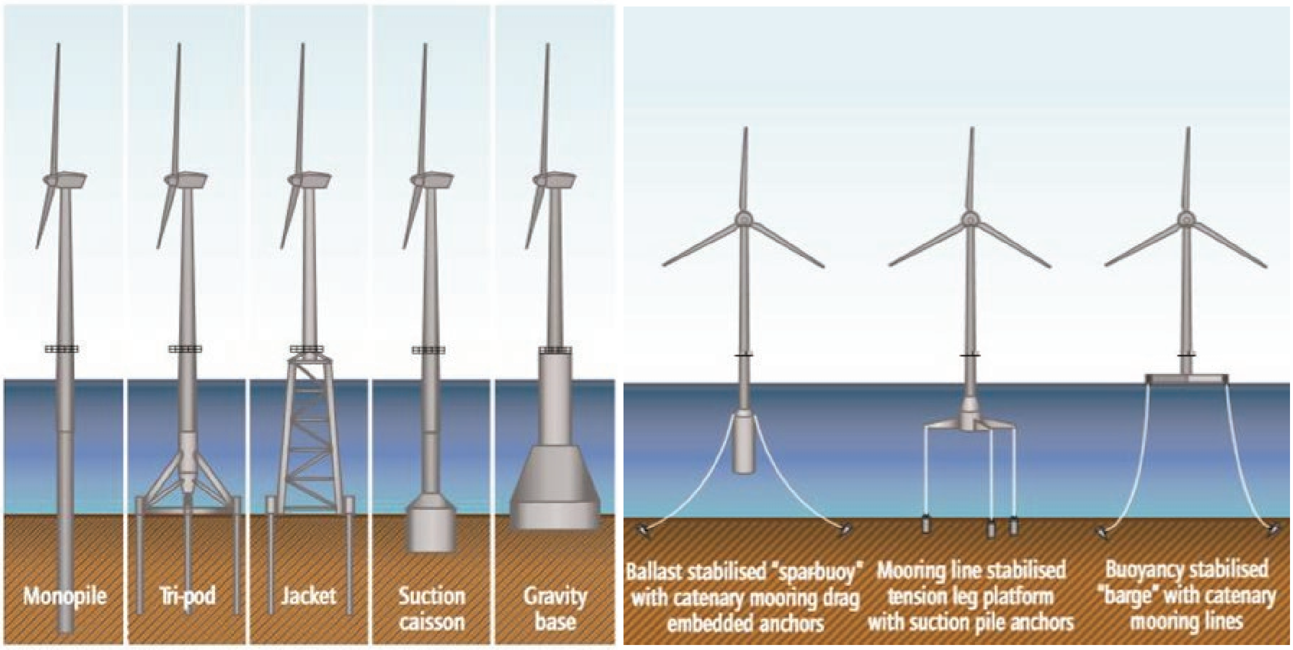
**FIGURE 4: PLANNED OFFSHORE WIND FARM IN SOUTH AUSTRALIA (STAR OF THE SOUTH)**
**www.starofthesouth.com.au**


## TECHNOLOGY IMPLEMENTATION

In shallow waters of less than 50m wind turbines are placed on foundations driven into or placed on the seabed. There are various types of foundations used though monopiles are the most widely used. For deeper water, commercial projects are now in operation using floating wind turbines[13] which are tethered by chain to anchors on the seabed (see Figure 5 for examples). The suitability of these technologies in Taranaki conditions will need careful assessment before any development occurs.



**FIGURE 5: VARIOUS TYPES OF OFFSHORE WIND TURBINE FOUNDATIONS; FIXED (LEFT), FLOATING (RIGHT)[14]**




12 *Star of the South, (2019, March 29), Fact Sheets. Retrieved from www.starofthesouth.com.au/assets/pdf/sots-fact-sheet_overview_290319.pdf*
13 *www.equinor.com/en/what-we-do/hywind-where-the-wind-takes-us.html*
14 *International Energy Agency Technology Roadmap – Wind Energy 2013*

Wind turbines used for offshore applications are generally larger than onshore and are up to around 150m in diameter with a top blade tip height of around 180m (the height of the central hub around which the blades rotate is over 100m).

It is expected that over the next decade typical commercial offshore turbines being installed internationally will produce more than 8 MW each (roughly enough to each power 5,000 households). Turbines of up to 12MW capacity are being developed.

Offshore wind turbines feed electricity into subsea power cables. Cables are then gathered at an offshore substation before power is exported via a subsea transmission line to the onshore transmission grid.

As with any onshore generation development, the capacity of the national electricity grid at the connection location is an important consideration. Transpower has advised that a 200MW offshore wind development in Taranaki waters may be able to fully export to the current grid while a large 800MW (or greater) offshore development would require either a grid upgrade or a dedicated connection to a regional industrial plant.

Transpower see nothing unusual about offshore wind. Connecting large generation facilities is business as usual for them.

## INFRASTRUCTURE AND SUPPLY CHAIN

Existing infrastructure at Port Taranaki should be suitable for importing and loading the monopile foundations, cabling, towers and blades required for developing a fixed foundation wind project. Maintenance could also be provided from Port Taranaki and New Plymouth Airport in a similar way to current oil and gas operations.

## BALANCING OF ELECTRICITY SUPPLY

Wind turbines do not constantly generate power throughout the day, season or year, with generation dictated by how much the wind blows at a particular time. This leads to daily and seasonal variation in energy output, so other forms of electricity generation need to be matched with wind generation to provide balancing for periods of low wind. In New Zealand this balancing is typically provided by hydro and fast start gas powered peaker generation. This requirement for matching is the same for both onshore and offshore wind, however offshore wind tends to have higher capacity factors and could deliver energy at times when nearby onshore wind farms cannot.

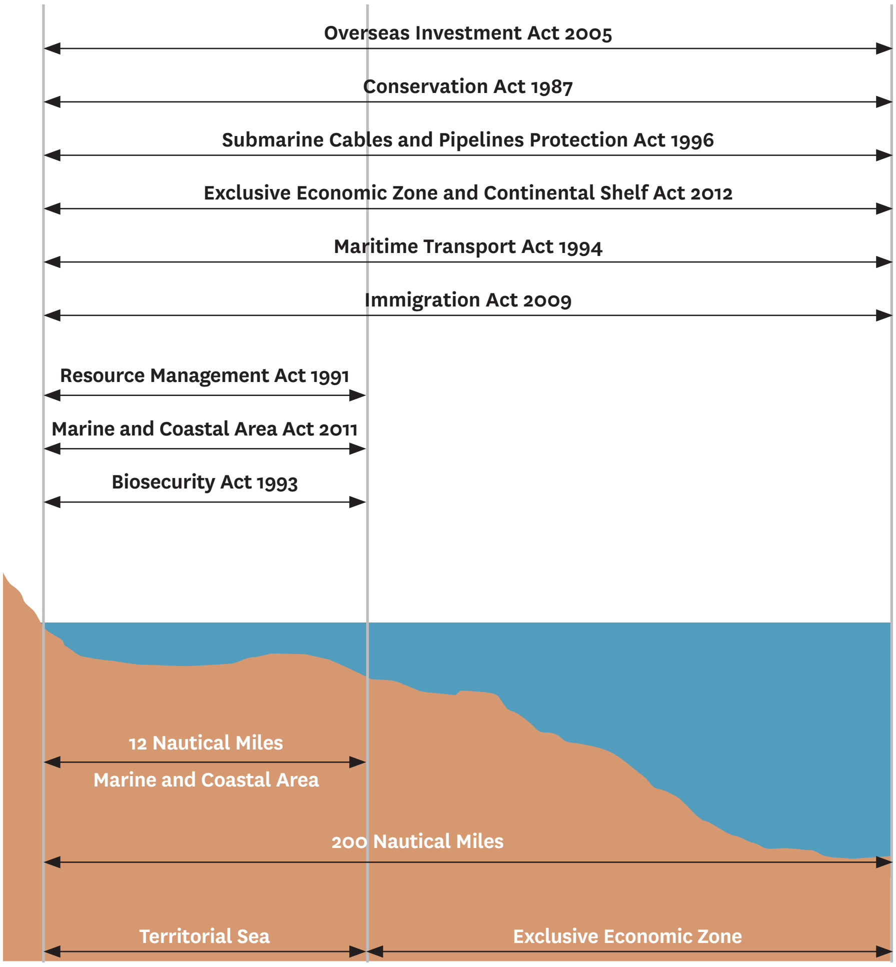
## REGULATORY MATTERS

In a New Zealand context, any offshore development will be framed by several pieces of legislation (see Figure 6) including the Resource Management Act, Marine and Coastal Area Act and Exclusive Economic Zone Act, and associated regulations, and their corresponding interrelationships with the Treaty of Waitangi. It is noted that much of New Zealand's waters out to 12 nautical miles (including Taranaki waters) are subject to claims of Customary Marine Title under the Marine and Coastal Area Act[15].

The Crown Minerals Act which regulates offshore petroleum activities will also have implications for any offshore wind development in Taranaki waters.

15 *tearawhiti.govt.nz/te-kahui-takutai-moana-marine-and-coastal-area/applications-made-under-the-marine-and-coastal-area-act/*

**FIGURE 6: RELEVANT LEGISLATION FOR THE DEVELOPMENT OF OFFSHORE WIND IN NEW ZEALAND[16].**




While none of these Acts provide specific barriers to offshore wind development in New Zealand, there will be many matters to address before any project occurs.

The typical onshore challenges of access for roading to sites plus rights of ways for cabling etc over private or public lands are different for offshore projects though there are still onshore consenting and access issues related to the transmission connection to the electricity grid. As no offshore wind projects have yet sought consent, the difficulty of gaining approval is as yet unknown.

## IMPACTS ON THE OIL AND GAS INDUSTRY

The impacts on the existing oil and gas industry which is currently operating in offshore Taranaki will need to be assessed, along with implications for parties which own mining and exploration rights.

Offshore wind developments would also provide opportunity to leverage the skills and resources of the oil and gas industry.

## IMPACTS ON SHIPPING AND BOATING

Commercial shipping routes will need to be considered in the layout of any offshore wind farm. Large scale commercial fishing (e.g. trawling) may be affected by wind farms. However, small scale fishing may benefit as foundations provide attractive habitats for some fish species. Recreational boating may have some limits placed on it (e.g. “no anchoring” zones).

## ENVIRONMENTAL IMPACT

It is important that any offshore wind development in New Zealand mitigates, reduces, or avoids potential environmental impacts. The potential impacts on whales, dolphins, fish, seabirds, and other marine life will need to be assessed. These would predominantly come from the noise during initial survey work and when piles are being driven, and by increased vessel movements during construction.

16 *Adapted from: Taranaki Regional Council. Draft Coastal Plan for Taranaki, Aug 2016. Retrieved from www.trc.govt.nz/assets/Documents/Plans-policies/CoastalPlan/Draft-Coastal-Plan-for-Taranaki-Main-body.pdf*

There are several methods of constructing offshore wind farms that minimise the construction noise. These include noise pile sleeves, bubble curtains, and construction timing strategies that may reduce any impacts on seasonal species. Once operational offshore wind farms tend to have little impact though this will need careful assessment.

Some of the waters noted in this report as having potential for offshore wind are included in the West Coast North Island Marine Mammal Sanctuary. The Sanctuary represents a zone in which there is protection from fishing, seabed mining, and acoustic seismic surveys[17]. However, these restrictions do not include offshore wind farms. The Sanctuary currently extends 22 kms (12 nautical miles) off the coast and extends from Oakura northwards to Maunganui Bluff in Northland[18]. The Government is currently considering extending the Marine Mammal Sanctuary southward to Wellington[19].

Any offshore wind development would also need to consider impacts on the community and stakeholders including visual impacts, impacts on the recreational use of the areas involved, impacts on commercial shipping and impacts on the existing oil and gas industry.

Some of the drawbacks of onshore wind are reduced for offshore wind operations. For example, while offshore wind uses larger turbines, their distance from shore means noise dissipates before reaching impacted parties. For the same reason, the visual impacts of offshore wind tend to be less than for onshore, although this is not universally the case since nearby population density and distance from shore affects this for each individual project. In addition, while the footprint of the mapped area for offshore wind can appear large, the area of seabed that is directly affected is only 50 $m^2$ per turbine (roughly 0.01% of the wind farm area).

## ECONOMIC ANALYSIS

Internationally, electricity generation prices from offshore wind are now competitive with fossil fuel generation, and costs are continuing to decrease quickly[20]. There is considerable growth in international offshore wind electricity generation, particularly in Europe, with China setting big growth targets, and the USA also expected to increase offshore wind supply. Early developments are also taking place in South East Asia and Australia.

Continuing improvements in offshore wind technologies suggest that the cost of supply from any offshore Taranaki wind development may be competitive with other generation sources in the near future. The improving economies and learning curves currently being experienced in Europe may be translatable to New Zealand through the Asia-Pacific regional expansion in offshore wind.

The 133MW Waipipi Wind Farm currently under development onshore at Waverley is a $277m project. This gives an indication of both the significant investment required to develop wind farms in Taranaki and the ongoing economic impact of such projects.

## ENERGY USE

The power from an offshore wind development in Taranaki could be exported into the national grid to meet growing New Zealand demand. The electricity could also be used in Taranaki-based industrial facilities e.g. to make green hydrogen[21] for transport fuels, energy storage, or as feedstock for green petrochemicals such as urea and methanol.



*17 www.doc.govt.nz/globalassets/documents/conservation/native-animals/marine-mammals/mauis/wcni-marine-mammal-sanctuary-users-guide.pdf*
*18 www.doc.govt.nz/nature/habitats/marine/other-marine-protection/west-coast-north-island/*
*19 www.doc.govt.nz/dolphintmp*
*20 Latest auctions for new generation in the UK showed a 30% reduction in generation cost from 2017 to 2019. The cheapest operator has proposed to provide electricity for less than £40 per megawatt hour. www.gov.uk/government/news/clean-energy-to-power-over-seven-million-homes-by-2025-at-record-low-prices*
*21 By electrolysing water*

# SUMMARY

Taranaki has the offshore skills, bathymetry and wind resource that means offshore wind energy is an exciting opportunity, albeit one that will require community buy-in, thorough environmental risk analysis, significant focus on local cost reduction, and adoption of international expertise for commercial development for both domestic use and potential export. Offshore wind could play a significant role in maintaining Taranaki as a leading energy hub.

This paper was prepared by Elemental Group and Venture Taranaki.

*Report prepared in association with:*

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