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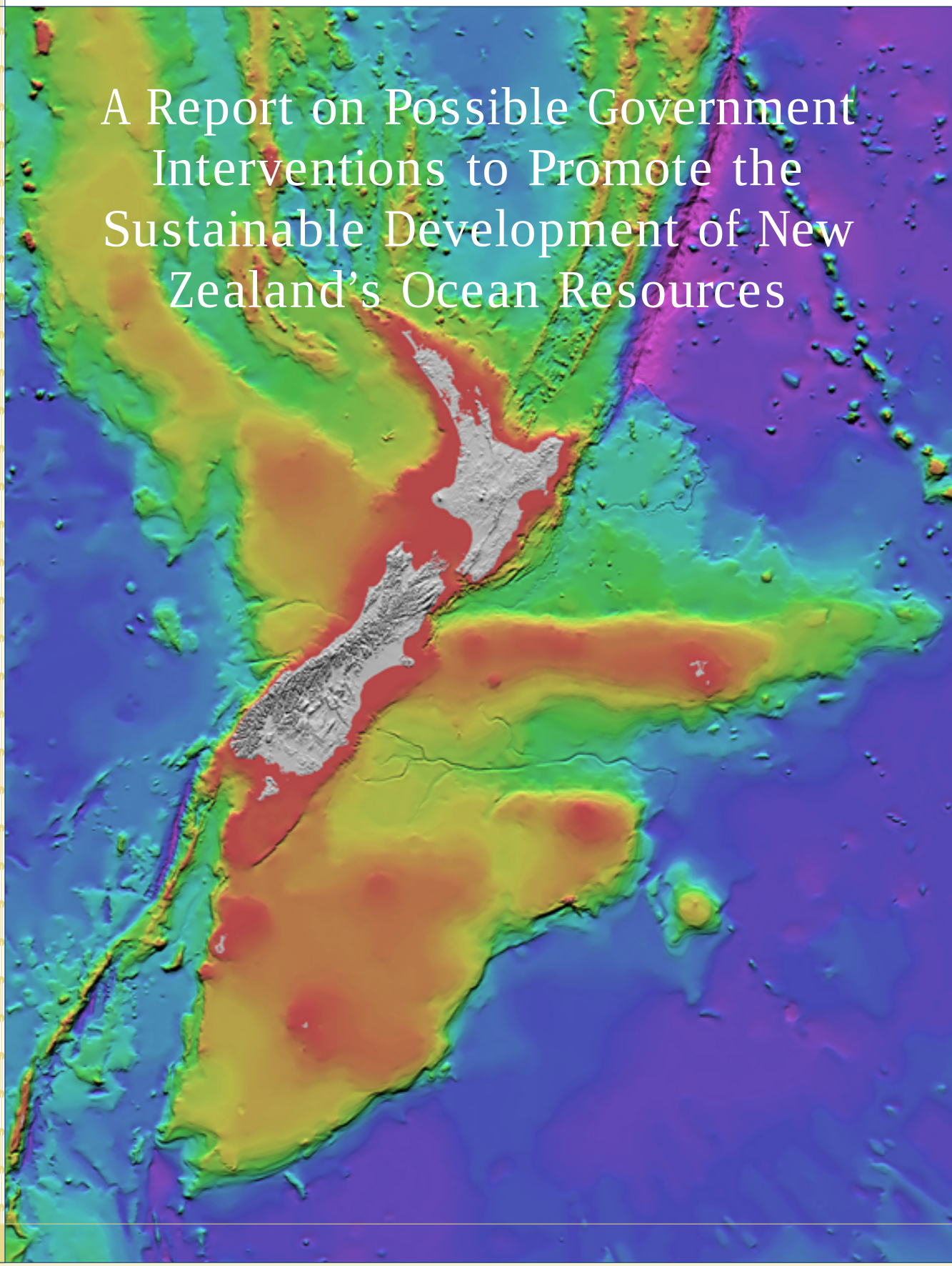
A Report on Possible Government Interventions to Promote the Sustainable Development of New Zealand's Ocean Resources



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A Report on Possible Government Interventions to Promote the Sustainable Development of New Zealand's Ocean Resources

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This report presents the views of CAE and selected representatives of marine industries. The recommendations have been generated independent of government to stimulate future discussion around marine economic opportunities. Some recommendations in the report relate specifically to identified barriers and opportunities facing certain marine industries.

CAE acknowledges that other recommendations in the report involving direct financial support, such as subsidies or tax reduction, would be welcomed by any industry. We comment that a strong case, such as demonstrated market failure, would need to be made before the government would consider their application to particular marine industries.

CAE is an independent-think tank and research facilitator funded by grants and sponsorships. CAE's mission is to advance social progress and economic growth for New Zealand through broadening national understanding of emerging technologies and facilitating early adoption of advanced technology solutions.

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DEFINITIONS

Commercial Development

Establishment of a new economic activity as a consequence of a viable business case.

Economic Development

Aggregate of commercial developments in a sector, region or the nation.

Frontier Territories

Oceans are Frontier Territories, where sovereignty has been established but only limited commercial and economic development has occurred and substantial untapped opportunities are perceived.

EXECUTIVE SUMMARY

Development of Oceans Policy to date has established that a substantial number of opportunities exist for possible commercial development, including expansion of existing industries and the development of whole new sectors of the New Zealand economy. CAE has contributed to that recognition, in particular through its "Our Oceans" Conference in 1999[1] and subsequent programmes of work directed at gaining better recognition of the economic importance to New Zealand of its Exclusive Economic Zone (EEZ) and continental shelf extensions.

In advancing the development of an Oceans Policy, the Ministry for the Environment has identified a desire to better understand the factors that lead to or impede commercial development, especially of new sectors, and has commissioned this investigation of the subject, with a view to informing the design of suitable interventions that could catalyse such sustainable development. Our basis is that Oceans Policy is intended to promote the sustainable economic development of marine resources, whilst preserving the integrity of oceans ecosystems and social and cultural values of the oceans

Clearly an analysis of the broad spectrum of oceans opportunities would almost be without limit. Therefore to gain a practical understanding of the issues, barriers and opportunities facing development of economic activities in the ocean this investigation considered only a selection of cases, all pertaining to the energy sector, and representing a temporal spectrum from historic (the discovery and development of the Maui gas and oil field) through contemporary (current oil and gas exploration and development) and near-term (wave and tidal electricity generation) to far-term (gas hydrate mining and conversion). These cases, in turn, spanned the full range of anticipated activities from fully commercial to future-focussed potential activity.

At various times in our history, the shape of the New Zealand economy has been impacted by bold government interventions at key junctures, for better or worse. One such instance was part of an aggressive response to the energy crises of the 1970's, which happened to coincide broadly with the discovery in 1969 and subsequent appraisal of the giant Maui gas field off the Taranaki coast by the Shell BP and Todd consortium. The exploration campaign that resulted in Maui was itself a response to two precursor conditions: the progressive international development and deployment of marine exploration and development technologies, and the passage of the Continental Shelf Act 1964 that provided for the application of the Petroleum Act 1937 beyond the narrow territorial sea and out to 200 nautical miles from shore (the Exclusive Economic Zone).

While these "settings" were sufficient to enable development of the resource that has done much to fuel New Zealand's economic activity over the past quarter century, during the early 1970's the business case for the field's development was marginal at best without the bold, direct involvement of the New Zealand government. The intervention took the form of a direct (50%) equity interest in the joint venture, in consideration for guaranteed project revenues through a take-or-pay contract. This commitment by government, in turn provided the impetus for development of the vast majority of the infrastructure needed for consumption – power stations, the pipeline grid and associated networks, and a petrochemical industry. Initially much of this was in public hands but eventually these enterprises were all corporatised and mainly privatised but collectively have accounted, both directly and indirectly, for a substantial proportion of national economic product over the intervening period; with particular regional importance in Taranaki.

As a consequence, offshore oil and gas exploration since Maui was brought on-stream in 1979 has not required government involvement; the former state oil company (Petrocorp) being privatised in 1987. A number of commer-

1 *Our Oceans - A Journey of Understanding*, CAE Comments Series No. 1, 2001

cial discoveries have been made offshore Taranaki, and some sub-commercial discoveries in offshore South Island basins. In recent years it has become evident that the rate of discovery and delineation of gas reserves in New Zealand has not kept pace with production, and with the pending depletion of the Maui field squeezing the reliability of future thermal fuel requirements for the national power system, government has decided to make some relatively modest interventions to stimulate exploration. The exploration sector remains at a critical juncture as rapid escalation in global oil and gas prices have impacted on activity levels and put pressure on the availability of core capability such as seismic vessels and drilling rigs. Policy settings are under constant review to ensure as far as possible that New Zealand's undiscovered conventional petroleum resources yield the desired discoveries to sustain and if possible extend fuel stocks and their contribution to our energy system.

As global oil and gas prices have reset the economics of energy technologies, and climate change policies have tended to promote renewable electricity generation in particular, marine renewable energy sources have begun to move closer to commercial viability. New Zealand has substantial potential opportunities for both wave and tidal power generation and currently up to 12 projects are under investigation. These all draw on the implementation of technology that has been developed overseas and adapted for specific New Zealand sites. In some respects this is analogous to most of the considerable wind power development New Zealand has seen in the past few years.

Setting aside the not inconsiderable technical risk factors that dominate investment in this industry our investigation has found that proponents of wave and tidal projects, while enjoying a high level of "moral support" from government policy including access to R&D funding, see themselves as being quite seriously impeded by issues generally lumped together as related to the Resource Management Act. Perhaps, more accurately, this reflects insufficient clarity as to property rights and market dynamics. It is obvious, however, that under current settings it is near impossible for a project sponsor to constrain the expense and delays that may be attendant on an initiative to secure the right to install a marine power station and offer its production into the electricity market.

The wave and tidal energy case illustrates the very best and the very worse of entrepreneurial or pioneer development. Technical risks are generally high and the often nebulous policy support for renewable energy (for example) is not sufficient to facilitate consequent development. Support to these types of activities must be supplemented by detailed attention to uncertainties in the business cases, which are related to completion and to revenue risk during early stage development.

Another potential energy source, yet to be proven viable, that research has been shown to be an important aspect of New Zealand's marine realm, is gas hydrate. The most optimistic timeline for commercial exploitation of gas hydrate is at least one decade away. While current research, at a modest but material level, is improving the inventory and characterisation of the resources offshore New Zealand, there appears to be a complete gap in research addressing the technology for sustainable exploitation of the resource, for which New Zealand is generally considered likely to be dependent on overseas innovation. There is no sign of commercial interest in gas hydrate commercialisation, and while such development would appear to be governed by the Crown Minerals Act 1991 it is not certain that this statute will indeed provide the optimal development regime. Also, investment will be discouraged by the very high risk levels in the absence of any fiscal incentives.

In summary, these three cases demonstrate that to be effective, interventions will have to be carefully tailored to meet the particular impediments or circumstance that face the various opportunities for commercial development in the ocean. Extending this finding to Ocean's development as a whole suggests that two key points are paramount:

Technological innovation is essential but a small economy can only expect to maintain a cutting edge position in very few fields and otherwise, the contribution of resources such as gas hydrate will have to await the availability of technology from overseas sources; as the

discovery of the Maui Field followed international technological advances in the 1960's.

An effective statutory and regulatory framework is essential for new sectors to develop in a desirable and orderly fashion. While resources such as petroleum and fish are governed by specific regimes, it is not apparent that these regimes can be extended universally into other marine-based industries. In the absence of such a framework, history tells us that the Resource Management Act proved an insufficient and unsatisfactory de facto regulatory framework for aquaculture, resulting in a moratorium that curtailed the realisation of the industry's growth potential. With the emergent marine energy sector reliance on current planning and consenting frameworks appears to be similarly compromising renewable energy initiatives.

Finally, where opportunities and technology exist, investment may still not be forthcoming when major risk factors cannot be offset. In such cases government may consider specific interventions even though these may distort market functionality. The interventions in the energy sector during the 1970's, while imperfect, have nevertheless delivered a key point of competitiveness to the New Zealand economy that would be desirable to sustain. Recent modest initiatives to facilitate gas exploration go some way, and other instruments should be considered, both to extend existing marine industries and to catalyse the development of others such as wave and tidal power and, eventually if proven technologically viable, gas hydrate.

1 BACKGROUND

1.1 Introduction

The Ministry for the Environment (MFE) is leading the whole-of-government development of an Oceans Policy that will enable the integrated and consistent management of the Ocean Territory within New Zealand's jurisdiction.

New Zealand's Ocean Territory encompasses close to 6 million square kilometres (or 15 times its terrestrial landmass), representing approximately 1% of the Earth's surface. However, only a very small part of it has been surveyed to date and early indications suggest vast and potentially valuable resource opportunities, including, for example:

- Hydrocarbon deposits worth approximately NZ$100 billion and Manganese deposits worth approximately NZ$200 billion[2];
- Phosphoric deposits (for use in agriculture) on the Chatham Rise worth approximately NZ$10 billion[3];
- The largest Methane Hydrate deposits in the South Pacific[4].

However, New Zealand's ability to realise the economic potential of these resources is limited by a number of factors, including the 'frontier' nature of the proposed activities and consequently high investment requirements, access to and availability of cost effective 'enabling' technology, appropriate legislative, regulatory and policy frameworks, and access to markets and margins that would justify commercial development.

MfE has sought to gain a better understanding of these factors by commissioning an investigation into barriers to the commercial development of 3 economic opportunity cases in order to ensure that the new national Oceans Policy framework will have the ability to support the sustainable development of such opportunities.

1.2 Purpose and Scope of Consultancy

The purpose of the project was for CAE, by consulting with a range of marine sector representatives, to bring a business-focussed perspective of the potential barriers to the commercial development of maritime opportunities, and to provide practical examples of corresponding strategies or interventions to overcome them.

The scope of the project was limited to consultation interviews with approximately 15 respondents to highlight and illustrate through case studies, the key ingredients for development of commercial activities through study of three specific maritime opportunity cases at different stages of commercial maturity. Consequently, this Report is not intended as an exhaustive solution to the challenges of formulating appropriate policies for each of the resource opportunities highlighted or provide conclusions that are applicable across the entire marine sector but, instead attempts to offer an assessment of the range of interventions that can assist with development of commercial activities.

[2] Dominion Post; 13/10/99: p11

[3] Economic Opportunities in New Zealand's Oceans; Centre for Adanced Engineering for Oceans Policy Secretariat: p6

[4] Economic Opportunities in New Zealand's Oceans; p5

2 APPROACH

2.1 Case Studies

CAE's previous work on Oceans Policy (2003) has identified a substantial number of areas with potential for commercial development in addition to those sectors that already contribute economic activity and have varying degrees of growth potential. The scope of the present project is limited to three case studies and one existing sector as a basis for comparison. We selected the Maui gas and oil field as the established case, and have chosen three cases, all concerned with energy resources, that lie on a spectrum from active through advanced pre-commercial to long-term commercial but research-dependent.

2.2 Consultation

Consultation with industry was undertaken in 3 phases:

a. Phase 1 consisted of wide ranging unstructured interviews with 5 general sector representatives who have policy, regulation, scientific and commercial roles in the maritime space;

b. Phase 2 consisted of in-depth structured interviews with a minimum of 3 respondents for each specific resource opportunity (9 respondents total);

c. Phase 3 consisted of a ½ day Workshop, involving MfE, MED, the CAE Project Team and the earlier respondents, to review and validate the issues raised in the consultation process.

2.3 Analytical Framework

Each of the 3 case studies were examined in terms of the impact of a range of critical ingredients (e.g. infrastructure, investment, technology, policy, etc) that would support the evolution of a particular sector from an 'embryonic' or emergent stage towards 'critical mass', at which point they would be expected to sustain material contributions to the national economy.

For each of the case studies, we attempted to identify and benchmark the gaps that exist between "embryonic" or "pre-embryonic" stages of a sector's development and the attainment of "critical mass", against an established case: the successful discovery, development and production of the Maui gas and oil field.

This analysis was intended to assist in the identification of optimal government interventions to address the gaps, so as to support the development of the resource opportunity and

CASE STUDY	RESOURCE OPPORTUNITY	RELEVANCE
Success Story	The Discovery, Development and Production of the Maui gas and oil field	When enabling technology became available, a governance framework already existed for a major discovery to be made. However, considerable intervention was necessary for its development
Current Opportunity	Oil and Gas Exploration	Considerable private sector investment in response to perceived opportunities, are governance arrangements optimal to give best chance of restoring inventory and sustaining supply?
Emergent / Undeveloped Opportunity	Wave & Tidal Energy	Emerging technology being tested but as yet no viable business case identified; governance and/or economic interventions may catalyse development
Future Opportunity	Methane Hydrates	Very large resource opportunity awaits technology development in first instance; governance deserves detailed consideration

Table 1: Case Studies

stimulate a growth sector that can ultimately enable the sector to achieve critical mass and contribute to the growth of the national economy on a sustained basis.

2.4 Case Study Structure

Each case study is intended to illustrate the following issues:

- Current activity in New Zealand and internationally, including proposed or actual commercial activity;
- Reported barriers and issues impacting on commercial development activities, specifically in terms of "Know How", "Capital" and "Property Rights";
- Analysis of the reported barriers and issues;
- Recommendations on potential strategies and/or interventions to overcome or mitigate the reported barriers, constraints and issues.

3 KEY FINDINGS

3.1 Summary of Case Studies

The Discovery, Development and Production of Maui

Success Story

Maui was discovered by the Shell-BP-Todd (SBPT) consortium in 1969 and commenced production in 1979. With an estimated 3830bcf of gas reserves, it was one of the largest offshore gas fields ever discovered at that time.

Key factors underlying Maui's successful development include:

- Exploration Technology – Acquisition of NZ's first seismic data by SBPT reduced their exploration risk and led to the discovery of Kapuni and then Maui; also, the discovery was drilled during the first deployment of an offshore drilling rig to New Zealand.
- Policy – Continental Shelf Act 1964 vested offshore resources with NZ Government and allowed the issuing of permits; the Government's role as the major purchaser of Maui gas (through the Take-Or-Pay agreement) enabled the economic production of the field; the oil crisis in the 70's led to the development of supportive policies e.g. energy self sufficiency and efficiency;
- Energy Demand – The international oil crisis and attendant high prices and short supplies in the Pacific created a substitution opportunity for fuelling the thermal power stations then being built and meeting the country's needs for transport fuels;
- Maui Joint Venture – provided for Government sharing of production risk, infrastructure development, cost overruns in platform construction and redesign, as well as the 'upside'.

Oil & Gas Exploration

Established industry

NZ has an active exploration industry focused on the Taranaki Basin where it has been successful in the past. Expansion of the industry is primarily dependent on the capital

and know-how of international exploration companies and their business decisions based on global market factors and their appreciation of prospectivity.

NZ currently ranks 14th internationally in terms of attractiveness to exploration investment[5].

Reported barriers to expanding exploration activity includes:

- The highly competitive international exploration 'marketplace', including higher prospectivity in other parts of the world, closer proximity to markets, better access to equipment, availability of and access to high quality exploration data, etc;
- The relatively small NZ gas market, historically low prices for gas in NZ due to oversupply from Maui, and associated transportation and logistics issues related to New Zealand's distance to other markets;
- The infrequency in recent times of economically significant discoveries like Maui (2000 discovery of the 700PJ Pohokura field is an exception) that would stimulate exploration activity;
- no discoveries to date of a scale to justify development of new infrastructure and production outside the Taranaki Basin;
- The predominance of gas rather than the more desirable oil in the NZ Basin structures.

Wave & Tidal Energy

Emergent opportunity

An emergent industry reliant on technology developed overseas. An industry grouping

[5] "The Oil & Gas Market In New Zealand: A Sector Summary", UK Trade & Industry

(AWATEA) has just been formed and there are approximately 12 projects at various stages presently underway. However, none are expected to be capable of deployment within at least a 24-month timeframe.

Reported barriers to the development of the wave and tidal energy industry in NZ were mainly related to their uncertainty in respect of the operation of the RMA which is a de facto "portal" for development but is seen as inefficient in dealing with novel projects for which plans are almost always silent. Specific issues identified by respondents include:

- The NIMBY issue and the ease in which objections can be lodged under the RMA and the potential for perceived vexatious objectors;
- The high perceived costs and complexities of consent applications relative to the small scale of the proof-of-concept or technology demonstration projects currently being planned;
- The absence of a specific protocol for offshore wave and tidal projects that would streamline and standardise the application process for both the industry and consenting regional authorities, thereby minimising inconsistent processing of applications across regions;
- Perceived sovereign risk as a result of the ongoing Foreshore & Seabed debate, the Moratorium on Aquaculture and Minister of Conservation's veto powers over restricted coastal activities;
- Perceived business risk in the allocation regime posed by the "first-in-first-served" policy and the potential for both "free riders" and speculators to secure occupancy and use rights ahead of industry trailblazers;
- Reliance on predominantly overseas developed technology that is largely still pre-commercial and unproven, and which is expected to be relatively expensive to import to NZ;
- Uncertainty over the cost of, and responsibility for, infrastructure development and access to the national grid as a result of the low priority given to wave & tidal by the big power companies;
- Investment difficulties due to negative media reporting of deficiencies and failures of the RMA process.

Such uncertainties, compounded, impose a risk premium that severely dampens any business case already burdened with significant technology risk, with the effect that the required capital investment will not be forthcoming until greater clarity is achieved, or unless the risks are offset through tax concessions, revenue guarantees, or similar instruments.

Gas Hydrates

Future opportunity

Future opportunity, not immediately commercialisable due to the technical complexities of extraction, transportation, environmental implications and a fundamental lack of scientific and engineering knowledge of the resource.

NZ gas hydrate deposits discovered offshore in the Hikurangi (East Coast) and Fiordland margins. Additional indications of deposits in Canterbury, Great South and Taranaki Basins.

Japan (USD$50m pa funding), Canada and the US lead gas hydrate research worldwide. Scientists from GNS, Canterbury and Otago Universities currently leading NZ research efforts.

3.2 Reported Cross Sectoral Issues and Barriers

The following issues were reported uniformly across the case studies.

Policy

- Need to address inconsistent application of environmental policy across different regional councils and government departments, particularly in respect of project planning processes – inconsistencies leading to delays and increased opportunity costs;
- Need to develop consent processes scaled to meet the scope of typical projects in frontier industries e.g. exploration, proof-of concept, technology demonstration, site assessment etc;
- Need to acknowledge and secure property rights of trailblazers / pioneers in frontier industries - the present allocation regime with its "first in first served" policy undermines investment in the industries by permitting "free riders" and speculators to secure property and use rights to resources without contributing to the development of the industry;
- Need to develop mechanisms to sanction speculators who secure use rights over resources but do not maximise the value of those resources to the New Zealand economy in a timely manner; [last 2 points are important and interwoven – one person's pioneer/trailblazer is another's speculator]
- Design property rights and systems for their allocation and administration that balance incentives to pioneers and trailblazers with constraints on pure speculators and monopolists, to foster the emergence of effective market dynamics in emerging commercial sectors.

Technology & Specialist Equipment

- Need to develop mechanisms that would provide timely access to new technologies and specialist equipment given New Zealand's reliance on overseas technologies and expertise resulting from the limited capacity NZ has to meet the high R&D costs for new frontier activities;
- Need to consider ways of attracting specialist operators and expertise to New Zealand in the face of worldwide demand and competition for equipment (e.g. oil and gas drilling rigs) and expertise - the tight supply is reportedly leading to significantly increased costs and delays in deployment and these delays in turn threaten tenure to prospective areas.

Investment

- Need to address the impact of policy related sovereign risk issues (e.g. Foreshore & Seabed, Aquaculture Moratorium) and business risk issues (e.g. allocation regime) on inwards investment – inconsistent and *ad hoc* policy is leading to uncertainty and perceptions of unreasonable risk;
- Pioneering investments that have the potential to seed developments from which new sectors can emerge may need to be favoured with taxation or other provisions (such as flow-through of losses to shareholders) to overcome risks that cannot be minimised.

Infrastructure

- Need for some level of government commitment to facilitate development at the 'frontier' stage to support the development of new infrastructure, expertise and investment due to the high infrastructure costs for new industries;
- Need to develop scientific, engineering and technical skills to enable rapid response to new frontier opportunities – despite the significant economic potential, none of the Universities in NZ have programmes dedicated to addressing new opportunities like wave & tidal or gas hydrates.

Resource Data

- Need for better access to accurate and up to date resource and site data as the key driver to increasing industry activity;
- Need for more intensive mapping of site, resource and reserve data - should be considered a national priority due to the strategic and economic value of the data to NZ;
- Need for a closer alignment between science and engineering research to focus on developing potential solutions to specific opportunities rather than undertaking scientific research with limited or isolated application.

3.3 Context For Policy Development

A "Frontier Territories" and "Frontier Activities"

The concept of the Ocean as a "Frontier Territory" is the fundamental theme emerging from the investigation and should be considered a central tenet in the development of the new Oceans Policy framework.

The case studies developed for this Report are, (were in the case of Maui), classic "Frontier activities", characterised by

- Significant technical risk;
- High start-up costs;
- Gaps in policy, governance and management regimes (at least at frontier level); and
- A long / convoluted / complex / uncertain path to market in the early stages of the industry.

While this point may seem obvious, it is an important contextual consideration that is too often overlooked as policy development all too often lags economic development requirements.

Production from the Maui oil and gas field took 10 years from its initial discovery and required the pioneering of an offshore gas production system in New Zealand (an activity that was then novel elsewhere in the world), new structural designs, new onshore infrastructure, new 'enabling' policies (energy self sufficiency, empowering legislation, Take-Or-Pay agreement etc) and new utilisation opportunities for the gas (e.g. synthetic fuels, methanol, other chemical derivatives, thermal fuels for power generation, LGP, CNG etc) to facilitate its economic development. While this process was consistent with international practice at the time, its application in New Zealand was 'unique'.

Oil & Gas exploration is the definitive frontier activity in New Zealand. Exploration activity occurs despite:

- Often limited geophysical information available for the permit area (which increases risk and costs);
- High prospecting costs (up to $100m to effect all of the work required to identify an offshore prospect and test it by drilling); and
- Low success rates (9 out of 10 prospecting wells drilled may be 'dry' holes despite promising seismic data).

The future development of a Gas Hydrates industry is likely to share most if not all of the features of both current oil and gas exploration, and the economic development of Maui. Current investment is limited to publicly-funded research. Although not a newly discovered resource, its potential as a significant energy source and economic opportunity is yet to be firmly established. However, the technical complexities involved in mining, processing and transportation of the hydrates in a useable form to market will mimic the conditions faced by New Zealand's embryonic exploration industry in Taranaki up to the Kapuni discovery in 1959, and in the development of Maui in the 1970's, but on a significantly larger scale. The enabling legislative steps were taken well in advance (Petroleum Act 1937; Continental Shelf Act 1964) of first commercial exploitation. Consideration should be given now to the adequacy of the enabling framework for future sectors such as wave and tidal energy, which is simply subjected to the blunt instrument of the RMA and faced with a turbulent electricity sector regulatory regime; and the gas hydrate potential, for which the Crown Minerals Act may prove similarly sub-optimal.

The embryonic wave & tidal energy industry in New Zealand also shares many of the characteristics of a 'frontier' activity - generation technology is still at an early stage of development and largely unproven. The novelty of the proposed activity in New Zealand is expected to result in delays in the consent application process, and niche markets will need to be identified and developed for an energy source that is projected to cost 3-4 times more per kWh than wind power.

The Commercial development of Frontier Opportunities WILL require:

- **A high return to match the high risk**

  At its most fundamental level, the development of economic opportunities in New Zealand's ocean territory will require a

strong business case, in particular, a return commensurate with the perceived level of risk involved.

The economic production of the Maui field required a high degree of certainty over the sale of a large quantity of gas for a sustained period of time. This certainty was provided by the Take-or-Pay Agreement entered into by the Government of the time, which obliged the Crown to purchase the agreed volume of gas over a 30-year period, irrespective of whether the gas could be utilised at the time it had to be paid for. In consideration of this, the Government gained a 50% share in the field. This intervention supported the economic development of Maui by offsetting the sovereign risk against a property right.

The Gas Hydrates case supports the greatest potential economic return to the country but carries the highest risk due to the technical complexities of extraction, transportation and production, along with environmental concerns that are still to be researched and are some considerable way from being resolved. While Japan has an annual gas hydrates R&D budget of ES$50m per annum, New Zealand's effort is limited to the activities of one small scientific team led by Dr Ingo Pecher at GNS in Wellington.

Given New Zealand's current vulnerabilities in respect of future thermal fuels supply (consideration of LNG importation is currently underway) and substantial indigenous sources of gas hydrate, a strong case could be made for a quantum increase in research effort towards expanding the excellent geoscience base in this country and complementing it with technological and environmental lines of enquiry. A dedicated agency, similar to the LFTB of the Maui era, may well be justified.

In the Exploration sector, the Risk-Return hurdle is also extremely high as an offshore prospecting programme may cost between NZ$7m and $10m over the term of the permit. The substantial arrangements in place in respect of oil and gas exploration, which in recent years have expanded with such specific instruments as frontier basin seismic surveys, and the enhancement of systems to provide existing exploration data at low or no cost, are intended to reduce risk and increase exploration activity. With the progressive depletion of Maui and other developed fields in Taranaki, New Zealand's exploration sector needs to be increasingly focussed on frontier areas. Success in such areas will raise infrastructural and potentially environmental issues that have been successfully addressed in Taranaki over the course of several decades. The Taranaki experience should be able to be adapted effectively to those regions where the industry proves successful in the future, so that the value of discoveries can be maximised.

The Risk-Return hurdle in wave and tidal energy is much lower than for hydrocarbons but is no less significant. The development of the wave and tidal energy industry is likely to struggle to become established until generation costs are reduced (currently estimated at 3-4 times the cost of wind per kWh due to technology costs) and next generation technology becomes available.

Besides the project sponsor, the costs and benefits of an operational wave or tidal power scheme will be borne locally and regionally. Pioneering development might best be catalysed by facilitation by local or regional interests, including local government but also potentially economic development agencies, lines companies and/or iwi entities. This route to commercialisation could well facilitate or promote project development through providing access to designated (non-consent) sites and guaranteed production revenue.

The High Risk-High Return argument has also been used to explain the lack of current activity in the offshore mining of manganese nodules. Despite innovative 'enabling' technology currently being available (which was demonstrated at the 1999 CAE Conference at Te Papa), the world price for manganese at present or for the foreseeable future doesn't justify commercial production.

- **An Internationally Competitive Risk & Return Scenario**

  New Zealand is both *reliant on* the capital and expertise of multinational companies in the commercial development of ocean opportunities (e.g. gas and oil) and *exposed to* the global market for these vital components of the commercialisation process. In this respect, the global market

may be both a threat and an opportunity for emergent industries in New Zealand.

On a negative note, New Zealand is ranked only 14th in the world in attractiveness to exploration investment[6]. This ranking is due to the predominance of gas rather than oil in the Basins, the low price for gas in New Zealand due to the historic surplus from Maui and a small domestic market, distance to other markets and related logistics costs, and lower prospectivity than other regions in the world. A number of government initiatives have been launched to increase exploration activity, including a $15m programme to acquire seismic data and as well as a database development project to provide access to this data to exploration companies.

On a positive note, however, there are indications that New Zealand's low population density and vigorous wave and tidal environment are attracting overseas wave & tidal energy technology developers. Two respondents to this study indicated approaches by European technology companies who were unable to secure access to suitable sites in their home countries and were interested in partnering up with New Zealand companies to demonstrate and prove their technology here. This is perhaps an opportunity for government intervention to assist in overcoming the risk hurdle the incumbents face, develop the local industry by expediting access to new technology and also capitalise on a potential international scientific and economic opportunity.

It has been suggested that New Zealand could capitalise on the opportunity through the development of a "marine energy technology incubation park", with research and pilot facilities that would facilitate the plugging-in of new technologies for testing or demonstration purposes.

- **The First Frontier Projects are Never Fully Commercial**

  As demonstrated by Maui and other projects internationally such as Wave Hub UK and EMAC (wave & tidal energy), some level of government assistance at an early stage is central to the development of new frontier industries.

  At its optimal level, government interventions will assist in the development of these frontier industries by providing certainty and confidence to pioneers by minimising completion risk, i.e. the risk of a project failing due to the incapacity of the sponsor to complete the development stage or other factors outside the immediate control of the pioneer, including sovereign risk or more broadly, retrospective application of new legislation or shifts in government policies.

- **The Level of Intervention should be Commensurate with the Risk-Return profile of the Opportunity**

  The successful development and production of the Maui gas and oil field required a 30-year commitment by the government (as the only possible purchaser due to factors underlying the economic development of the field) to purchase an agreed volume of gas at an agreed price irrespective of utilisation

  The economic development of the gas hydrates opportunity may require a similar level of commitment, perhaps even on a larger scale, due to the complexities of discovery, development and production demonstrated by the high levels of gas hydrate R&D being undertaken by Japan, the US and Canada, which New Zealand is in no position to emulate. Japan in particular is striving to achieve a target of commercial production of gas hydrates by 2013.

  Despite the huge economic potential of gas hydrates to the country, New Zealand is not in a position to match the level of funding by Japan, the US and Canada. However, the case study has indicated that New Zealand researchers are implementing, and are continuing to develop, 'smart' ways of leveraging their available contribution to these international efforts, and in doing so, sharing the results of the international R&D activities.

  Anecdotal evidence from respondents suggests that increasing New Zealand researchers' visibility and participation at international conferences is an extremely cost effective mechanism for increasing scientific collaboration. (In one case cited, participation at an international conference which cost the host organisation under NZ$5,000, has since led to an exchange programme and invitations to the host organisation to participate in a fully funded

[6] "The Oil & Gas Market In New Zealand: A Sector Summary", UK Trade & Industry

survey of one of the gas hydrate zones in New Zealand in approximately 12 months time. The opportunity cost of otherwise purchasing participation would be in the hundreds of thousands.)

While we applaud the approaches being taken by the respondents and other members of the New Zealand scientific community the study team wishes to caution that such activities should be driven by strategic game plans rather than short-term science objectives.

In contrast to the above, exploration and the wave and tidal sectors are nearer term opportunities and interventions are, or should be, scaled accordingly to achieve a primary objective of minimising 'opportunity costs' to both the pioneers and the New Zealand economy from delays to the development of the industry.

While a wide range of interventions is currently available to the exploration sector, including tax incentives and adjustments to the royalty regime and free access to seismic data, wave & tidal proponents have limited support. This is perhaps not unexpected given the emergent nature of the industry and the lack of capital formation within the current industry grouping but, importantly, suggests a need for some facilitative action from government.

Interventions suggested by the respondents included MfE facilitation of the development of a Code of Practice for the industry, sponsorship of a test case of this Code of Practice through the Environment Court to identify the issues involved in securing resource consent for this new and novel activity, funding for more site and resource data research, and further research to gauge the feasibility of developing a "marine energy technology incubation park" in New Zealand. The two marine parks in Europe (Wave Hub in the United Kingdom and EMAC in Portugal) have allowed the wave & tidal energy industry there to develop at a faster rate than would have been possible without the facilities.

It has been suggested that a New Zealand marine energy technologies incubation park, should it be viable, would provide a number of benefits, including:

- Providing New Zealand with advance access to new technologies;
- Opportunities to test and demonstrate new technologies under New Zealand conditions;
- Capacity building opportunities across the sector.

B Development of Frontier Opportunities will require New Zealand to compete internationally for investment and expertise

All the case studies presented are characterised as 'frontier' activities by a dependence on the capital, resources and know-how of multinational companies. This dependence is the result, among other things, of New Zealand's small economy being unable to provide the high levels of R&D funding and investment required to develop these frontier opportunities, or support a permanent pool of indigenous expertise.

Unfortunately (for New Zealand), multinational companies make their business decisions within a global context and in many cases, it is inevitable that opportunities in other parts of the work will prove more attractive for investment than particular opportunities in New Zealand, for some combination of 3 key factors – acceptable returns on investment, acceptable levels of risk and certainty of completion.

All three factors are within the scope of government intervention and the appropriate mechanism to do so will be a policy framework that balances the risk return equation to provide pioneers with an acceptable rate of return which does not compromise competition in the frontier activity and at the same time, also explicitly supports and incentivises the identification and commercial development of new and novel economic opportunities.

Suitable generic policy instruments could include 'flow-through' tax concessions which would allow tax losses from frontier activities to be offset against the tax liabilities of investors in such projects, 'bounties' to reward the first successful fully commercial projects in specific frontier industries, and the development and testing of Codes of Practice for new frontier activities at an early stage of the industry, i.e. before they become commercially necessary.

C The commercial development of Frontier Opportunities will inevitably challenge conventional resource law and governance

The identification of new and unique opportunities in frontier territories, and the drivers for their commercialisation, often emerge well in advance of relevant governing policy because conventional policy development is concerned with managing risk, and is therefore generally more reactive rather than proactive and tends to focus on known or existing (quantifiable) activities.

However, frontier activities are by their very nature, pioneering endeavours undertaken in the unknown, with longer-term commercial time horizons and higher risk tolerances than 'Business-As-Usual' projects in established industries (e.g. Japan's US$50m/pa gas hydrates R&D budget to achieve commercial production by 2016).

Consequently, the study team has formed a view that in order for Oceans Policy to be supportive of frontier activities, it must give effect to the principle that there should be tolerance of risk commensurate with the uncertainty prevalent in frontier activities posed by the lack of information. Frontier opportunities are activities for which considerable allowances are made to the conventional business case evaluation process because there is insufficient data about the specific opportunity and even more critically, a lack of knowledge regarding potential consequences, BUT where the potential returns from successful development can justify this latitude. Our argument is that without greater tolerance for risk, pioneers may be unwilling to develop these opportunities, ultimately to the detriment of the New Zealand economy.

We accept that this is at odds with the dominant paradigm but believe that it is consistent with international best practice and the science of risk management.

3.4 Recommended Interventions

The successful governance of frontier territory opportunities will require a policy framework that:

- Is based on Clear Principles to provide Continuity and Consistency to Pioneers and Developers
- Manages With Risk, rather than attempting to Manage Risk
- Maximises the Opportunity Value to New Zealand of the resource opportunities
- Actively provides for and supports the emergence of Entrepreneurial and Pioneering activity.

The Ministry's key contribution to the development of the case study (and other appropriate) industries may well be the leadership and facilitation role it can play in:

a. Facilitating the advance development of consent protocols / codes of practice for specific new and novel activities and in taking test cases through to the Environment Court in order to identify and resolve issues before the protocols are needed commercially;

b. Facilitating consistent and standardised application of policy across the country. One opportunity would be to develop a training programme around the Taranaki Regional Council's extensive expertise and experience in processing offshore consent applications for all the other regional councils;

c. Facilitating better communication and understanding of the RMA and success stories to both reduce uncertainty and prevent the small number of negative stories to evolve into urban myth. In the wave & tidal energy industry, in particular, we note that participants reported RMA hurdles impacting on their business without having verified them or sought external advice;

d. Facilitating the development of a wide skills base that would support the commercialisation of new, novel and undiscovered opportunities by:

    - Encouraging Universities to expand their existing academic programmes to include relevant learning modules for near term opportunities in the oceans arena;
    - Encouraging linkages with best-of-breed programmes and researchers at other academic institutions; and,
    - Encouraging a closer alignment between

science and engineering research, as both fields complement each other and are central to the development of potential solutions.

At a broad policy level, the following suggestions should be considered:

e. Allocation regimes need to both incentivise commercial development of opportunities and also sanction applicants who act as speculators or squatters on resource opportunities (as seen in the aquaculture sector);

f. The inclusion of more flexibility in management and consent regimes to reflect the embryonic state of the case study industries (with their focus on R&D, proof-of-concept, technology demonstration and site evaluation, rather than commercial deployment) and allow for better scaling of consent requirements to the scope of projects;

g. There needs to be greater consideration of the impact of jurisdictional boundaries (particularly between regional councils) on near shore activities compared to frontier activities undertaken beyond the terrirotial limits.

3.5 Summary & Conclusions

The principal theme emerging from this investigation is that the New Zealand's Exclusive Economic Zone and its continental shelf extensions should be considered as "Frontier Territory" as these areas are basically "uncharted". As a country we are only just beginning to understand the marine environment, the ocean process that operate within these boundaries and the resource potential that lies within. As this understanding grows and knowledge increases, it is inevitable that new resource opportunities will present themselves. We argue that to capitalise on these emergent opportunities, it is appropriate to accept a higher risk tolerance in respect of commercial development activity and that focus should be given to policies and practices that are *adaptive* to the risk circumstances in this context.

This is reflected in the case studies seemingly characterised by gaps in resource information, high upstream investment requirements (exploration and prospecting, site evaluation, resource mapping, new pre-commercial technology), a "first in first served" allocation regime if one is available, the absence of a specific management regime for commercialisation of the resources, and the need for new infrastructure, among others.

The respondents to this investigation are aware that as "trailblazers" or pioneers, they will be exposed to the high costs of creating precedents with the relevant regional and Crown authorities, of pioneering consent and other regulatory protocols and processes, of developing infrastructure, and quantifying and qualifying economic opportunities, only to have the threat of "free riders" and speculators swooping in on the back of their efforts to obtain occupancy and use rights to resources that they have sought to secure for themselves. They are also aware that as new or novel activities, governmental policies impacting on their businesses could be applied retrospectively at anytime.

CAE suggest that the following policy considerations should be deliberated on in the development of Oceans Policy so as to encourage the development of new and novel opportunities in New Zealand's oceans and to support the transformation of their embryonic industries into mature industries contributing significantly to the national economy:

1. **"New Zealand's Economic Future lies in its Oceans"** – the diminishing of terrestrial resources will focus attention on developing new economic opportunities in the Oceans. Oceans Policy must be flexible enough to allow new opportunities to be developed in a cost effective manner with all due regard to applicable allocation, governance and management regimes.

2. **"The Ocean is Frontier Territory"** – Oceans Policy should reflect the fact that 'frontier activities' are unique because they will involve significant technical risk, high costs and a long uncertain complex pathway to market in the early stages of the development of the industries. Ocean Policy should also be cognizant of the fact that pioneers are operating in a dearth of information, in hazardous conditions and have to react quickly to both hazards and opportunities.

3. **"Frontier Opportunities are Business Development Opportunities"** - without an appropriate business case, and a return commensurate with the risk involved, there isn't a viable opportunity for policy to support.

4. **"Risk And Return, Opportunity Costs and the Time Value of Money are the key drivers to the Development of Frontier Opportunities"** – frontier opportunities are by necessity speculative ones. Long-term opportunities are likely to be driven by risk-return considerations, while immediate and near term opportunities will be driven by the opportunity costs and time value of money. The provision of 'certainty' through policy is thus especially crucial for near term opportunities where the commercial viability of a pioneering project is particularly sensitive to delays and impediments to the business plan.

5. **"New Zealand Ocean Opportunities Must Be both Nationally and Internationally Competitive"** - the commercial development of opportunities in New Zealand will require competitive business cases firstly, because New Zealand is dependent on multinational companies, who operate in a global market for their capital, expertise and resources; and secondly, because local markets need to be established to support the development of infrastructure, supply chains etc for economic production.

6. **"Early Projects in Frontier Industries are Rarely Fully Commercial"** - The first few projects in 'frontier industries' have historically benefited from a level of government intervention to clarify policy principles, formalise property rights, establish certainty and reduce completion risk, among other things.

7. **"Frontier Projects require Flexible and Discretionary Policy Frameworks"** – policy elements that control established industries may not be appropriate for embryonic or emergent industries. Under the current RMA regime it is apparent that the scope of required reporting, investigation costs and timeframes required for planning approvals are disproportionate to the scale of early stage projects; being predominantly technology demonstration and evaluation projects.

8. **"Policy Frameworks for Frontier Activities must be based on Clear Principles"** – clear principles will provide certainty to pioneers; and the clearer the principle, the sooner an opportunity is likely to be commercialised.

9. **"Policy Frameworks for Frontier Activities must maximise the Opportunity Value to New Zealand"** – this includes ensuring sufficiently robust policy mechanisms are in place to balance, among other things, the natural desire by pioneers for monopolies versus the government's role to promote and support competition.

10. **"Conventional Policy Frameworks must and should apply once an industry is established"** - the availability of infrastructure and supply chains to support the commercialisation of a frontier opportunity generally indicate the difference between a mature and an emergent industry.

3.6 Issues For Further Investigation

The study team has posited a view that encouraging the sustainable development of new economic opportunities in New Zealand's Ocean Territory will require both their treatment as 'frontier opportunities' as well their management under a policy framework that will *manage with risk* rather than attempt to manage all risks inherent in frontier activities.

The development of a policy framework that "manages with risk" will require further investigation into the following issues:

1. What are the underlying issues to the adoption of a risk based approach?
2. What are the optimal levels of "risk tolerance" for new economic opportunities in New Zealand's Oceans, which would actively support, encourage and incentivise the development for new marine opportunities without imposing undue risk or fiscal burdens on the New Zealand economy as the development of Maui has been found to have done?
3. What are the optimal balance points between providing pioneers with sufficient incentives to investigate and develop frontier opportunities while ensuring sufficient competition to maximise the opportunity value to the New Zealand economy?
4. Should work programmes be a standard requirement for all new frontier activities?

Work programmes could address the issues faced in the aquaculture allocation model in which speculators were able to lock up optimal aquaculture sites through the consent process without any intention of utilising the resource directly themselves.

5. The results of these investigations could then provide the basis for a focused *Risk Management Framework for Offshore Frontier Activities.*

CASE STUDIES

CASE STUDY No 1:
THE DISCOVERY, DEVELOPMENT AND PRODUCTION OF THE MAUI GAS & OIL FIELD

a. Introduction

The Maui gas field is located 35km offshore of the Taranaki Peninsula (see Fig 1) in water depth of 110m[1]. In 1969, it was the eighth largest gas field discovered in the world to date, with reserves of gas estimated at approximately 3830 billion cubic feet.

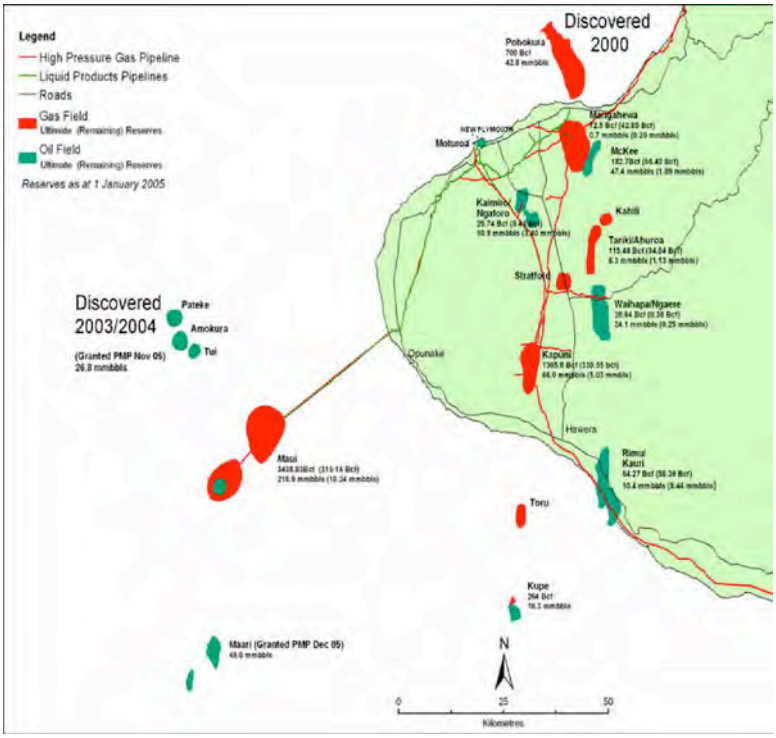

Fig 1. Taranaki Basin Petroleum fields (source: Crown Minerals, Ministry for Economic Development)

Production commenced in 1979, 10 years after discovery. Reasons for the delay included the technical complexities of developing the field, infrastructure design parameters that were beyond anything previously attempted, and also because development of offshore gas fields was, at that stage, still novel on a world wide basis and completely unknown in NZ.

Additionally, the economic production of the Maui field required the producers to secure a committed sale of a large quantity of gas over an extended period of time. The New Zealand government was the only possible buyer for such a large quantity of gas and entered into the Take-or-Pay Agreement that committed it to purchase gas from the field for a 30-year period. In consideration of this, the NZ Government gained 50% ownership of the field.

Production on the Maui Field is from 3 reservoirs within separate formations of the Kapuni Group. The Maui-A platform wells commenced production in 1979, while Maui-B came on stream in 1993. 34 wells have since been drilled in the field as of 2003, consisting of 14 production wells within Maui-A and 12 development wells within Maui-B, along with a further 8 exploration/appraisal wells.

Maui accounts for between 75%[2] and 80%[3] of New Zealand's hydrocarbon production. Annual production from the year to June 2002 was:

- 168 bcf (Billion cubic feet) of gas

[1] Taranaki Basin Producing Fields, MED pg 22
[2] Economic Opportunities In New Zealand's Oceans (2003); Centre For Advanced Engineering for the Oceans Policy Secretariat; p3
[3] Taranaki Basin Producing Fields, MED pg 23

- 6 mmbbl (million barrels) of oil and condensate
- 168,000 metric tonnes of LPG[4]

Since commencing production in 1979, Maui has made a massive contribution to the New Zealand economy. In addition to providing approximately 50% of the (relatively cheap) fuel used for electricity generation, it has also contributed an estimated $472m directly[5], excluding revenue to the government from other downstream activities, e.g. Methanex.

Production from field reduced in 2003, following a downwards revision of the size of the reserve and is expected that the specified economic reserves will be depleted sometime after 2008. Projections are that additional reserves will be delineated to enable additional production that could well extend this timeframe[6].

The decline of the Maui field may prove to be a double edged sword for the New Zealand economy. While the low price of gas from Maui has contributed significantly to New Zealand's international competitiveness by allowing the government to attract large multinational companies like Methanex and in the South Island, Comalco, by providing them with low cost electricity contracts over a long term. On the downside, it has also suppressed the commercialisation of new gas field discoveries (particularly Kupe, discovered in 1986 and with first production now scheduled for 2008) and disincentivised exploration, because the Maui gas prices made concurrent production from other fields uneconomic.

b. Factors Supporting the Development of the Maui Gas & oil field

Know How

- Shell-BP-Todd (SBPT) as well as Mobil, Gulf Oil, Hunt and Exxon undertook marine seismic surveys during the 1960's and early 1970's as the technology became widely available;
- The first offshore drilling campaign based on seismic data led to the Maui discovery;

Capital

- Cooperation between Shell, BP and the NZ company Todd enabled them to leverage off each individual company's strengths to discover and develop the field - the previous onshore discovery at Kapuni was the culmination of a joint venture to systematically explore the most prospective parts of New Zealand, with Shell operating the western side of the country and BP the eastern;
- Government stepped in to promote and facilitate the development of Maui during a period when energy security and affordability was (as again today) very high on the political agenda globally. However, even with governments of both parties persuaded of the desirability of facilitation and commercial involvement on an unprecedented scale, the path from discovery to development took 10 years.

Clear Title

- The Continental Shelf Act 1964 vested ownership of resources of the Continental Shelf with the NZ Government; and extended the reach of the Petroleum Act 1937 over the newly gazetted territory.

c. Barriers

- The main barrier to the development of the field was the lack of a ready market for the production of gas on the scale required for commercial development;
- There were also a number of technical and technological hurdles that had to be addressed, as offshore gas production was unknown in New Zealand and relatively novel elsewhere in the world at the time.

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[4] Economic Opportunities In New Zealand's Oceans (2003); ibid; p3

[5] Economic Opportunities In New Zealand's Oceans (2003); ibid; p3

[6] Hooper, RJ, "Medium Term Vulnerabilities Within The New Zealand Gas Market", Paper to New Zealand Petroleum Conference 2006:p8.

d. Interventions

- The Take-Or-Pay Agreement entered to by the government enabled the commercial development of the field by securing the sale of a fixed volume of gas to the government irrespective of whether it was, or could be, utilised;
- The development of a market for Maui gas in New Zealand was facilitated by massive predominantly government investment into the development of infrastructure for processing, transportation and consumption (power generation, synthetic petrol etc);
- Government also took an active lead, through the Liquid Fuels Trust Board, Power Planning Committee and the Department of Trade and Industry among others, to develop utilisation options for the gas;

Summary & Conclusions

Think Big gave government intervention a bad name.

However its failures largely arose from the collapse of oil price negating the underpinning case for self-sufficiency. While much attention has been given to the negative outcomes associated with this fundamental impact on specific business cases, nevertheless the development of Maui has had a large and widely distributed positive effect on the competitiveness of the New Zealand economy due to its sustaining of competitive energy prices, enjoyed by manufacturing and other industries. For example, Taranaki was until 2003 one of the most efficient sites for methanol production in the world.

More importantly however, the establishment of a viable gas industry in New Zealand was only made possible by the infrastructure that was established and the gas market that subsequently ensued. The Gas industry remains an important contributor to national GDP.

CASE STUDY No 2: OIL & GAS EXPLORATION IN NEW ZEALAND

a. Introduction

The modern era of exploration in NZ began in New Zealand in 1955 when Shell and BP established New Zealand's first major consortium with the Todd Brothers of Wellington. Their acquisition and analysis of the first seismic data shot in New Zealand led eventually to the discovery of the Kapuni Field (264bcf of gas reserves) in 1959 and Maui in 1969 (3830bcf of gas reserves), who together produce approximately 83% of New Zealand's oil and 87% of its gas production.

The commencement of production from Kapuni in 1970 marked the beginning of the natural gas industry in New Zealand, and Taranaki as the hub of New Zealand's oil and gas industry.

Although Taranaki is the most explored and commercially successful of the NZ Basins (with 350 exploration wells drilled to date), it is still relatively under-explored by world standards. Increasing levels of exploration over recent years has led to an enviable success rate for wildcat drilling and a commercial discovery success rate of one in three in the Taranaki Basin based on recent exploration activity[7], while offshore discoveries have also been very successful commencing with Pohokura in 2000, and Tui and Karewa in 2003.

Fig 2: Hydrocarbon Basins in New Zealand's EEZ (Source: Crown Minerals, Ministry of Economic Development)

New Zealand is currently rated 14th in the world in terms of attractiveness to oil and gas investment[8]. As the business process for investment is driven entirely by oil company investment and know-how, exploration investment and activity in New Zealand is limited primarily by the risk perceptions established by oil companies in a highly competitive global market, rather than resource potential[9].

[7] "Petroleum Systems Of New Zealand", Crown Minerals (1991) - http://www.crownminerals.govt.nz/petroleum/systems/index.html
[8] "The Oil And Gas Market in New Zealand: A Sector Summary"; UK Dept. of Trade & Industry; p7.
[9] Economic Opportunities In New Zealand's Oceans (2003); ibid; p4

However, New Zealand's ranking may change as exploration activity in NZ is expected to increase dramatically in the near future due to:

- The impending depletion of Maui, that will drive the need for new discoveries as a result of New Zealand's heavy dependence on gas including for electricity generation, with around 50% of total national gas production used to generate 23% of the national energy supply;
- The incentives for new discoveries, due to rising gas prices (200% in the past 3 years) inline with the run down of production at Maui in addition to global sector profitability due to high oil prices, peak oil concerns and Middle East instability;
- Shell's withdrawal from 2004 from all prospecting in Australasia, which is expected to make NZ more attractive to smaller exploration companies by reducing competition for prospecting permits;
- The potential for significant commercial hydrocarbon discoveries in the 7 additional Sedimentary Basins besides Taranaki that have been severely under-explored. Many untested structural closures could be potentially larger than the Maui field;
- A lack of alternatives to gas fuelled electricity generation due to the New Zealand public's resistance to coal-fired power plants, new hydroelectric dams and nuclear-power stations, which will create unique opportunities for exploration companies to create value when gas demand, with its associated pricing, is at its maximum and energy alternatives are at a minimum.

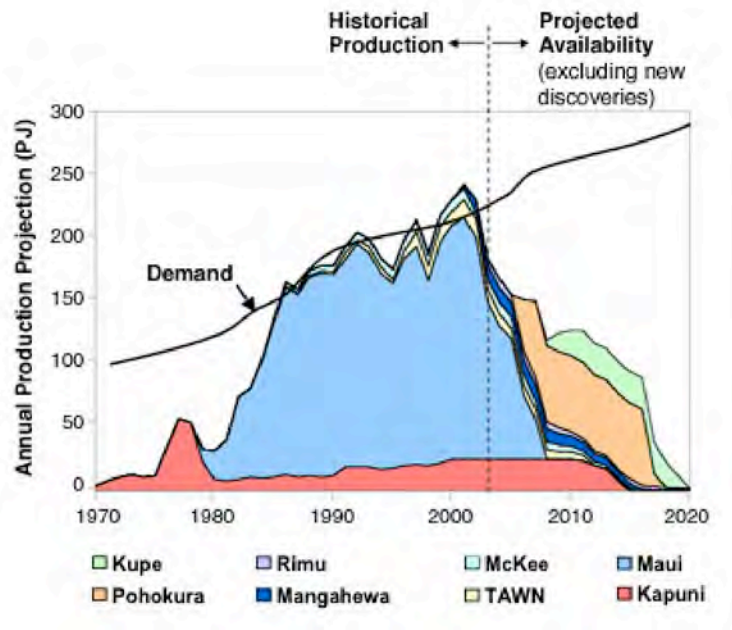

Fig 2. New Zealand Natural Gas Supply & Demand [Source: TAG Oil (NZ) Ltd]

b. Reported Barriers

The business case process for oil and gas exploration is mature, key sensitivities include field (prospect) size, flow rate, costs, timing and prices. Despite the positive factors supporting the development and expansion of the exploration sector in New Zealand, a number of issues were raised by respondents as potential barriers, or causes of curtailment, to their activities.

a. TECHNOLOGY & EQUIPMENT

- Global scarcity and heavy bookings for specialist equipment was reported as one of the main barriers to the respondents expanding their future exploration activities in NZ. Supply of rigs worldwide is tightening as international exploration increases in response to high oil prices.

- Although 14th in the world in terms of attractiveness to oil and gas investment[10], New Zealand is also becoming less attractive as a prospecting destination than some other parts of the world due to a predominance of gas rather than oil in the New Zealand sedimentary structures.
- The scarcity of specialist equipment is contributing to difficulties experienced by the respondents in aligning the completion of work programme commitments with equipment availability within the permit time frames.
- Cost of equipment was also cited as limiting factor for future exploration, especially in areas of lower prospectivity. Rig costs have increased from $70,000/day in 2003-04, to $128,000/day in 2005-06, to a projected $378,000/day for 2007-08.
- Demands for work programmes of 12 months or longer from rig operators may also contribute to the ongoing scarcity of specialist equipment for New Zealand exploration activities as the small NZ exploration industry would struggle to support such a commitment in the absence of a "primary contractor" willing to underwrite a 12 month rig programme.

b. POLICY: Permit Regime And Work Programmes

- Respondents raised concerns about the 'aggressiveness' of the current permit regime, in particular the difficulties they faced in aligning the requirements of their respective work programmes with the availability of rigs and other equipment, within in their permit timeframes.
- Respondents suggested more flexibility in or extensions to permit terms may be required as the worldwide demand for specialist equipment is increasing the time horizon to relocate rigs to New Zealand beyond 2 years. Exploration permits currently run on a 2-year rolling system.
- In conjunction with their inability to meet their work programme requirements due to non-availability of equipment, respondents also cited difficulties in securing deferments to their Work Programmes from Crown Minerals as an additional barrier to an expansion of their exploration activity.
- Lack of access to exploration acreage was also raised as an issue, despite the previous bid round being significantly under subscribed.

c. POLICY: Resource Management Act

- Inconsistencies in the treatment and processing of resource consents by different councils was reported as being of concern, especially when it impacted on the respondents' abilities to either plan for or meet their Work Programme commitments. Most regional councils are generally focused on consent protocols for onshore / land based projects, and only Taranaki was reported to have high quality in-house RMA expertise for offshore projects.
- Exploration permits and activities that crossed territorial boundaries increased the scope and scale of the consent application process, which compounded the inconsistent treatment reported above.

d. FISCAL REGIME & INCENTIVES:

- Currently, tax incentives are only available for new gas discoveries only. However, respondents suggested that the incentives should be applied for both types of hydrocarbons as oil and gas are generally found together and NZ has greater dependence on oil.
- Respondents also suggested that the incentive regime be applied to the development of previous discoveries, which may now be more economic to produce with the demise of Maui.
- Respondents also questioned the implications of the recent initiative by IRD to remove the tax obligations on survey ships and rigs operating in New Zealand

[10] The Oil & Gas Market in New Zealand: A Sector Summary; UK Dept. Trade & Industry: p7

beyond the 186-day exemption period while maintaining the obligation on rig support vessels. Respondents pointed out that rigs operate symbiotically with support vessels and this initiative could increase both the cost of drilling programmes and lead to potential delays due to non-availability of the rigs.

e. RESOURCE INFORMATION

- Respondents cited 'prospectivity' as the greater driver for exploration activity than the availability of infrastructure in proximity to new discoveries, and shared their experiences of difficulties in accessing seismic data purchased by the Crown for this purpose. *These experiences have not been reported here because it was the consensus of participants at the Workshop that the opinions expressed weren't valid.*
- Recent government initiatives to increase prospectivity and provide access to the seismic data include:
  - The NZ$15m MED programme commencing in 2005 to acquire data in frontier basins, in conjunction with a database project that will provide free online access to both old and new exploration data[11];
  - A NZ$23m FRST funded multidisciplinary programme in conjunction with GNS to undertake mapping, geological analysis and modelling of yet-to-be discovered petroleum accumulations to reduce exploration risk and increase exploration success for both established companies and new entrants[12];

f. INVESTMENT

- Respondents suggested that New Zealand's attractiveness to international investment in exploration was limited by low prospectivity, a predominance of gas rather than oil in recent discoveries, its relatively small market size and distance to larger markets, and the historically low gas prices due to the oversupply of gas from Maui.
- The lack of a domestic exploration sector capable of completing frontier type activities unless in conjunction with international investment. Above the relatively small scale of Austral Pacific and NZOG, only Todd (as a domestic company) has created a linkage with overseas companies to drive offshore exploration in New Zealand. However, these multinational companies operate globally and tend to come and go as more competitive opportunities emerge elsewhere.

g. INFRASTRUCTURE

- Some respondents reported that although their exploration activities outside the Taranaki Basin had yielded discoveries, they were unable to commercialise their discoveries due to lack of infrastructure. *However, it is worth noting that size of the discoveries did not justify government intervention to lead the development of new infrastructure that the discovery of Maui did.*
- One respondent cited lack of access to existing pipeline infrastructure as the reason for his company's inability to commercialise discoveries within Taranaki. The lack of access was reportedly for commercial reasons but the respondent chose not to discuss this further. *It may be useful to investigate to what extent this is an issue for other exploration companies operating in the Taranaki Basin as it could conceivably be an uncompetitive practice.*
- Respondents all supported government intervention to kick-start the development of infrastructure outside the Taranaki Basin as a means of encouraging and supporting exploration activity in the other Basins. *However, we comment that this would first require the existence of a proven petroleum system sufficient to support such an investment, which is yet to be achieved. Internationally, government investments in infrastructure are typically linked to the development stage, not exploration.*

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[11] "Kiwi's Help Exploration"; Hart's E&Pnet.com, Jan '06 - http://www.eandpnet.com/articles/newsAndComments/4187

[12] http://www.frst.govt.nz/Research/Success_Stories/Oil_and_Gas_Exploration.doc

c. Suggested Interventions

1. Adjustments to the tax regime – exemptions for support ships, incentives for new oil and gas discoveries, incentives to developed existing discoveries.
2. Strategies to attract small to medium sized international exploration companies – respondents suggested that exploration in New Zealand Basins is more suited to small to medium sized exploration companies, who are likely to be hungrier and more responsive to current government initiatives to boost exploration activity.
3. Strategies to assist NZ companies to develop into world class operators – respondents highlighted the opportunity for government to assist local companies to be come internationally competitive as a result of anticipated local demand and high world prices.
4. Strategies to increase the availability of specialist exploration equipment in NZ – respondents suggested that the Government might have a role as a 'primary contractor' or underwriter for an extended drilling programme.
5. Adjustments to permit regime:
   - Consideration of exit points - respondents suggested that a more flexible approach be implemented for the work programmes, in particular
   - More flexibility in reasons for deferral other than rig non-availability

The Study acknowledges that Government has already moved in part in the above areas by adjustments to taxation regimes and the provision of seismic data sets without condition to interested parties at no or limited cost. Our investigation suggests that more could be done to better match initiatives to the business interests of that targeted mid sized exploration companies. In respect of specialist exploration equipment, we suggest that there may well be a role for Government in underwriting rig programmes for extended periods and then tendering spare capacity to the industry. Such an initiative or similar scaled interventions will however, require further investigation.

Summary & Conclusions

The oil and gas industry in New Zealand is currently at a crossroad due to the depletion of Maui. In particular:

- It is an established industry with a tight geographical focus (the Taranaki Basin) facing a contracting gas market, competition from imported oil and gas and a high incidence of dry holes;
- Despite the drilling of almost 600 exploratory wells, it is still considered a 'frontier territory', with a well density of 1:14km^2 in the Taranaki Basin that is considerably lower than other geologically similar regions around the world[13];
- Successful discoveries (e.g. Pohokura) have been counter-cyclical and 'lumpy', causing strains to infrastructure and support services.

The depletion of Maui is creating an energy shortfall for New Zealand and new opportunities for the industry, as exploration activity will need to be significantly increased in order to produce sufficient successful discoveries for appraisal and development to secure New Zealand's energy system. For example, a recent article on the Foundation for Research Science & Technology's website suggests that exploration intensity will need to increase by a minimum of 300% to come up with the discoveries to meet anticipated petroleum demand[14].

The Study Team suggests that the following issues, which were outside the current scope, will require further investigation:

1. How should the sector cope with sub-optimal known discoveries (i.e. proven reserves that are either too small, too expensive or of uncertain quality to warrant extraction at current prices) through existing infrastructure and support services?

[13] UK Dept. of Trade & Industry website - http://www.uktradeinvest.co.nz/services/trade/sectors/oilandgas.htm
[14] "Success Story: In Pursuit Of Petroleum"; Foundation for Research Science & Technology - http://www.frst.govt.nz/research/Success_Stories/Oil_and_Gas_Exploration.cfm

2. Assuming the stimulation of exploration activity through the current incentive programme, how should the sector cope with any resulting new discoveries that do not conform to the Maui 'profile' on which the existing infrastructure is optimised for, i.e. discoveries in new basins, discoveries with different mixes of oil and gas, discoveries of different sizes?
3. Which government agency should take the lead in facilitating capacity development in the sector that would address the above?

CASE STUDY 3: ISSUES AND BARRIERS IN THE DEVELOPMENT OF A WAVE & TIDAL ENERGY INDUSTRY

a. Introduction

Marine Energy, often referred to as "Blue Energy", is a renewable and sustainable energy resource with relatively limited impacts on the environment and marine life. Although the 'Marine Energy' definition can encompass energy derived from offshore winds, ocean currents, heat and salinity exchange, and marine biomass conversion, the focus of this project is on devices to generate energy from wave action and tidal currents.

New Zealand is particularly suited to wave & tidal energy production as it is surrounded by ocean, has a large wave energy resource in the western and southern coasts from waves generated in the Southern Ocean and Tasman Sea, significant tidal currents in Cook Strait, French Pass and Foveaux Strait, and a number of harbours (e.g. the Kaipara and Hokianga) with tidal movements.

The concentration of the NZ population along the coastline also provides many potential opportunities for the deployment of wave & tidal devices as options for localised or distributed generation, supplanting the need for high cost transmission network upgrades.

A recent EECA fact sheet on Marine Energy[15] highlighted some additional commercial arguments for the deployment of wave & tidal energy devices, including the shorter transmission distances from localised utilisation, modular and incremental deployment options that minimise installation costs and capital requirements and the more rapid installation timeframes compared to hydro or thermal fuel plants (although this is not always the case).

b. Wave and Tidal Devices

Table 1: Types of Wave and Tidal Devices

WAVE	Wave Power System devices	Generates energy by translating wave displacement into hydraulic force to rotate onshore turbines
	Oscillating Water Column devices	Generates energy when rising and falling waves move air in a fixed volume chamber, which rotates a turbine
TIDAL	Barrage devices	Generates energy by forcing water through turbines along a dam
	Tidal fences	Generates energy when tidal currents rotate turnstiles along a fence stretching across a strait
	Tidal turbines	Generate energy when tidal currents rotate turbines more to the seafloor - similar to the generation of wind energy

As of 2nd March 2006, there are currently 7 wave energy and 6 tidal energy devices nearing or at commercialisation stage worldwide (Table 2).

[15] EECA Fact Sheet No 5 – Marine Energy

Table 2. Current Market Readiness of Wave And Tidal Devices[16].

	System	Company	Country	Size*	Status
WAVE	PowerBuoy	Ocean Power Technologies	USA	20 kW	Commercial
	Pelamis	Ocean Power Delivery Ltd.	UK	750 kW	Commercial
	Limpet	Wavegen	UK	500 kW	Commercial
	"Buldra"	Fred. Olsen Ltd.	Norway	500 kW	Prototype testing complete - set for commercialisation
	"Parabolic Wall"	Energetech	AUS	300 kW	Prototype testing complete – set for commercialisation
	'Manchester Bobber'	The University of Manchester Intellectual Property Ltd	UK	Variable	Prototype testing
	Archimedes Wave Swing	Teamwork Technology B.V	Netherlands	2 MW	Prototype testing
TIDAL	Turbine	Verdant Power	USA	36 kW	Commercial
	Turbine	Hammerfest Strom	Norway	300 kW	Commercial
	Seaflow	Marine Current Technologies	UK	1 MW	Prototype testing complete - set for commercialisation
	Tidal lagoons	Tidal Electric	UK	Variable	Planning developments
	Vertical axis turbine	Blue Energy	Canada	250 kW	Planning full scale prototype
	TidEl	SMD Hydrovision	UK	1 MW	Planning full scale prototype

**The size of the device given here is the rating for one device though many are designed to be built as an array utilizing multiple units.*

Literature references suggest that wave power is likely to be best suited to small to medium sized generation extending to 20MW capacity at any single site. Tidal current systems are likely to be a magnitude greater[17].

c. The International Wave & Tidal Energy Industry:

Tidal barrages have been generating energy in Europe since 1966 (i.e. the 240MW La Rance plant in France) and in the US since 1984 (i.e. the 20MW Annapolis plant)[18]. Despite falling out of favour due to its adverse environmental effects, a new 254MW tidal dam is currently being built in South Korea. Their contributions have, however, been small and development has been slow.

[16] Sherman, M & Fisher, GW; "The Current Status of Wave & Tidal Energy", Pacific Clean Energy, p2 (pers. comm.)
[17] CAE, New & Emerging Renewable Energy Opportunities in New Zealand (1996):pp169-188
[18] Sherman, M & Fisher, GW;, ibid

This is despite tremendous support internationally (and from European governments in particular) for the development of commercial devices within 3-5 years[19], including:

- The opening of the European Marine Energy Park (EMEC) in 2004;
- A GBP 50m UK Marine Energy Development Fund; and,
- A pledge of GBP 42m (NZ$111m) in 2005 by the UK Minister of Energy to facilitate wave and tidal energy feeding into the UK national grid by 2008[20].

The WaveGen and the Pelamis devices are already producing energy for local grids in a number of locations and other devices are expected to come on stream shortly. The availability of these devices commercially is leading to the emergence of a NZ wave & tidal industry.

d. The New Zealand Wave & Tidal Energy Industry:

There are currently 12 wave & tidal projects underway in New Zealand at various stages of development[21]. Most of the projects appear to be relatively small, privately funded, led by entrepreneurs and enthusiasts and focused on testing or proving devices developed overseas in New Zealand conditions.

One government-funded project was identified - the FRST funded NIWA-IRL-Power Projects Ltd joint venture (FRST Contract C08X0401). This project commenced in 2004 with the objective of deploying a nominal commercial device in NZ waters by July 2008[22]. The JV are currently evaluating a range of potential devices while one of the JV Partners, IRL, is understood to be developing a device of its own.

Power companies, who would be expected to be involved in evaluating both devices and potential installation sites as part of a balanced generation portfolio, reported low levels of interest and activity in wave and tidal energy, merely maintaining of "watching briefs". They cited the more established and predictable **resource consent** outcomes for wind projects, lower comparative generation **costs**, **proven technology** and existing **policy support** as factors for their focus on wind over wave and tidal energy.

None of the NZ projects reported deployment horizons of less than 24 months, for reasons including capital, availability of suitable devices and timeframes for consent applications, for construction of on-site and site-to-shore transmission infrastructure and for negotiating grid access.

However, AWATEA (the Aotearoa Wave And Tidal Energy Association) noted at its inaugural meeting in Wellington on the 10th of March that the association was expecting the deployment of a pre-commercial or demonstration technology in NZ within 3-5 years. This seems optimistic.

A more realistic scenario, however, may be a deployment horizon as far out as 10 years from 2006. This was the consensus that emerged at a Renewable Energy Technology Scanning Workshop run by CAE for MED and NZTE in Christchurch in February 2006.

However, while deployment and installation timeframes for wave & tidal devices will be shorter than for large scale hydro or thermal due to their modular design and scalability and also their relatively low environmental impact, timeframes are dependent on the availability of installation equipment (e.g. 'jack up' rigs to drill mooring points into the sea bed), specialist staff, access to transmission infrastructure, and securing both use rights and resource consent approval.

Whilst a promising technology, international experience suggests that without some form of government assistance wave and tidal projects, in the near term, will be unlikely to achieve the price point at which they are competitive with wind or other conventional forms of renewable energy.

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[19] EECA, ibid.

20 Huckerby, John Maritime 21 Presentation, February 2006

21 John Huckerby, Presentation at inaugural AWATEA Meeting, 10-02-2006

22 John Huckerby, Presentation on Wave & Energy Conversion at the Maritime 21 Oceans of Opportunities Workshop, Lincoln University, Feb 2005

e. Reported Barriers

The following issues were raised by the respondents as potential barriers to the development of a wave & tidal energy industry in New Zealand.

a. POLICY

The policy issues reported by respondents were centred on the scope and resulting cost of the RMA process, the perceived inconsistent processing of applications and the need for a specific protocol for wave and tidal energy applications to potentially address the former. *The RMA difficulties reported are largely anecdotal and have not been validated.*

Resource Management Act

It was argued that the RMA was too blunt an instrument to support the development of the emerging wave and tidal industry because:

- The extensive data and consultation requirements were disproportionate to the small scale of the predominantly Proof-of-Concept or demonstration projects proposed;
- The respondents would bear a disproportionate share of the costs of developing a standardised protocol for assessing wave and tidal applications;
- The costs to meet the above were consequently disproportionate to the scale of the projects and was diverting capital away from expenditure items on engineering and other project activities;
- As a relatively new activity, a standard protocol to specifically assess wave and tidal applications isn't available. Respondents reported that they were anticipating high direct and opportunity costs while such a protocol was developed and refined, and

  This is anticipated to lead to relatively high application and opportunity costs for the respondents as the data requirements for the consent application (e.g. effects, hazards and resources) are still undefined, baseline data to measure potential effects is not available and may need to be developed from scratch;
- The NIMBY syndrome and the relatively easy process for objections were cited as major concerns, along with concerns related to so-called 'vexatious' objectors within the RMA legislation;
- This uncertainty was also deemed to be compounded by the varying levels of expertise among regional councils in processing applications for offshore projects, which in turn was expected to create delays in the approval process as consent officers sought external advice to process new and unfamiliar scenarios. *It is also worth noting that none of the respondents had actually applied for consent although an application was likely from one respondent within 6 months.*
- Respondents also cited the provisions of the Marine Reserves Act, the Aquaculture Moratorium and the Foreshore and Seabed issues as having a significant impact on their risk management plans and capital raising activities due to the resulting uncertainty surrounding their ability to secure use, occupancy and/or property rights;
- Respondents cited the related issues of "first in first served" and "the free rider problem" as barriers to development of the industry in general. Better-resourced respondents expressed a reluctance to expend capital to 'blaze a trail' and develop a new industry, when doing so would lower entry barriers to 'cowboys'. *It is also worth noting that one respondent was thinking tactically about this issue and planned to exploit perceived loopholes in the RMA legislation to secure occupancy rights and block potential competitors. However, no detail on these loopholes was provided on the grounds of commercial sensitivity.*

Allocation Regime

- The issue of consent "squatters" was also raised, with parallels to the aquaculture industry where speculators sought to lock up, through the consent process, and then sell access to significant areas of coastline to aqua-culturists;

- Respondents operating as entrepreneurs or enthusiasts generally seemed to fixate on the bad news surrounding the RMA process, particularly with respect to cases from parallel industries like aquaculture and coastal development;

Restricted Activities

- Respondents also cited fragmentation in policy, implementation (by regional councils) and regulation (by government departments and agencies) as significant issues. Additionally, funding issues were perceived as being the reasons for lack of interest among specific government departments to address issues impacting on their industry unless specifically tasked to do so and only for the areas in which they have been tasked;
- Extent and the complexity of consultation were also raised as an issue. Large scale consent applications for wave and tidal are likely to treated as a restricted coastal activity. As such, consent applications would require to be approved by the Minister of Conservation as the final decision maker under the RMA. The likelihood also of additional information being sought by regional councils and other stakeholders will all contribute to higher costs disproportionate to the scale of the anticipated projects;
- The establishment of a responsible Allocation regime was raised as a priority activity for Government due to potential competition for the relatively few optimal tidal sites and more extensive wave sites;
- Finally, the effect of possible retrospective policy changes as the new Oceans Policy regime is implemented was raised as another issue that respondents felt could impact on their projects. *We suggest however, that this is simply a project risk management issue.*

b. INFORMATION

Respondents suggested that resolution of the following issues would greatly assist them in their projects:

- Resource data needs to be centralised, as it is currently fragmented and not easily accessible;
- Resource data need to be updated as the currently available information dates back to the late 1980's to work undertaken by ECNZ as part of its limited evaluation of wave and tidal energy technology. *It could be argued that this is a private good and ultimately the responsibility of a developer. A comparison with current wind projects indicates that in the case of wind, project sponsors have gathered the site information at their own volition*;
- Reasonably priced access to resource data needs to be facilitated. Respondents have reported issues accessing the ECNZ resource information from Shell, who purchased the information from ECNZ in the mid 1990's;
- At a national level, more extensive resource mapping and collation of site specific data would allow better matching of sites to projects of a particular scale or utilising specific technologies. The availability of site specific information could have a positive impact on the allocation regime by moderating competition for sites. *See comment above. We accept however, that there is a public good element in data gathering and collection but it is a matter of achieving the right balance*;
- More extensive and accurate site specific baseline data would enhance the impact assessment requirements of the RMA process. *We suggest that this is a sponsor's responsibility*;
- More information required on the environmental effects of subsurface structures. While structures would increase biodiversity, they could also attract more intelligent organisms e.g. dolphins wanting to play;
- More resource information will be required for ocean tidal vs. harbour tidal, in-situ production opportunities (e.g. hydrogen), materials design and development;

Whilst we may not be totally in agreement with the comments above, they reflect the realities faced by the current wave and tidal project sponsors in that the requirements being placed on them for detailed baseline data is inappropriate given the lack of information in the public domain. The result is thus, a potentially unfair burden is placed on such frontier activities. We refer to our comments in the main body of the report that in these situations, a greater risk tolerance is an appropriate response.

c. TECHNOLOGY & SPECIALIST EQUIPMENT

The issues reported centred on the availability and cost of the devices and the availability of equipment for their installation and deployment.

- Technology licensing costs are high despite lack of investment grade information (e.g. licence for Pelamis device estimated at NZD $400k despite no info on power curve or whole-of-life costs);
- Respondents believe that they will face delays in accessing specialist technologies (e.g. rigs) for installation of their devices due to the tight supply internationally;

d. INVESTMENT

As discussed previously, most of the projects are small in scale, run by enthusiasts (rather than power companies) and appear undercapitalised.

The following issues were cited as factors impacting on investment into their projects:

- The uncertainty caused by policy issues such as the Foreshore and Seabed debate and the Aquaculture Moratorium (around their perceived ability or otherwise to secure resource approvals, suitable sites and long-term operating approvals).
- Legislation restricts certain potential investors/strategic partners from entering the market– e.g. the Electricity Industry Reform Act requires separation of 'generation' from 'networks' or distribution and restricts, for example, lines' companies ownership of power plants.

e. INFRASTRUCTURE

The following infrastructure related issues were reported:

- Some level of government assistance will be required for to kick-start the development of offshore, onsite infrastructure;
- Access to the national grid will need to be facilitated;
- Determining responsibility for back up storage or co-generation facilities to smooth generation peaks;

f. OTHER

- The lack of a wave or tidal energy focused courses within existing Renewable Energy programmes courses at New Zealand universities will limit the development of the necessary skill base to service the industry. This is already being seen in the inability of the respondents to secure qualified people for small scale POC or demonstration projects. *In the view of the Study Team, this is an irrelevancy as core skills in mechanical engineering, power engineering, control systems and related skills areas are well covered by conventional tertiary engineering programmes. The issue is that these skills are in high demand and there are excellent other opportunities in the marketplace*;
- The single tank testing facility at Auckland University is not designed for the testing and development of wave and tidal devices. Respondents suggested that inadequate facilities will limit activity in the industry and force proponents to test technology offshore. *We note on the other hand, that overseas technology developers do not see this as a major issue as presumably they have access to their own in-house facilities or similar*;

f. Suggested Interventions

POLICY issues:

1. Government should consider taking the lead on facilitating the development of a specific assessment protocol for wave & tidal energy projects which reflects the risk profile of these types of activities. The protocol should take into account the scope of proposed projects (i.e. demonstration or proof-of-concept vs. commercial projects) and scale the data and consultation requirements accordingly, which should expedite the consent process to the advantage of the project sponsor;
2. Better communication on resource consent applications, outcomes and corresponding rationales could address the respondents' general fixation on failures in the RMA process;
3. An Web Directory to direct wave & tidal practitioners to appropriate experts and advisers would ensure that they receive timely advice to prevent poor information and misconceptions from becoming entrenched;
4. Government should also consider developing a training programme for Regional Councils around the Taranaki Regional Council's expertise in offshore resource permits in order to address the reported processing inconsistencies across other councils;
5. The centralisation of the approval process for offshore consent applications is a further intervention that Government should consider to streamline the consent process to ensure consistency of application of the RMA across the regional councils;
6. Government should also consider the policy framework to prevent the emergence of a Wild West scenario for wave and tidal energy previously seen in the aquaculture industry (i.e. first come first served, squatting, overlapping permits). One mechanism may be to implement an oil & gas exploration type work programme regime or fishing quota type regime;
7. Government should also facilitate wide consultation around the development of a Code of Practice to test RMA and identify issues specific to wave & tidal projects;

RESOURCE INFORMATION issues:

8. FRST support for a National Wave & Tidal Resource Database should be investigated. An estimate of $4.6m over 5 years has been provided for the development of a nationwide wave-rider buoy network that could provide data for wave & tidal, hazard investigations, navigation advisory, hydrodynamic modelling, marine structure design analysis. The precedence for FRST support for such an initiative has been set by its funding of the National Water Resources database established in the 1950's. Benefits would include more moderate competition for sites by allowing closer matching of technologies and generation capacities with specific sites;

INVESTMENT issues:

9. Addressing the policy issues discussed above will probably resolve the sovereign risk issues affecting inwards investment;
10. Government should probably consider mechanisms to facilitate information sharing regarding wave and tidal or renewable energy funding programmes;

INFRASTRUCTURE issues:

11. Government could facilitate discussion around industry funding the development of a 'Marine Energy Park' similar in concept to Wave Hub UK or the European Marine Energy Centre (EMEC).
12. This Marine Energy Park could operate as a technology incubator, testing ground for new devices and perhaps as a conduit for commercial energy parks located in close proximity. It could be expected that establishment of a second tank testing facility onsite would be integral to the Energy Park;

13. Government should be facilitating discussion between wave & tidal proponents, other power companies and the transmission company to develop a grid access protocol and also issues around the scale and responsibility for back up storage facilities;

g. Commercial Opportunities:

a. The establishment of a Marine Energy Park in New Zealand with a technology incubation focus could attract more wave and tidal R&D and demonstration projects from overseas. A number of respondents reported approaches from overseas companies interested in conducting wave and tidal R&D projects in New Zealand on the basis that New Zealand's lower population density will provide better access to test sites than in Europe.

b. Respondents have also suggested that government support for an international Conference on wave & tidal energy, given the current interest in the industry and the number of devices currently being commercialised, could go some way towards establishing New Zealand as a centre for wave and tidal energy R&D.

However, we note that Government may have other priorities under its Growth and Innovation Strategy in respect of where New Zealand might reasonably expect to achieve world class performance in new technology development.

Summary & Conclusion

Based on the interest and activity in the industry, and the range of devices currently being commercialised, the Study Team's provisional conclusion is that one or more business cases are about to emerge that could establish the platform for the growth of the wave and tidal energy industry in New Zealand.

In the short to medium term, the early wave and tidal energy projects are likely to address niche opportunities by seeking to offset some level of financial return against the opportunity to leverage or demonstrate the technology and/or secure access to the marine resource. Their underlying business cases are likely to be sub-commercial (or commercial only on a small scale), where their economic value is likely to be in terms of supporting network reliability rather than from pure generation potential.

While the respondents have indicated a preoccupation with resource issues, it is the Study Team's position that the wave and tidal energy industry represents a **technology rather than a resource opportunity** as we believe that technology risk issues, rather than access to the wave and tidal resource, that will form the main impediments to fully commercial deployment.

Finally, the Study Team suggests the following areas for further investigation:

1. A review of the development of the Wind Power industry could provide a more relevant 'guide' or critical success factors for the development of the wave and tidal energy sector than the Maui success story used for this investigation;
2. An analysis of the impact of relevant marine legislation and policy, and the Marine Reserves Act in particular, on the economic implications to the economy from the exclusion of optimal wave and tidal energy sites from commercial use;
3. A review of the Aquaculture sector could provide some useful lessons towards the development of an allocation regime for the wave and tidal industry that would encourage development of the industry while sanctioning inefficient use of the resource and anticompetitive use of the consent process.

CASE STUDY 4: ISSUES AND BARRIERS IN THE DEVELOPMENT OF A GAS HYDRATE SECTOR

a. Introduction

Although surveys have indicated the potential presence of large volumes of gas hydrate on the Hikurangi Margin off the East Coast of New Zealand's North Island and the Fiordland-Puysegur Margin on the West Coats of the South Island, the study team was unable to identify any participants in the oil and gas sector currently involved in or planning in the near term to participate in the economic development of the gas hydrate resource.

Consequently, this Case Study is based on feedback provided by members of the Science community, in particular GNS and NIWA.

b. Methane Hydrates

Natural gas hydrates are solid, ice-like materials containing predominantly methane and small quantities of other gases bound in a lattice of water molecules formed at moderate high pressure and at temperatures close to the freezing point of water. They are found in high concentrations in the "Hydrate Stability Zone", which are permafrost regions onshore and in ocean bottom sediments in water depths exceeding 450m.

One of their unique characteristics is that at sea level and at standard pressure, gas hydrates will disassociate or dissolve and the methane component of the hydrate lattice or cage will expand to 163 times its 'frozen' volume.

Gas Hydrates have attracted a lot of interest in the past decade because:

- Natural gas is expected to be the fastest growing primary energy source in the world over the next 25 years[23];
- Methane Hydrates constitute a potentially vast, relatively climate friendly and efficient source of natural gas, with large deposits located in close proximity to expected growth demand areas (e.g. Japan and India) compared to current resource areas for conventional gas[24];
- Significant methane hydrate deposits have been discovered within the jurisdiction of countries currently without indigenous oil or gas resources, e.g. Japan, India, Korea.

The "Central Consensus" estimate of the potential size of the methane hydrate resource worldwide is approximately 742,000 trillion cubic feet (tcf) of gas, compared to the estimated natural gas resources (excluding methane hydrates) of approximately 13 million tcf[25]. Irrespective of the actual figures involved, the magnitude of the potential resource base of gas hydrates could, if successfully commercialised, power the world for centuries.

c. The Importance of Methane Hydrates to New Zealand

New Zealand shares with the rest of the world, an ongoing and increasing demand for natural gas. The depletion of the Maui gas field and the lack of capacity from both existing wells and recent discoveries to meet anticipated demand in the future will force the introduction of new strategies to meet the energy supply gap. One potential opportunity may be the economic development of New Zealand's considerable methane hydrate resources.

New Zealand has the most promising known gas hydrate resource potential in the Southwest Pacific, with the Hikurangi Margin in particular deemed to be one of the most promising gas hydrate provinces in the world[26].

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[23] Natural Gas 1998: Issues And Trends; Energy Information Administration; p73

[24] Pecher, I.A & Henrys, S.A, Potential Gas Reserves In Gas Hydrate Sweet Spots on the Hikurangi Margin, New Zealand; Science Report No 23, Institute of Geological & Nuclear Sciences (2003)

[25] Natural Gas 1998: Issues And Trends; Energy Information Administration; p73

[26] Pecher, I.A; Gas Hydrates-Fuel Of The Future: A New Zealand Perspective, Presentation to MfE Workshop, Wellington, 13-03-2006

The Hikurangi Margin covers an area of approximately 50,000 km^2, extending from offshore Gisborne on the East Coast of the North Island southwards to offshore Marlborough. A recent study by Pecher and Henrys (2003) suggests a methane hydrate resource base of approximately 228.5km^3 of gas, with approximately 813 trillion cubic feet or tcf potentially recoverable. More importantly, Pecher & Henrys suggest that up to 10% of this area may be covered by "sweet spots" or areas with very high gas hydrate concentrations. They have further suggested that these sweet spots collectively could contain recoverable gas more than 6 times the size of Maui and more than 16 times the size of New Zealand's known gas reserves as of June 2002[27]. One sweet spot in particular is estimated to contain recoverable gas equivalent to 10% of the original volume of the Maui field.

Notwithstanding the technical complexities of extraction and production and a number of environmental concerns, gas hydrate sweet spots could provide an economically viable opportunity for New Zealand.

d. Gas Hydrate Research

Despite the huge potential economic opportunity, funding for gas hydrate research in New Zealand is not on par with the levels of research funding in Japan, Canada or the US.

Japan is the current leader in gas hydrate research, with an annual research budget of USD$50m and a target of commercially viable production of natural gas from gas hydrates by 2016. Since commencing in the mid 1990's, the Japanese programme has developed two exploration test wells, one onshore in the McKenzie Delta in the Canadian Artic in 1997 and one offshore in the Nankai Trough, Japan in 2000, as well as an onshore production 'concept' well in the McKenzie Delta in 2002. It is worth noting that as recently as March 2006, the Japanese programme has claimed that they expect to achieve their target of commercial production of gas hydrates within a 2-year window of 2016[28].

US gas hydrate research is close behind Japan, with US$50m in gas hydrates research funding committed over a 5-year period by the Federal Methane & Hydrate R&D Act 2000. The US research programme includes two dedicated Ocean Drilling Programme (ODP) legs at Blake Ridge on the US East Coast (which commenced in 1995) and at Hydrate Ride, off the coast of Oregon (which commenced in 2002), as well as collaboration with Japan and Canada in exploration activities on Alaska's North Slope.

The United States Geologic Survey has estimated Alaska's North Slope methane hydrates resources at 590 trillion cubic feet, with an additional 32,375 trillion cubic feet in the nearby Beaufort and Chukchi Seas. The location of methane hydrates near proven conventional gas reserves will ensure that Alaska's North Slope will be the premier area for methane hydrate research and future production in the near future.

India, Korea and China are also involved in gas hydrate research, predominantly into its characterisation as a potential energy source.

e. Gas Hydrate Research in New Zealand

Notwithstanding the relatively low levels of gas hydrate research funding, the quality of New Zealand research appears to be internationally recognised and valued. Evidence of this may be found in the participation of New Zealand researchers in a number of international research projects and also in their key role in driving and securing international support for the development of an "International Gas Hydrates Research Corridor" on the Hikurangi Margin.

There are two key Crown funded research projects currently underway:

- An investigation into the characterisation of New Zealand's gas hydrates as a potential energy source, funded by the Foundation for Research, Science and Technology (FRST) between 2003-09;
- An investigation into the relationship between the disassociation of natural gas from gas hydrates into the ocean under natural conditions and seafloor stability, sponsored by the Marsden Fund.

[27] Pecher, I.A & Henrys, S.A (2003); ibid: pg1
[28] Pecher, I.A. (personal communication)

The GNS gas hydrate Task Force led by Dr Ingo Pecher, a marine seismologist, currently heads New Zealand gas hydrate research. Members of the Task Force include:

- GNS - Stuart Henrys, marine seismologist; Susan Ellis, modeller; Kevin Faure, geochemist; Jens Greinert, University of Ghent, Belgium currently undertaking an EU Fellowship at GNS, geochemist;

The Task Force is currently in collaboration with:

- Otago University - Andrew Gorman, geophysicist; Gareth Crutchly and Miko Fohrman, PhD candidates and geophysicists;
- NIWA – Helen Neil, paleoceanographer and Steve Chiswell, oceanographer;
- GeoForschungsZentrum in Potsdam, Germany – Nina Kukowski, modeller.

International collaboration in 2006-2008 includes:

- A joint US-New Zealand funded expedition on the NIWA vessel R/V Tangaroa in 2006 to conduct high resolution seismic and piston coring of the Hikurangi Margin;
- A German funded expedition on the German research vessel R/V Sonne in 2007 that will assist them to address some of the objectives of the Marsden and FRST projects;

In the medium to long term, New Zealand researchers hope to leverage their research capabilities by:

- Expanding existing collaboration arrangements with Chile & Korea;
- Establishing an "International Gas Hydrates Research Corridor" on the Hikurangi Margin;
- Developing new collaboration opportunities through attendance at relevant international conferences;

f. Reported Issues and Barriers

POLICY

- The significance of the potential economic value requires policy debate now, and potentially the development of appropriate allocation regime to protect the resource while encouraging the development of a gas hydrates industry. Gas hydrates represent truly frontier opportunity, with limited information and high technical risk. Consequently, a robust yet risk tolerant regime will be required to facilitate development of the opportunity.
- Attention was drawn to the Marine Reserves Act 1971 which would potentially strand new opportunities as it prohibits protected areas (e.g. national parks) from prospecting and other commercial activities.

RESOURCE INFORMATION

- Although the Hikurangi Margin has been surveyed to some degree, more research is still required to map and appraise gas hydrate sweet spots in the area, and prioritise sweet spots for future development when the technology becomes available;
- More research into the characterisation of the New Zealand gas hydrate resource is also required as methane compositions in hydrates can vary geographically, with resulting implications for extraction and production;

TECHNOLOGY & EQUIPMENT

- Commercial production technology is currently unavailable, although conventional oil and gas technologies could be adapted;
- Significant technical issues currently exist around extraction and transportation of gas hydrates;

INVESTMENT

- The high levels of gas hydrate research may be an indicator of the potentially high cost of extraction and production technology when they become available;

- Access to the technology may require some level of government involvement or support, as occurred with the development of Maui;
- Attracting inwards private investment on the scale anticipated will require attractive policies and incentives OR better promotion of the higher prospectivity of the New Zealand gas hydrate resources relative to Alaska and Gulf of Mexico, the current focus of hydrate research by USA, Japan & Canada.

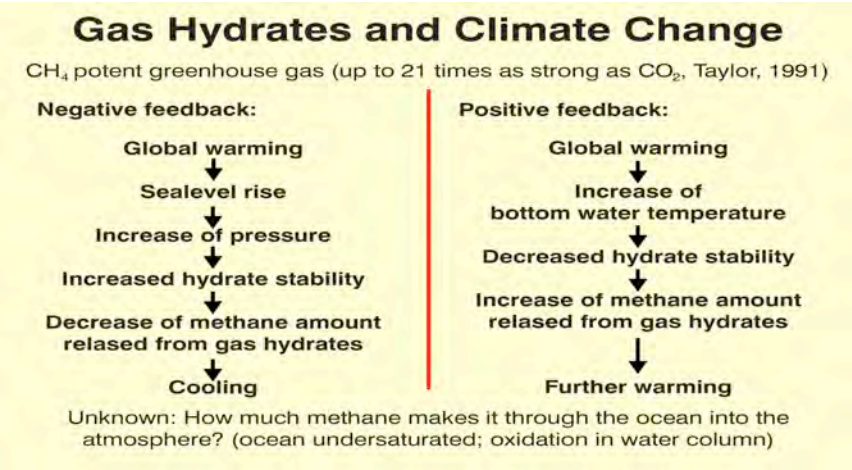
INFRASTRUCTURE

- Existing onshore Taranaki infrastructure could be utilised if the technical issues around extraction and transportation are successfully addressed;
- There may also be a business case for the development of new infrastructure on the East Coast of the North Island to be in closer proximity to the sweet spots on the Hikurangi Margin. Such infrastructure is likely to follow successful petroleum development in the region;

ENVIRONMENTAL

There are a number of environmental issues currently being debated internationally around gas hydrates.

- The "Smoking Gun" hypothesis suggests that the release of methane into the atmosphere from disassociating gas hydrates creates one of two climate change scenarios:



Source: Ingo Pecher: Presentation to MfE Workshop 13/0/2006

- There is also the ongoing debate around the proposition that the extraction of gas hydrates from the seabed could affect seabed stability and lead to landslips or slides, resulting in tsunamis;
- Finally, there are "chemo-synthetic" bio organism colonies associated with gas hydrate deposits that not well understood or researched. This lack of information will have a bearing on the ability of pioneers to secure resource consents under the present consent regime.

g. Suggested Interventions

1. Respondents have suggested that Government should lead a national or international discussion on gas hydrates, while the industry is still in formative stage, to identify issues pertinent to economic development of New Zealand's gas hydrate resource to ensure adequate debate and encapsulation of issues into policy;
2. Respondents have suggested that policy should ensure that relevant Ministers retain their discretion to permit new or novel opportunities, such as gas hydrates, to emerge in New Zealand's ocean territories. *The key point here is that the regulatory environment needs flexibility to provide for new activities*;

3. Given the potential economic significance of gas hydrates, both respondents and the Study Team agrees that policy needs to be set before 'trailblazing' should be allowed to commence;
4. We agree that the policy environment should attract inwards investment for exploration, discovery and development. Gas hydrates could provide a long term opportunity to replicate the skills and engineering base that the development of Maui catalysed and NZ has developed into a significant export opportunity since;
5. The respondents, participants at the MfE Workshop and the Study Team agrees that a closer integration of science policy (e.g. mapping sweet spots and characterising hydrates) and a 'national' engineering policy (i.e. to develop 'enabling' skills and technologies) with Oceans policy in the short to medium term should occur as a strategy to facilitate the eventual commercial development of the gas hydrates opportunity,
6. Further to this, we concur that in support of the development of a gas hydrate industry in New Zealand, Government should actively facilitate the opportunity development continuum from science investigation, to resource mapping, to a pre-commercialisation stage, at which point the typical oil & gas field development process can kick in prior to commencing commercial production;
7. Finally, we also agree that a strategy needs to be developed to ensure that the mapping and quantification or appraisal of hydrate reserves, including intensive testing of sweet spots on the Hikurangi Margin, becomes a strategic national priority.

Summary & Conclusion

The economic development of New Zealand's Gas Hydrates resource represents a truly classic frontier opportunity, involving high risk and potentially higher rewards on a scale vastly larger than any of the other case studies considered in this investigation.

Given the significant economic potential of its successful commercialisation, the study team suggests that further investigation is required into the following issues:

- **To what extent and in what timeframe does NZ need to prepare for the economic development of this resource?** Given that technology is not currently available for extraction and production, should New Zealand wait till it becomes available to begin developing policy or should discussion on an appropriately risk tolerant policy framework be commenced now?
- **At what point and in what role should government become involved in the development of the industry?** Using the analogy of gas hydrates as a "ripening crop" waiting to be harvested, it is important to note that pioneers may be prepared to accept "green fruit". Consequently, there is a dynamic that has to be actively managed between ensuring that policy enables pioneering activity while simultaneously protecting the national interest to the extent that "picking winners" does not prevent an optimal development of the resource opportunity. *Again, the key point is that the regulatory regime needs flexibility to allow unfettered entry and exit*;
- **Are gas hydrates governed by the Crown Minerals Act and if so, are the provisions appropriate to the sector?** As gas hydrates fall within the "hydrocarbon" definition of the Crown Minerals Act, prospecting permits can be granted under the current regime. However, an analogous case has arisen in respect of minerals (notably gold) associated with active and extinct volcanic vents. In 2002 a very large permit covering virtually all of New Zealand's potential resources of this type, was given to an Australian entrepreneur. While this may or may not lead to the emergence of a viable new industry, the possibility that a monopoly situation might arise that limits other potential entrants should exploration prove successful may be undesirable, and this consideration needs to be carefully balanced with the need for a property right of sufficient scale to encourage investment.

  Additionally, the conventional permitting regimes may need to be adjusted as the development of the gas hydrate opportunity is likely to fall outside the timeframes that

apply under current act (i.e. a 10-year permit term) thereby requires a more flexible permitting regime;

- **What is the optimal regime to enable the Crown to capture a benefit from the development of the resource?** Will a unique regime be required or will the existing regime support the expected low margin high volume business case? Without an appropriate regulatory framework in place, there may not be the required allocation and environmental management regimes to maximise their resource potential.
- **What is the optimal policy framework for gas hydrates?** Given the size of the potential economic opportunity and the international interest, the Study Team suggests that it needs to be based on clear principles, contains codes of practice that constrains proponents to act competitively and also provides clear certainty that projects will not be compulsorily acquired, nationalised or taken over.

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APPENDICES

APPENDIX 1: LIST OF RESPONDENTS

Name	Organisation	Contribution
Brian Gundersen & Don Turley	Kensington Swan	RMA / Legislation / Maui
Tara Ross-Watt	Maritime NZ	RMA / Oceans Policy / Oceans Jurisdiction / Wave & Tidal
John Huckerby	AWATEA	Wave & Tidal
Murray Hill	Meridian Energy	Wave & Tidal
Gavin Fisher & Micah Sherman	Pacific Clean Energy	Wave & Tidal
Paul Henson	Pearson Innovation	Wave & Tidal
Anthony Bellve	Crest Energy	Wave & Tidal
Dennis Jamieson	NIWA	Wave & Tidal
Paul Hazledine	NGC	Exploration / Maui / Gas Hydrates
Geoff Cassells	Ex Shell	Exploration / Maui
Clyde Bennett	Tap Oil	Exploration
Dr Mac Beggs	GeoSphere	Exploration
Ingo Pecher	GNS	Gas Hydrates
Ian Wright	NIWA	Gas Hydrates

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