MAKE WAY
TAPUAE ROA
FOR TARANAKI

Energy Futures Action Plan

March 2018

A plan to prosper Taranaki

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Executive Summary

Energy Futures opportunities are blue skies and high risk, but potentially high return. They build on Taranaki's world class energy capabilities, natural resources and infrastructure, and have been identified as a primary growth sector for Taranaki being fundamental to the success of our region for generations to come.

The energy sector represents almost 30% of Taranaki's GDP, and makes a significant contribution to the region's service sector. It is our economic backbone, and a primary source of wealth.

The global energy sector is amid a significant transition, driven by new technologies, changing consumer preferences, and efforts to reduce pollution and greenhouse gas emissions. The International Energy Agency conservatively projects that in the next five years to 2022, growth in renewable electricity generation will be twice as large as that of gas and coal combined. This transition will create demand for new products and services both in New Zealand and in export markets.

Taranaki is well positioned to participate in the growing renewable energy markets. Built on the energy sector, we have a world class industrial and technical capability across engineering, fabrication, manufacturing, construction, logistics, operations, maintenance, and health and safety.

However, the region lacks tertiary and research institutions and is at risk of losing skills, capability and infrastructure when the existing industry activity fluctuates. New renewable and low emission energy technologies are challenging to commercialise and the Energy Futures work stream aims to consolidate activities in the region and leverage existing industry and skills to create new energy opportunities for Taranaki and New Zealand.

The desire for renewable low emission transport and heat solutions is also driving international interest in hydrogen as a clean energy carrier. McKinsey estimates that Hydrogen Council member and government investments in hydrogen of US $20-$25 billion per annum could create a self-sustained market by 2030, turning over more than $2.5 trillion and creating some 30 million jobs along the value chain.

Taranaki is particularly well suited to pilot a zero-emission hydrogen ecosystem. It has significant water, wind and solar resources, established gas infrastructure, and a deep-water port with convenient geographical position for access to Australia and Asian export markets. Uniquely, Taranaki is also home to the largest hydrogen producers in NZ, the significant technical capability they possess, and a geographical cluster of heavy industry users. These assets could be leveraged by the H2 Taranaki initiative.

The Energy Futures Action Plan is ambitious and reflects the desire of the Taranaki energy sector to continue "punching above its weight".

Two major initiatives are proposed:

- **New Energy Development Centre**
  Establish a New Energy Development Centre in the region to support new energy technology development and commercialisation. The aim is to facilitate new energy demonstration and scaling projects that typically have significant capital requirements, longer timelines, and infrastructure components that can make them challenging to enact within existing innovation and commercialisation programs. The Centre will partner with local industry and research institutions to create a testbed environment for national and international energy research demonstration.

- **Hydrogen Energy Ecosystem – "H2 Taranaki"**
  Establish a hydrogen based energy ecosystem for the demonstration of zero emission transport solutions for heavy transport, renewable energy storage solutions, industrial feedstock and heating, and the export of renewable energy. The initiative will enable aggregation of demand and the development of public infrastructure that will provide a platform for scaling and participation in international supply chains. The initial focus would be on the development of refuelling infrastructure and piloting of hydrogen transport solutions.

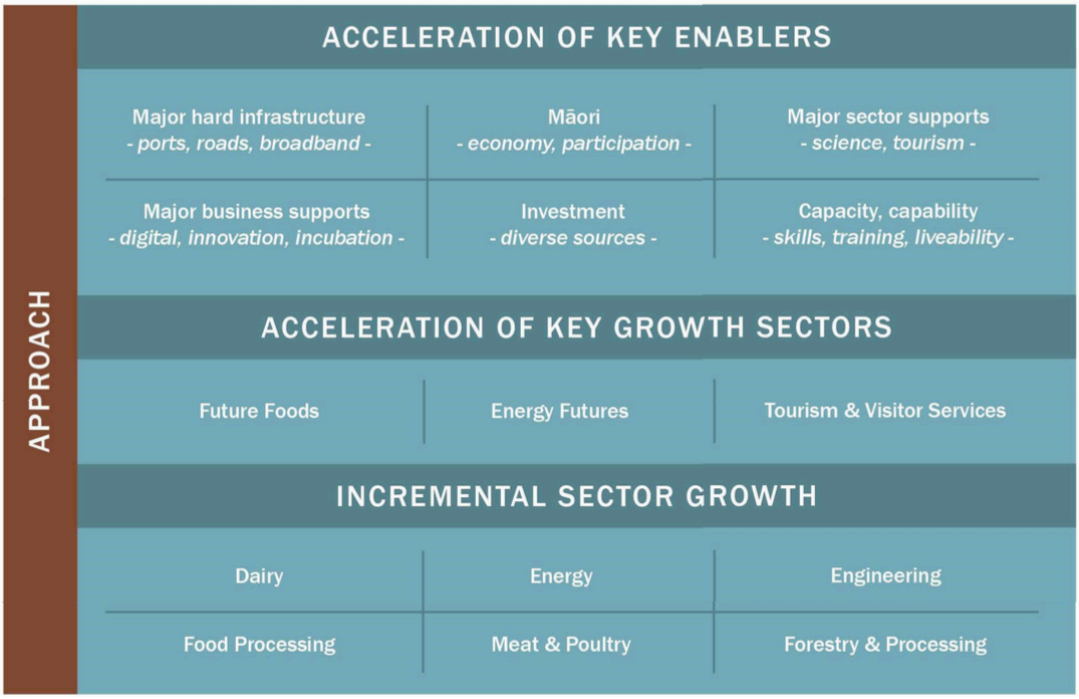
Three support actions are also proposed:

- Branding and marketing of Taranaki's energy vision and capability.
- Community engagement to create awareness, support and participation.
- Industry and public-sector engagement to secure critical infrastructure and skills, and promoting the development of spin-off businesses in the region.

Contents

Background

Energy Futures has been identified as a key regional growth sector by the Tapuae Roa strategy. It is a sector capable of accelerated growth, in addition to the incremental growth of the region's large, established sectors. It is supported by the key enablers.



Energy Futures will be fundamental to the success of our region for generations to come. It is the pathway to provide secure and sustainable energy for Taranaki and for New Zealand as a whole, that builds on existing regional strengths.

Global context

Significant structural shifts are occurring that will impact the supply and demand for traditional fossil fuels over the next 10 to 50 years. The largest economies in the world (Europe, North America, and China) are leading the transition to renewable energy and low emission fuels, and represent over 70% of new vehicle sales globally. European countries are banning new diesel and petrol vehicles starting with the Netherlands and Norway in 2025, Germany from 2030, and the UK and France from 2040. Similarly, increasing regulations around industrial emissions are driving development of low emission process technologies. Manufacturers, suppliers, and customers are looking for solutions, which creates opportunities for progressive regions to develop and test new energy technologies and develop low emission energy solutions.

New Zealand energy context

New Zealand enjoys a high proportion of renewable electricity production with approximately 85% of the electricity supply from renewables (wind, hydro, solar) and low emission (geothermal) sources. However, renewables only account for 40% of NZ's total energy use and transport in particular is dominated by oil imports.

The New Zealand Labour Green Coalition Agreement states the ambition to:

1. Generate 100% of its electricity from renewable sources by 2035
2. Achieve net zero carbon emissions by 2050
3. Make the government's vehicle fleet emissions free by 2025/26

The New Zealand Energy Efficiency and Conservation Strategy (NZEECS), championed by MBIE and EECA, is seeking to address the areas that remain high energy use and high GHG emission sources. The NZEECS focuses on three priority areas to achieve its goal and objectives:

- Renewable and efficient use of process heat
- Efficient and low-emissions transport
- Innovative and efficient use of electricity

To achieve these aspirations, several new energy technologies need to move from research into development and commercialisation. Examples include biocatalysts for waste treatment and bio-fuel production, industrial emission reduction technologies, waste to energy technologies, energy storage, micro-grid systems, next generation of renewable marine energy technology, smart grids, and zero emission transport solutions. The proposals outlined in this plan seek to encourage new energy technology development and adoption and are aligned with the Labour / Greens agreement to stimulate up to $1billion of new investment in low carbon industries by 2020, supported by a Green Investment Fund of NZ$100m.

Regional context

Taranaki is the heart of the New Zealand Oil and Gas industry. It is New Zealand's largest exporter of energy and has a high energy production and industrial use per capita. It is also a key player in energy generation and distribution in New Zealand. The energy sector covers oil & natural gas production, and related processing and energy generation and distribution. These industries are Taranaki's largest contributors to GDP, accounting for NZ$ 2.1 billion in 2016. The sector represents almost 30% of the regional economy,

provides high income jobs, and supports a significant portion of the engineering and construction activity based in the region.

The energy sector also creates demand for several service/supply chain sectors that are strong in Taranaki including freight and logistics, fabrication, and professional services. It attracts highly paid temporary workers to the region who create additional income for Taranaki accommodation providers, restaurants and retail businesses.

While Taranaki is well positioned as a natural gas producer being a lower emission alternative to coal and oil, industry growth and export development will continue to be dependent on international markets and successful natural gas resource exploration, which has declined rapidly in activity over the past five years. There is a near to mid-term imperative that support continues for the existing energy industry allowing growth to support New Zealand through the energy transition and displace higher GHG forms of energy. At the regional level, this will require ongoing transparency, community engagement, and alignment with district planning activities.

Taranaki has the highest GHG emissions per capita in New Zealand due to its strong industrial base, and is home to large logistics companies which are likely to be impacted by policies to reduce emissions. Freight transport is key to the regional economy due to its geographic isolation. The development of low emission transport solutions will be key to the region's future prosperity.

Taranaki is in a strong position to "ride the wave" of the global transition to low emission energy. However, Taranaki also risks being caught by the breaking wave of disruption of the conventional energy economy. Without action, the region's economy is at risk with significant implications for New Zealand's economy and energy security. There is a strong driver for Taranaki to demonstrate leadership in future energy technologies and their adoption to future proof and enhance the regional economy.

Energy Futures Vision

The Energy Futures vision for Taranaki is that in 50 years' time, Taranaki will:

- Have strong, secure and sustainable energy and petrochemical industries.
- Be an exporter of new energy ideas, solutions, and technology nationally and internationally.
- Be an exporter of renewable energy.
- Be a location of choice for new energy companies and energy technology developers.
- Have affordable, secure and sustainable energy that provides a competitive advantage for regionally. based industries, and attract new businesses to the region.
- Be a national and international energy leader.

The journey involves:

- Leveraging the existing strength of supporting enablers and infrastructure.
- Creating a critical mass of diverse energy related businesses in the region.
- Increased Maori involvement in the sector.
- Providing challenging, innovative and inspiring job opportunities.
- Improved training and educational opportunities.
- Retooling of existing industry.
- Dissemination and leverage of skills, international connections, and innovation concentrated in the highly skilled energy sector.
- Attracting new businesses, talent and investment.
- Developing and demonstrating new energy technologies and models.

Why?

- To provide for future generations.
- To care for the region and nation's environment, and contribute to the global climate change challenge.
- To energise Taranaki to be the "smart place" to live and attract new talent to the region.
- To enhance the region's standard of living and quality of life by creating new sustainable industries and attracting investment to the region.

Opportunity identification and assessment

The Energy Futures focus is on identifying opportunities that can provide growth beyond the incremental growth of the existing energy industry. As a result, the opportunities may be perceived as high risk, but are also potentially high return. They build on Taranaki's world class energy capabilities, natural resources, and infrastructure, and could be a key driver of growth in the region.

The action plan's focus is on activities that have the potential to:

- develop and diversify the region's technical capability;
- leverage the natural and human resources of the region;
- capture new export opportunities;
- attract local and international investment; and
- provide tangible and measurable economic outcomes.

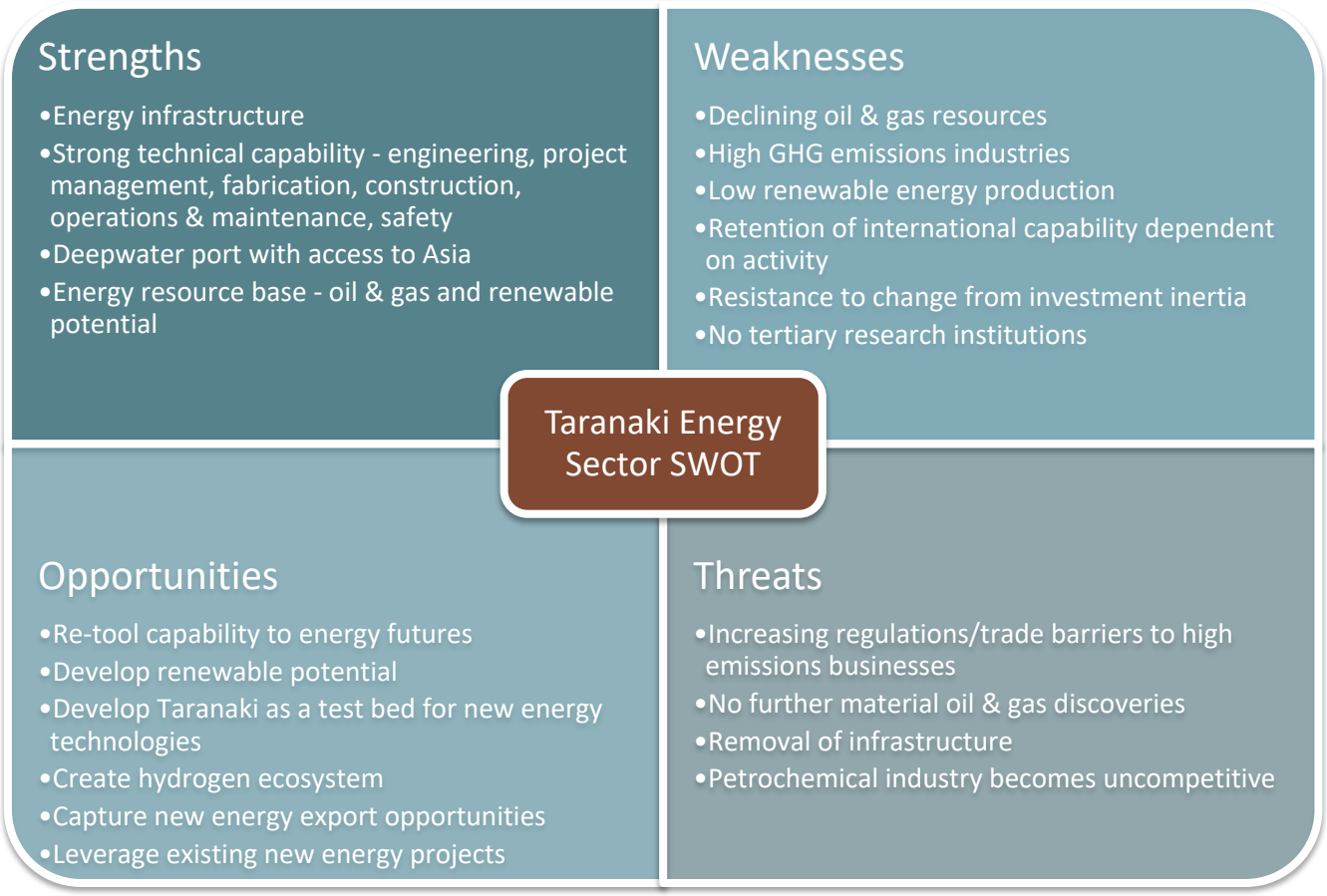
Workshops and consultations were held with a broad cross-section of the energy sector and key stakeholders to help frame the energy futures opportunities. The process confirmed the awareness of a global transition to lower emission energy sources and a desire for the region to be a part of a more sustainable and renewable energy future.

Four key action themes emerged from the workshops and consultation process:

- Refocusing our strong technical capability
- New energy export opportunities
- Reducing GHG emissions from Taranaki's energy intensive industries (future proofing)
- "Taranaki as a testbed"

These themes are summarised in detail in the Appendices and have provided valuable input for the analysis and action plan development.

A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis has subsequently been utilised to structure and focus the opportunities.



Taranaki Energy Sector SWOT Analysis

Strengths and weaknesses

Taranaki has fundamental sources of competitive advantage to support the Energy Future's Action Plan:

- Significant water, wind and solar resources that create a natural competitive advantage compared to other regions in NZ.
- A deep-water port and geographic position that provides access to Australian and Asian export markets.
- It is the heart of New Zealand's oil and gas operations.
- The region has established energy generation and electricity and gas distribution infrastructure.
- It has significant petrochemical, engineering and manufacturing capability.
- The region has the skills and capability to support new energy technology & infrastructure development:
    - world class engineering design and project management;
    - manufacturing, on and off-shore fabrication and construction expertise;

  - operations & maintenance skill that could be re-directed, retrained and re-tooled for future energy industries;
  - leading safety culture with experience of working safely with hazardous materials, gases, drilling for oil and gas, and high voltage power; and
  - a highly skilled oil and gas sector employees with strong international connections.
- Taranaki's energy industry is skilled at innovating, adopting, and adapting advanced technologies to improve competitiveness.
- The Taranaki community is positive, energetic, and pragmatic and has been largely supportive of the existing energy industry.
- Local and regional government support.

However, the region lacks tertiary institutions and research institutes, and as a smaller and geographically isolated region in New Zealand lacks the technology development and commercialisation support available in larger centres. Large players have tended to directly acquire research and development capabilities from global networks when they have a perceived requirement so may not recognise the need to use Taranaki based development services.

The region has little installed renewable energy generation and its geographic isolation creates a natural discouragement of the electrification of transport due to lack of range.

Threats and Opportunities

While Taranaki lacks tertiary research institutions, the region's industry has a track record of innovating and adopting new technologies. The region can harness and expand that capability with a focus on the application of research and commercialisation and establish "Taranaki as a Testbed". This would create an enhanced, more robust technical capability and strengthen connections between industry and research institutes and universities to increase R&D intensity in the region.

Energy technologies are often challenging to commercialise as they require significant capital, engineering, and commercial skills not typically found in the start-up ecosystem, and they fall outside the mandate for tech incubators and typical early stage funding sources. However, technology development, demonstration and scaling will be critical to reducing GHG emissions of existing industry in the region.

Key areas for reducing the regions GHG emissions include carbon capture, storage and use, industry energy efficiency improvements, and alternative low emission energy sources. The application of carbon capture and alternative industrial processes has the potential to lower the region's GHG annual emissions by 2-3 MT CO_2e.

Extension of the solutions and strategies developed beyond Taranaki to similar industries in other regions of NZ has the potential to achieve significant national reductions.

The region can build upon leading edge work already being undertaken including waste to energy, hydrogen market development, micro-grid development, and smart grid applications. These projects are excellent examples of leveraging the Taranaki geography and capability, but they could benefit from broader industry and community awareness of the initiatives, better coordination between activities, and improved funding pathways.

Potential energy export opportunities identified during the industry consultation process included LNG, hydrogen, and ammonia. LNG and ammonia export industry development both rely on new natural gas discoveries. Hence, a key threat is the lack of oil & gas exploration activity. The investment climate and initiatives required to encourage exploration activity is dominated by macroeconomics and primarily involves central government interaction with the existing oil and gas sector including representative associations such as PEPANZ. The cost of one exploration well is typically in the range $20m-$60m with a success rate of 1 in 7-10, highlighting the economic risk given the probability of a successful discovery.

The key activities identified in this action plan seek to maintain the core technical capability and supply chain required to develop gas discoveries in the region by diversifying the energy industry and increasing the region's resilience to periods of reduced exploration activity. Energy Futures action plan also recognises that regional government has a continuing role to play to ensure favourable conditions for exploration in the region.

Taranaki has been identified as a potential location for hydrogen export by a number of Asian consortiums actively looking for secure supply of renewable hydrogen. This opportunity has gained further momentum with the recent announcement of a joint venture between Taupo based Tuaropaki Trust and Japanese construction company Obayashi to build a pilot hydrogen production facility utilising geothermal energy. Hydrogen production and export could become a significant source of economic growth for the region. The action plan initiative "H2 Taranaki" that aims to develop a domestic market and capability, combined with maintaining key infrastructure, are initiatives designed to support Taranaki's attractiveness as a location for large scale hydrogen export opportunities.

Japan, Korea, China, California, South Australia and several European countries including Germany, Denmark, Norway and the UK, have developed strategies and roadmaps for hydrogen technology adoption and infrastructure investment. Germany is investing €3.4billion 2017-2026 on hydrogen market activation measures, including investment in infrastructure and mobility, now that technologies are commercially available.

Hydrogen can become the backbone of low emission energy production, storage, distribution, and use for transport fuel, heating, manufacturing, and industrial feedstock. It is therefore one of the technology areas capable of reducing regional GHG emissions. When used in fuel cell electric vehicles, hydrogen can provide increased range and the ability to carry heavier loads than battery-only electric vehicles. These features become increasingly important in commercial mobility applications in geographically isolated regions such as Taranaki.

Taranaki has a long history in the production and use of hydrogen as a key feedstock of the petrochemicals manufacturing sector. Hydrogen is the major product, together with process heat, derived from natural gas steam reformation utilised in both the manufacturing of ammonia, a primary component for agricultural fertiliser, and methanol. Taranaki's large gas sector, with hydrogen experience, is well suited to retraining and retooling to support a hydrogen-based ecosystem, and participating in a growing global supply chain.

Actions

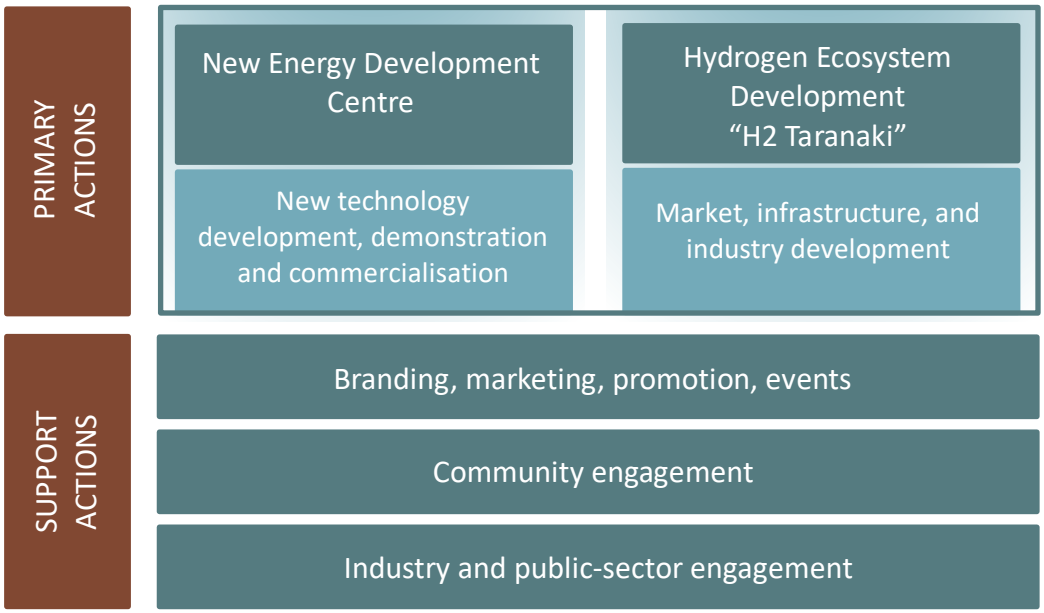
The action plan aims to overcome inertia. Encouraging and incentivising change is a key driver behind the plan rather than placing additional burdens on the existing industry in the region. The existing sector is trade exposed and needs to maintain competitiveness. However, a number of the energy futures opportunities could be seen to represent technical and commercial risk and not necessarily align with the existing industry participants activities, so industry support will require capable leadership and government intervention.

Two key interventions to achieve progress are proposed:

- Establish the New Zealand New Energy Development Centre
- Establish "H2 Taranaki" to implement a hydrogen-based energy ecosystem

Support actions:

- Branding and marketing of Taranaki's energy vision and capability
- Community engagement to create awareness, support and participation
- Industry and public-sector engagement and alignment to secure critical infrastructure and skills, support and participation, and to promote the development of spin-off businesses in the region



Elements of the Energy Futures Action Plan

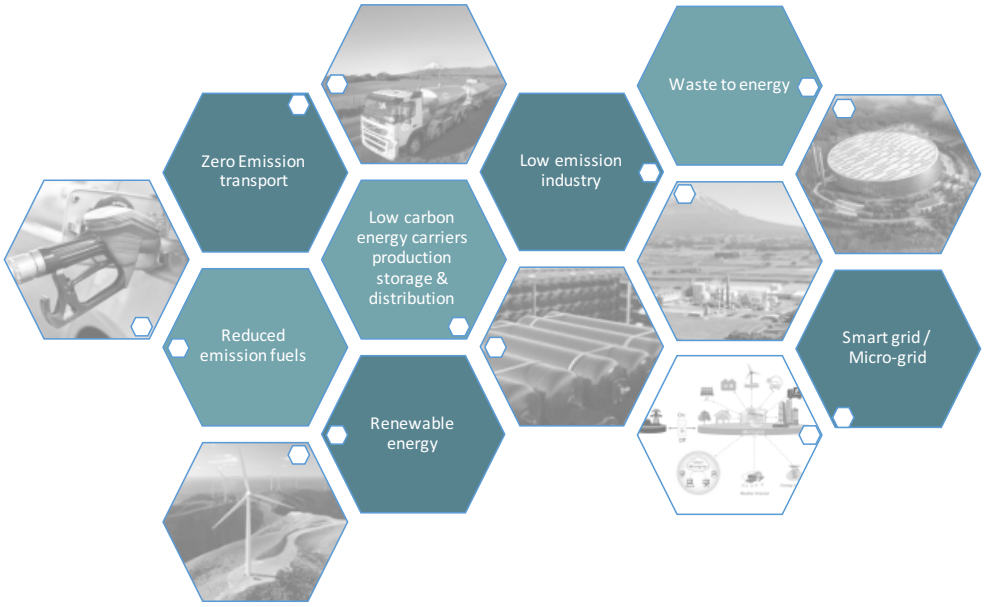
The Centre and H2 Taranaki will both have a clear mandate to support and encourage local companies to participate in their projects. There will also be a preference for initial projects to involve community and Maori and build local skills and expertise.

NZ New Energy Development Centre

The New Zealand New Energy Development Centre will create a focal point for new energy development projects in the region. The Centre would support and seed new energy technology development and demonstration projects that leverage regional capability and infrastructure, and support the region's transition to lower GHG emission energy sources.

The emphasis will be on the development, demonstration, piloting, testing, and commercialisation of new energy technologies and models to build an international reputation and attract projects to the region.

The Centre will boost commercialisation through the capability to quickly and efficiently research, develop, evaluate, and demonstrate products and services. It will provide linkages with technical expertise and world class research, and support the development and commercialisation of new/ clean energy technologies.



The New Energy Development Centre will be responsible for delivering an integrated technology development program. It will:

- Develop a new energy opportunity funnel by identifying technologies that have the maturity for test/pilot deployment.
- Create technology maturation roadmaps for new energy technologies, aimed to mature researched technology into pilot/full scale development.
- Create and maintain an inventory of local resources and capabilities to facilitate joint projects.
- Identify research and development themes with greatest potential impact for the region.

- Identify and resource regional competence gaps for development projects.
- Identify partners and potential funding sources for development and demonstration themes.
- Link Taranaki companies to national and international research capability.
- Kick-start projects by providing IP landscape mapping, techno-economic analysis and business case. development, and access to R&D and other funding sources.
- Attract international projects and funding to the region.

The creation of the Centre is also designed to help address regional barriers identified:

Barrier	Intervention
Sectors of the energy industry operating as silos without cross sector alignment	The Centre would become a focal point and facilitator between sectors. Whole of industry events could be organised that break down industry silos and encourage the collision of ideas. Events may also include leveraging speakers from technology and innovation hubs to share approaches and ideas.
Investment inertia - companies heavily invested in status quo	The Centre would provide vision and roadmaps to help existing industry understand new energy opportunities and their impact. It will also assist industry to pilot new technologies.
Perceived lack of financial incentive to reduce GHG emissions	The Centre would help build business cases and visibilities on the emerging technologies and their economic impact and viability to inform government policy.
Lack of funding for new infrastructure and loss of infrastructure (eg. HV power to Port Taranaki)	The Centre would help develop business cases to support grant applications and investment, and to underpin future proofing the region's infrastructure.
Lack of funding for technology demonstration	The Centre would build business cases, facilitate structures such as joint ventures, and identify funding pathways for technology demonstration and commercialisation. It will use a Technology maturation process that moves technologies from the development centre into a (multi) business environment. It will seek investment from multiple sources including corporations in the region.
Requirement for industry and training organisations to "re-tool" and/or refine technical capability	The Centre would work with industry and tertiary institutions (eg WITT locally and NZ organisations such as MITO) to identify the energy futures capability requirements. The technology road-mapping and project pipeline will give visibility on near and mid-term technologies. This is also a key action of the talent, skills, and innovation workstream.
Lack of regulatory framework for new energy technologies	The Centre would work with central government and industry to identify best practice and ensure efficient, safe, and practical implementation of technologies.
Perception that Taranaki is "Old Energy" and therefore not part of New Zealand's Energy Futures	The Centre will be the face of the regions energy technology leadership and champion the region as the place to develop new energy technologies.
Potential for loss of technical capability from the region due to lack of oil & gas activity	The Centre will, through all its activities, be a key driver to develop new energy technologies and businesses that in turn provide high quality jobs and enhance the attractiveness of the region. It will help provide resilience through diversification of energy activity in the region.

Barriers addressed by the Centre

The core competencies of the Centre would be:

- IP landscape mapping and strategy development
- Techno-economic analysis and business case development
- Technology commercialisation
- Research and development partnerships and project management
- Stakeholder and community engagement, and promotion and regional capability advocacy

Technology themes identified for the Centre are outlined below and draw from the industry consultation:

Technology opportunity	Outline
Zero emission transport (BEV and FCEV)	Roll-out of EV infrastructure and light vehicle technology has accelerated in recent years with strong central government support. The existing battery technologies have limited practicality/commerciality for regional applications due to range, weight, and recharge time requirements. Heavy transport electrification requires further maturation. Taranaki, with its large distances and hub-based transport operations (dairy, energy, civil services), is a natural test bed for heavy transport electrification solutions with range extension technologies such as fuel cells (methanol, hydrogen, DME) and emergent battery technologies.
Reduced emission fuels (Synfuels, biofuels including GEM)	Technologies that leverage existing infrastructure and vehicle assets provide transitional solutions for both energy security and a degree of net emission reduction. With the existing petrochemical expertise and facilities in the region, the opportunity exists to mature alternative fuel solutions such as methanol and develop renewable methanol production to achieve net zero emissions.
Waste to energy	Waste to energy typically takes the form of generation, collection and use of biogas (primarily a mixture of methane, carbon dioxide and hydrogen sulphide); or thermal energy production. Initiatives are already leveraging off the gas processing and plant fabrication capability in the region to create commercial solutions. This technology could be further extended to develop both industrial scale products and scaled modular solutions for smaller communities. Biogas also marries well with hydrogen technology, either as a feedstock for production, or combined to produce pure methane for injection into the natural gas grid.
Renewable energy technologies including marine energy technologies	Taranaki has significant renewable energy potential due to the western coastline and mountain topography, yet only a limited number of developments exist. The intermittency of renewables and the dominance of gas thermal generation in the region has traditionally challenged the economics of such projects. Commercialisation of energy storage and "power to X" technologies are shifting the economics of small to mid-scale projects. Opportunities have been identified in the region that would leverage the existing industry, infrastructure and capability.
Smart grid and micro-grid technologies	Microgrids are an integrated set of power generation, distribution and system management capabilities that increasingly include Distributed Energy Resources (DER). These DER include multiple generation sources (i.e. solar PV, diesel or biogas generation), storage and demand responsive consumer appliances or loads (i.e. the Internet of Things (IoT); including connected electric vehicles). Microgrids can be off-grid integrate with existing grids. Microgrid enabling technologies are forecast to grow rapidly into a multi-billion-dollar per annum market (Navigant Research, 2015). As the cost of these technologies falls dramatically and the intelligence in their integrated deployment increases, new opportunities for businesses and consumers are opening. Resolving the challenges in deploying microgrids can boost New Zealand's economic performance through, new options for resilient power supplies, rural and agricultural development and efficiencies in power infrastructure and consumer investments.

Low carbon energy carriers: production, storage and distribution	Low carbon energy carriers (eg "green" ammonia, hydrogen) have the potential to provide true zero emission transport solutions, large scale renewable energy storage (managing the intermittency challenge), a major reduction of industrial GHG emissions, and large scale renewable energy export potential. The core technology required to produce, store, and distribute hydrogen has matured to the point where staged deployment of ecosystems is accelerating globally. However, emerging technologies such as liquid organic hydrogen carriers (LOHC), methane cracking and photo-chemical hydrogen production will warrant further development. "Green" ammonia requires significantly more development to be economic.
Low emission industrial processes	A significant amount of research is being conducted globally and in New Zealand on emission reduction technologies such as carbon capture and storage (CCS), carbon capture and use (CCU), and low/zero carbon alternatives for industrial processes. Taranaki with its existing high emissions industry and engineering and fabrication capability, is a natural location to develop pilot and up-scaled plants as "bolt-ons" to existing facilities.

Technology themes for the Centre

First Steps - NZ New Energy Development Centre

IMMEDIATE Priorities

- Proposition development
  - Map current regional capabilities and resources
  - Map current industry research links – NZ and international
  - Confirm research and development technology themes
  - Identify initial projects and potential funding sources and in-region partners
  - Engage with other applied research and development initiatives in NZ and overseas
  - Engage with research institutions in NZ and Callaghan Innovation
  - Ensure alignment with Tapuae Roa and coordination other actions including innovation hubs
- Preparation of a detailed development plan
  - Detailed assessment including costs and shareholder/stakeholder indications over a 5 to 10 year period
  - Governance, operational guidelines, key roles, and staffing
  - Secure core funding commitments and investment for the first five years of operation

MEDIUM TERM Priorities

- Establish the Centre
  - Appoint initial Board
  - Hire CEO and agree initial budget including staff, overheads and project funding if applicable
- Commence operations
  - Identify research and development themes with greatest potential impact for the region
  - Develop a new energy opportunity funnel – a list of technologies that have the maturity for test/pilot deployment
  - Create a technology maturation roadmap, aimed to mature researched technology into pilot/full scale development
  - Identify partners and resources and regional competence gaps in supporting new energy opportunity funnel
  - Facilitate commercial partnerships for deployment of technology testing
  - Link Taranaki companies to national and international research capability
  - Attract international projects and funding to the region

Hydrogen ecosystem development “H2 Taranaki”

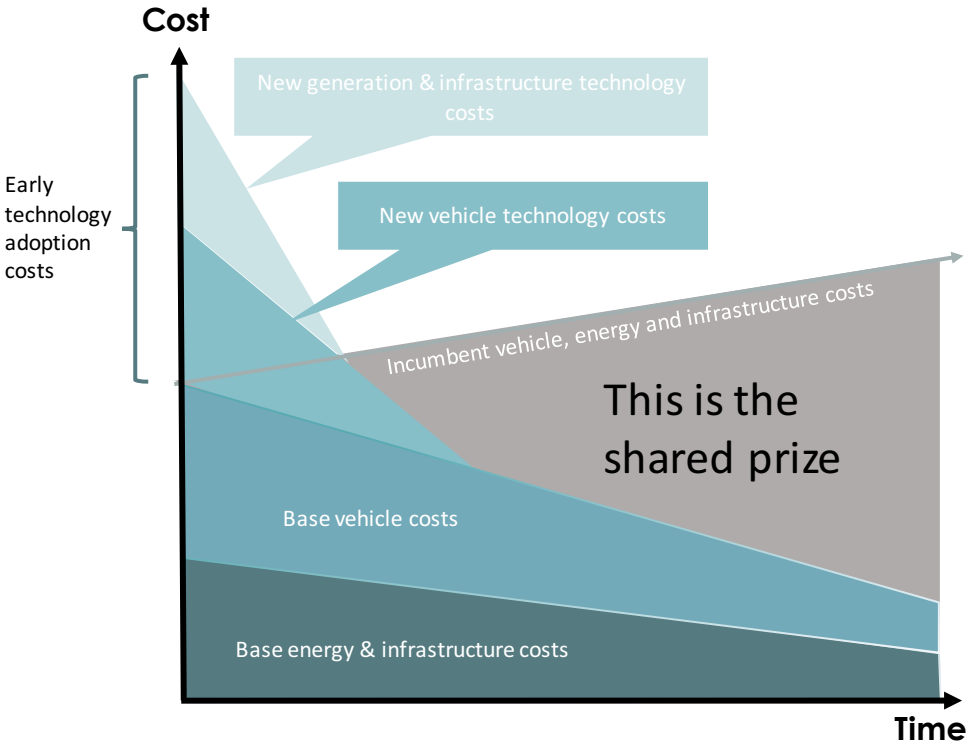
The H2 Taranaki work stream will cover market, industry and technology deployment and infrastructure investment. Aberdeen provides a useful example where H2 Aberdeen was formed as a public/private entity that has directly supported hydrogen projects. H2 Taranaki will be an independent organisation with an emphasis on establishing the industry, attracting private investment to leverage government funding, and establishing a domestic and export market for hydrogen.

The development of a pilot hydrogen ecosystem in Taranaki is an opportunity to demonstrate energy leadership, leveraging the regions natural and human resources to accelerate New Zealand’s transition to a clean, safe and sustainable low emission economy.

The initiative aims to create economic growth by:

- Attracting investment in hydrogen production, leveraging gas industry capability and access to renewable energy.
- Accelerating local demand for hydrogen as an economic, low emission, renewable and secure input for transport, energy and industry.
- Positioning Taranaki businesses to participate in a growing international industry.
- Nurturing and enabling the development of a hydrogen export industry.

The business case for public/private investment will be primarily driven by the long term shared benefit of a hydrogen ecosystem where the spend is spread across multiple participants and no one participant receives or can monetise all the benefit. High upfront capital due to early stage commercial technologies provides a clear role for public sector intervention to bridge the finance gap, ensuring the public benefit is realised. This might be likened to tax incentives for the encouragement of oil & gas exploration.



Cost vs time vs commercial benefit of hydrogen adoption in transport

- Initiatives similar to H2 Taranaki have seen a 4:1 multiplier of private/public sector investment.
- Initial hydrogen export opportunities suggest potential for export revenues > $1bn per annum.

H2 Taranaki will:

- Ensure capability, infrastructure and regulatory environment for industry development.
- Assist public sector hydrogen vehicle and infrastructure strategies and business case development.
- Co-fund initial demonstration projects to attract industry investment and create public awareness.
- Co-fund FCEV infrastructure to provide accessibility within the region and connections with other regions.
- Promote maximum in-region company participation in projects.
- Advance the uptake of hydrogen by industry, councils, businesses and the public.
- Advance Taranaki industry participation in the emerging global hydrogen supply chain.
- Ensure Taranaki is an attractive location for renewable hydrogen export.

The H2 Taranaki projects could cover each of the following end user transport applications:

- A hydrogen fuel cell bus fleet for New Plymouth and regional buses.
- Regional or City council light vehicles (may include Port and Airport).
- Combined power and back-up generation project for regional infrastructure.
- Materials handling demonstration project.
- Light commercial vehicle fleet hub project.
- Medium service vehicle demonstration (ie. waste collection or street sweeping).
- Heavy commercial vehicle fleet hub project.

These projects would represent a critical mass of projects within the region across the key end user transport segments that could utilise shared infrastructure.

The funding will be used to leverage private investment. For example, it is envisaged that H2 Taranaki would enable public entities to purchase and test vehicles that would otherwise not be possible under current whole-of-government purchasing.

With additional funding the number of vehicles and infrastructure could be increased to ensure better traction with international technology providers and a better pool for testing under different operating conditions. Projects of sufficient scale are more likely to attract international technology providers to the region and establish relationships that create the basis for participating in the developing global supply chain.

There would be significant additional benefits for the region and New Zealand if the projects were expanded to include:

A. Regional transport services and inter-regional transport services. For example, demonstration of fuel cell electric coach transport between Taranaki, Auckland and Wellington.

B. Expansion of initial refuelling infrastructure in other regions to create connectivity between Taranaki and other regions in New Zealand. It is envisaged that the funding would supply matched infrastructure funding for the capital costs and support Taranaki based companies to work with other regions to supply and install and manage the infrastructure.

C. A rail project to demonstrate the replacement of diesel locomotives with fuel cells powered electric locomotives (“Hydrail”). A Taranaki project could be the world’s first demonstration of

hydrogen for freight transport. Fuel cell trains are a clean, efficient and quiet alternative to diesel, with extended range and lower infrastructure costs than electric. Fuel cell trains have been trialled in Germany, Japan, China and California for passenger and shunt/yard locomotives. The project could involve hydrogen refuelling at KiwiRail's switchyard in New Plymouth or at Port Taranaki, the conversion of diesel-electric or import of electric locomotive and integration of fuel cell and hydrogen storage.

D. A marine transport project. Norway is in the process of developing fuel cell marine transport, and Taranaki has a pedigree of marine architecture, ship building capability and facilities. Work is already being undertaken to combine the technology opportunities. This could potentially marry well with a blue water highway initiative being considered in the Accessibility and Connectivity theme.

First steps - H2 Taranaki

IMMEDIATE Priorities

- Proposition development
    - Business case development for initial "H2 Taranaki" projects with district and regional councils and Central Government to develop a road map for H2 adoption in Taranaki
    - Connect with other countries and regions to understand progress, learnings, and opportunities to work together
    - Participate in MBIE led initiative to establish a New Zealand Hydrogen Industry Association
    - Agree administrative and governance structure and funding plan
- Establish administrative and governance structure
    - Appoint independent directors to oversee the establishment of the management and administrative structure, branding and marketing, and detailed project planning

MEDIUM TERM Priorities

- Execute base scope projects
    - Fuel Cell Electric Vehicle (FCEV) bus fleet for New Plymouth and regional/ city council light vehicles
    - Combined power and back-up generation for regional infrastructure
    - Materials handling demonstration
    - Medium commercial vehicle fleet hub
    - Heavy commercial vehicle fleet hub
- Execute expanded scope projects
    - Inter-regional infrastructure
    - Regional and inter-regional transport services
    - Rail project demonstrating replacement of diesel locomotives for regional freight
    - Marine project leveraging Taranaki's marine architecture and shipbuilding capability

Support Actions

Branding and marketing of Taranaki's new energy vision and capability

The aim is to create high quality branding and marketing for the New Energy Centre and H2 Taranaki to:

- attract investment in the region;
- increase industry awareness, collaboration, and cross pollination of ideas; and
- encourage the development of the hydrogen economy supply chain in the region.

This work stream will support the activities of the proposed Centre and hydrogen ecosystem development. It will involve:

- Branding and selection of most appropriate names for the Centre and H2 Taranaki.
- Creation of websites, digital marketing, and web optimisation to attract international and national web traffic to relevant activities.
- Events organisation including Industry conferences and seminars.
- Attracting international speakers to Taranaki and facilitating Taranaki speakers at international events.
- Attracting and hosting international delegations.
- Coordination with NZTE and MFAT to coordinate foreign investment opportunities.
- Capability building and diversification of skills.

Community engagement to create awareness, support and participation

The aim is to encourage community support for the Centre and hydrogen ecosystem development, and accelerate the adoption of new energy technologies in the region.

Actions may include:

- Development of advertising campaigns and public information.
- Organising community events that encourage participation and interaction with new/clean energy technologies.
- Promoting the use of new energy technologies at major events held in Taranaki.
- School educational visits.
- Providing early advice on how to increase community engagement with the Centre and hydrogen projects.
- Creating connections and involving artists and creative professionals to improve the aesthetics

and therefore community perception of new energy technology and projects.

- Running art and design competitions that build on the Len Lye Centre and kinetic art installations in the region.

As an example, the Land Art Generator Initiative (LAGI) is a global competition that connects designers all over the world who develop designs of future energy forms as an attractive art form. (http://www.landartgenerator.org/project.html).

Industry and public-sector engagement

The aim of this support action is to ensure access to critical infrastructure and skills, and to promote the development of spin-off businesses in the region. Critical infrastructure includes a skilled work force and secure means to transfer energy within the region and to other regions.

On-going engagement will be required to ensure that the flow on benefits of increased economic activity are realised by the two key initiatives. This will involve working with industry groups and associations and with MBIE to encourage the creation of new jobs in the region. It will be important for the initiatives to co-ordinate their activities with the existing energy sector to maximise alignment and minimise conflict.

It is proposed that the projects funded by the Centre and H2 Taranaki have a requirement for regional company participation and preference given to those with higher proportion of local industry participation.

It is recognised that the H2 Taranaki initiatives will inevitably require the import of new technologies that have been developed in other parts of the world. However, there are opportunities to use local engineering, manufacturing, and fabrication capabilities for activities such as vehicle integration, and refuelling infrastructure fabrication and installation. There will be opportunities for maintenance and support services to be based in the region.

The import of technologies will build understanding and capability in-region that can provide the basis for the development of new technology and the integration of local products into global technology supply chains. It is recommended that opportunities to locate international technology providers' manufacturing capability in Taranaki are investigated.

Lead partner / associate partners

It is likely that Venture Taranaki will be the lead agency for the proposition development for the NZ New Energy Development Centre.

New Energy Development Centre

The proposition development for the Centre will require working with district, regional and national government, the national and international research and innovation ecosystem, Taranaki industry, Iwi, potential investors, and broader stakeholders.

Some examples of international Centres are included in the Appendices. Links with similar initiatives in other energy regions and initiatives should be developed and strengthened as part of the planning process.

The Centre can leverage already strong industry-to-industry connections with these international regions – Scotland, Denmark and Norway in particular, due to the existing oil and gas industry in Taranaki. Many of these regions are now leading new energy initiatives. For example, Taranaki smart/micro/transactive grid experts have strong international research and industry connections (such as with Oxford University).

The Centre will require the support of key stakeholders NPDC and TRC and will involve working with:

- VTT, to promote and enhance the attractiveness of Taranaki as a test bed for new energy technologies for New Zealand.
- R&D institutions and Callaghan Innovation.
- EECA, as both a funding source as well as development partner and advisor to ensure alignment of the strategy with the larger New Zealand energy efficiency and conservation strategy.
- Electricity Authority and Commerce Commission, to ensure appropriate regulatory framework for smart, transactive and micro- grids.
- NZTE and MFAT, to strengthen relationships with potential export partners, overseas micro-grid aid opportunities, and foreign investors.
- MBIE, MoE, and MoT.
- Training institutes and organisations such as MITO.
- Taranaki industry and Maori groups.
- Sources of investment.

Hydrogen ecosystem development

The H2 Taranaki initiative will require the support of key public-sector stakeholders and involve working with:

- VTT, to promote and enhance the attractiveness of Taranaki as a head office location and the equipment distribution, servicing and manufacturing hub for New Zealand and Australasia.
- NPDC, TRC and central government agencies, to ensure strong regulatory framework for hydrogen production, storage, distribution, and use.
- EECA, as both a funding source as well as development partner and advisor to ensure alignment of the strategy with the larger New Zealand energy efficiency and conservation strategy.
- NZTE and MFAT, to strengthen relationships with potential export partners and foreign investors.
- MBIE, MoE, and MoT.
- The innovation ecosystem in Taranaki, including proposed innovation hub and Taranaki Technology initiatives.
- Industry associations including NZ Renewable Energy Association, Sustainable Electricity Association of New Zealand, NZ Business Council, Materials Handling Association, MIA, and SIA.
- Training institutes and organisations such as MITO.
- R&D institutions and Callaghan Innovation.
- Taranaki industry and Maori groups.
- Sources of investment.

Support Actions

VTT is the natural lead for this work stream. Additional external resources are recommended to supplement VTT skills. It will be critical that the branding and marketing is world class. Use of leading digital media content generators, digital marketing and optimisation providers will be required to ensure that target audiences receive the optimal message with the desired results.

This work stream will require:

- Engagement and coordination with NZTE, MFAT, MBIE, MoE, Chamber of Commerce.
- Engagement with industry news providers such as Energy News.
- Engagement with industry and public sector.
- Community engagement.

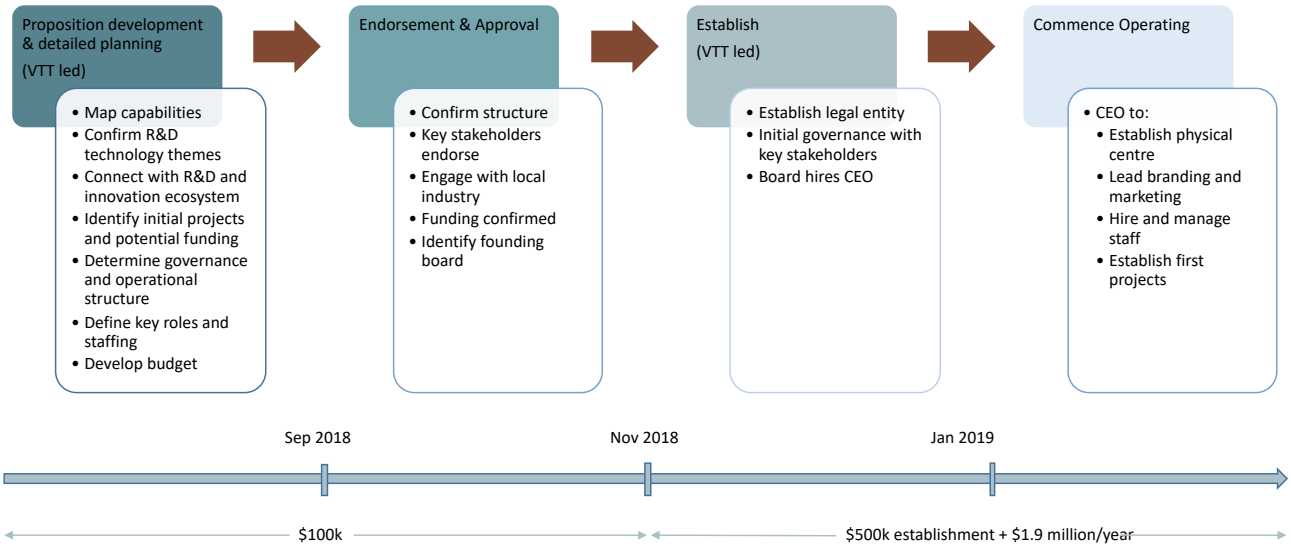
It may involve the preparation of submissions to central government on relevant policies and commissions, such as the Productivity Commission's recent inquiry into New Zealand's transition to a low carbon economy.

It will require the involvement and support of our regional elected representatives and senior staff, including the Mayors and council CEOs.

Investment and funding

New Energy Development Centre

It is estimated that a new Centre will require approximately $10 million regional growth funding to establish over a 5 year period. The funding will cover initial set up costs, premises, hiring of key staff and contractors, and governance. It will also include funding of key projects that create test-bed capabilities within the region that can be leveraged to attract international technology demonstration and testing projects.



A sustainable plan for ongoing funding will need to be determined. Some of the activities envisioned may be designed to provide an income stream to financially support the Centre. Examples might include direct investment, IP royalties, and management fees for joint venture projects.

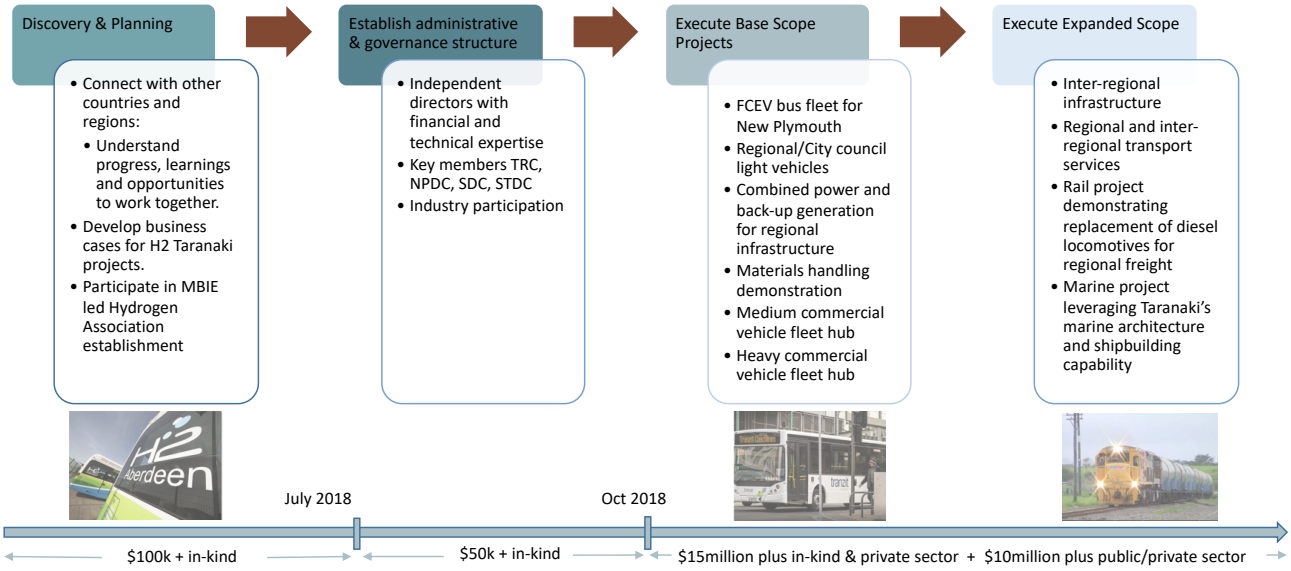
VTT can facilitate the development of the detailed investment and business case for the establishment of the Centre.

Hydrogen ecosystem

The business case development for H2 Taranaki projects and connecting with hydrogen regions overseas is estimated at $100,000. Additional funding may be required for an independent study of the economic, social, and environmental benefits to the region to secure wider public support for the initiative.

The H2 Taranaki projects will require significant support, leveraging existing government funding and attracting private investment.

The co-funding required to accelerate a critical mass of demonstration projects is expected to be in the order of $15 million. This would be used to encourage and leverage private and public-sector investment. Similar initiatives in other global regions have attracted a 4:1 private/public investment ratio. If an export industry is established in Taranaki, the seed investment will have significantly higher multiplier effects.



The expanded projects, including a rail demonstration project, would increase the required funding. For that project, potentially KiwiRail could purchase the locomotive and co-funding could be used to support private sector provision of hydrogen and fuel cell integration services, engineering and project management. However, the expanded inter-regional and rail projects could require co-funding on the order of an additional $20 million depending on scope and other public sector funding.

Support Actions

Funding for the support actions is estimated to be:

- Branding, marketing and community engagement - $100,000 during the first year and $50,000 thereafter
- Industry and public-sector engagement - $100,000 per annum leveraging support from VTT

Key outcomes

The Energy Futures Action Plan contributes directly to the mission, vision, and goals of the strategy: Kaitaikitange, Whanaungatanga, and Tuakana Teina. It is a necessary and visible manifestation of the 'talent, skills, and enterprise' theme with the potential to produce jobs with a high technical and creative content that will attract and retain people who will generate and bring wealth to the region.

Major benefits of the Centre include the creation of high GDP per capita technology based industries, together with the export of clean energy, new energy products, technology, and skills from the region.

McKinsey has calculated that the annual total investment outlined by Hydrogen Council members of $20-$25 billion per annum until 2030 will create a self-sustained market, turning over more than $2.5 trillion and creating some 30 million jobs along the value chain. The H2 Taranaki initiative will position the region to participate in this emerging global industry and supply chain. The development of a domestic hydrogen industry and regional capability will also increase the attractiveness of the region as a large-scale hydrogen export.

The actions will create a pathway to achieve the publicly stated carbon emission goals of the Labour Coalition government and local government, while creating jobs and export opportunities in the region. In July 2017, New Plymouth District Council committed to developing and implementing action plans to reduce GHG emissions locally. At a central government level the development and demonstration of new energy technologies will be critical to meeting the goal of net zero emissions by 2050. The electrification of transport and the reduction of industrial GHG emissions without the closure of significant industries or disadvantaging regional areas are two key issues the action plan addresses.

The Centre will fill a commercialisation gap for new energy technologies, provide a testbed for their development. It will enable development and scaling of new energy technologies and create an environment where convergence between technologies can be explored.

The H2 Taranaki will demonstrate the commercial viability of hydrogen technologies and encourage market adoption of:

1. Zero emission transport for:
    - inter-regional travel;
    - commercial and heavy vehicles; and

- freight including heavy road transport and rail.

2. Hydrogen as buffer storage to enable 100% renewable energy generation.
3. Remote and emergency back-up power replacing fossil fuel energy.

The Energy Futures actions are a way for New Zealand to benefit from the unique attributes of the Taranaki region and participate in a rapidly growing global transition to low emission energy forms.

Success indicators

Success would be the development and adoption of new energy technologies in the region, creating new jobs and attracting new businesses.

Specific performance measures may include:

- New energy technology investment in region.
- New energy exports from the region.
- New renewable energy installed in the region.
- Creation of new jobs in new energy sector.
- Carbon emissions reduction in the region.
- Provision of public infrastructure for zero emission transport:
    - Number of refuelling / charging stations.
    - Ability to travel within Taranaki and to other key regions using zero emission transport.
    - Number of zero-emission vehicles in the region.
- Number of visiting delegations.
- Number of projects supported by the Centre.
- Number of events organised and attended.
- Visits to websites and enquiries generated.

Appendices

Insights from industry and stakeholder consultation

Key themes emerging from the workshops and industry consultation are summarised in the following section. The ideas generated have been fleshed out in greater detail by the action team.

The ideas have been used to formulate the Energy Futures' vision and action plan.

Key areas considered and summarised in the following tables are:

- Refocusing our strong technical capability
- New Energy Export Opportunities
- Reducing GHG emissions from Taranaki's energy intensive industries (future proofing)
- Taranaki as a Testbed

Refocusing our strong technical capability

Vision	**NZ's strongest region for complex, industrial design, build and operation**		
Benefits - the "Why"			
• Quantitative Benefits	• The Taranaki hydrocarbons industry supports companies who directly employ ~*1500* skilled FTE's; technical, trades, operations. In addition, the hydrocarbons industry brings in an additional *3000* 'work-day' visits from people out of Taranaki. • This results in spending in local Taranaki businesses (hotels, restaurants, retail etc) • The direct employment adds to the local government via rates/taxes • In addition, the Taranaki hydrocarbon industry results in indirect employment of people involved in services. • The average salary of engineering personnel in Taranaki is 20% higher than the next closest region. This will result in a higher discretional spend in the region.		
• Qualitative Benefits	• Strong community support from local businesses (e.g. WOMAD, Aquatic Centre etc)		
Activities required	• Benchmark current capabilities • Map out future pathways and understand skill sets required • Determine how/where to get skill set (i.e. retraining, buying in, outsourcing etc.)		
Building Blocks	**Design Capability**	**Fabrication & Construction Capability**	**Operations Capability**
Capability & Resources			
• What is required?	• Engineering; process, mechanical, instrumentation, electrical, civil, structural • Project Management capability	• Heavy and light construction; mechanical, electrical, instrumentation, civils and structural • On- and off-shore fabrication	• Operations and Asset Management capability
• What do we have?	• General engineering and project management capability (WorleyParsons, LogiCamms, Plant & Platform) • Companies with global reach (e.g. WorleyParsons) • High quality primary and secondary education	• Strong local capability; FEGL, Energy Works, Wells, Meco, etc • WITT- *how strong is connection between WITT and industry?* • Other groups such as Engineering Taranaki Consortium (ETC) • Strong apprenticeship scheme	• Strong technical knowledge within current operations • Strong operations knowledge within current operations • Energy skills association to help structure requirements www.energyskills.co.nz • WITT Certificate in Process Operations • Asset Management capability

	• Other groups such as Engineering Taranaki Consortium (ETC) • Energy skills association to help structure requirements www.energyskills.co.nz • Leading safety culture including BeSafe Taranaki • Good primary and secondary schools	• Good experience in construction, including management of specialist contractors • Energy skills association to help structure requirements www.energyskills.co.nz • Leading safety culture including BeSafe Taranaki • Good primary and secondary schools	• Leading safety culture • Good primary and secondary schools
• What are our gaps?	• No local university and weak connections between NP design companies and universities • Specialist engineering disciplines related to new technologies	• Specialist capabilities related to new technologies	• Specialist capabilities related to new technologies • No local university and *weak connections between NP operating companies and universities*
Initiatives Underway	• Accelerator programme	• Accelerator programme	• Accelerator programme
Enablers	• VT, Taranaki Futures • Great lifestyle	• VT, Taranaki Futures • Great lifestyle	• VT, Taranaki Futures • Great lifestyle
Disablers, Barriers & Risk	• Risk that hydrocarbon market slows and other areas don't pick up as quickly and capability slowly drifts away • Risk of company closures • Cost of living high relative to larger other regions • Small job market makes it hard for partners to find work • Competition for resources in other industries/locations that appear sexier	• Risk that hydrocarbon market slows and other areas don't pick up as quickly and capability slowly drifts out away • Risk of company closures • Cost of living high relative to larger other regions • Small job market makes it hard for partners to find work • Competition for resources in other industries/locations that appear sexier	• Risk that hydrocarbon market slows and other areas don't pick up as quickly and capability slowly drifts out away • Risk of company closures • Cost of living high relative to larger other regions • Small job market makes it hard for partners to find work
Who will we link in with?	• Existing NP design companies • Universities • Engineering Taranaki Consortium (ETC)	• Existing NP fabrication companies • WITT • Engineering Taranaki Consortium (ETC)	• Operating companies, including those in the new energy sectors • WITT
Funding support required	• TBD	• TBD	• TDB

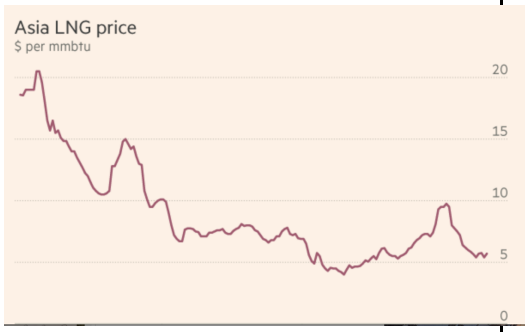
New Energy Export Opportunities

Vision	**Taranaki will retain and grow its position as the largest net energy export region in New Zealand**		
Benefits - the "Why"			
Building Blocks	**Ammonia**	**Hydrogen**	**Natural Gas**
• Quantitative Benefits	Ammonia is an internationally traded commodity for fertilizer, but also a potential energy carrier for large scale energy export. Ammonia (NH3) can be used as a hydrogen carrier (technologies are being developed for removing Nitrogen) or used directly in ammonia fuel cells, ICEs and burned to produce electricity. Spin off benefit is reducing imports - NZ imported 650,000 tonnes of urea in 2105-16 costing $281 million. .	Significant new multi-billion dollar export industry, increasing markets for existing resources and underpinning development of new energy resources (geothermal, wind, gas, hydro). Hydrogen is currently a $100billion p/a industry and growing rapidly as potential export destination countries move to lower emissions. NZ has potential to generate 9 x present energy consumption as renewable energy available for export. Spin-off domestic hydrogen economy, displacing fuel imports comprising net ~200 PJ/Annum (33 MMBOE) at a trade deficit of $1.6 bn/Annum ($50/bbl).	LNG is a proven technology for export of natural gas resources and is a multi-billion dollar export opportunity. Australia exported 37 million tonnes of LNG in 2015-16 worth $16.55 billion. (AAPEA, 2016) and this is forecast to double by 2021. Global use of natural gas is projected to increase as it is a lower emission energy alternative to both coal and oil.
• Qualitative Benefits	Regional skilled employment opportunities Help ensure longevity of upstream oil and gas and energy sector Maintain security of fertilizer production in NZ and support agricultural needs. Potential to develop green ammonia produced from hydrogen from electrolysis, or by carbon capture during the process and recombination to produce urea.	Major regional skilled employment opportunitiesBusiness models aligned with long term national, regional and Iwi development strategies Develop and export knowledge (IP) Provide attractive job opportunities for talent attraction and retention Diversified national income Reduced global carbon emissions Improved energy security	Major regional skilled employment opportunities Ensure longevity of existing upstream oil and gas capability in region

Building Blocks	Ammonia	Hydrogen	Natural Gas
Activities required	Exploration activity Feasibility studies to support investment decisions Ensuring infrastructure and land and resource access for export facilities	Promotion of New Plymouth as preferred export location for NZ Ensuring infrastructure and land and resource access for export facilities Macro-economic modelling of hydrogen export industry Development of domestic industry Maturation of multiple suitable low cost/large scale hydrogen production processes that leverage off NZ resources Assessment, selection and maturation of suitable Hydrogen storage and transport technologies	Exploration activity Feasibility studies Oil and gas investment in LNG facilities: Estimated minimum size 3-400PJ (similar to Maui) Ensuring infrastructure and land and resource access for export facilities
Capability & Resources			
● What is required?	Large scale natural gas resource with low cost of production Export facilities Production & processing Transport (energy source / ammonia to export) Finance	Export market and transport method Energy / raw material source Water Export facilities Production & processing High voltage infrastructure and industrial space proximal to port Trade links with target market governments and energy businesses Research agreements with technology companies and research institutes Demonstration and pilot studies Domestic transport Finance	Large scale natural gas resource with low cost of production - discovery of another Maui Export facilities Production & processing Transport - gas to LNG processing facility to Port Finance
● What do we have?	Energy source - natural gas, potential for greening via production of hydrogen via electrolysis Export facilities Production and processing expertise Local manufacturer - Ballance	High proportion of low emission & renewable generation with potential for significant increase - Taranaki has significant wind resource.	Energy source - natural gas prospectivity Regulatory framework known Human capital - Project developers, management, engineering, operations and maintenance, marketing

Building Blocks	Ammonia	Hydrogen	Natural Gas
	H&S capability Regulatory framework known Human capital - management, engineering, operations and maintenance, marketing.	Hydrogen production and processing expertise (used in operations at Methanex, Ballance, Technix) Hiringa Energy new energy company based in New Plymouth to develop hydrogen projects High voltage infrastructure and industrial space proximal to export facilities Green NZ brand Human capital - project developers, management, engineering, operations and maintenance, marketing	NZ has relative shipping cost advantage to US Gulf (~1.5US$/mmbtu cheaper) Regulatory framework known Human capital - management, engineering, operations and maintenance, marketing
● What are our gaps?	Access to large scale natural gas resource - dependent on individual oil and gas company exploration decisions	Research and development for key enabling technologies Support for domestic industry development: ● Funding for technology demonstration ● Industry training for hydrogen refueling and use ● Regulatory framework for domestic transport use of hydrogen	Industry interest dependent on security of supply - current production doesn't support large scale LNG export LNG facility expertise Finance dependent on off-take - market pull in other countries Suitability of Port facilities for onshore LNG Capital and ability to build liquefaction facilities at competitive price. US has brownfields options, deep labour pool - Australian developments 2-4 US$/mmbtu more expensive. Floating LNG production may be option
Initiatives Underway	Ballance seeking to build new state of art facility for domestic fertiliser market	Hiringa Energy working with potential export consortium to develop domestic hydrogen projects to support pilot export facility	Existing acreage exploration programmes offshore Taranaki,

Building Blocks	Ammonia	Hydrogen	Natural Gas
Enablers	Resource and capability in region Stable regulatory regime Domestic transport capabilities Power and gas infrastructure Deepwater port	Resource and capability in region immediately available Stable regulatory regime High proportion of renewables in NZ grid Ability to incorporate with consented wind generation Power and gas infrastructure Deepwater port	Resource and capability in region Stable regulatory regime Domestic transport capabilities Power and gas infrastructure Deepwater port
Disablers, Barriers & Risk	Access to large scale natural gas resource is dependent on individual oil and gas company exploration decisions Large capital investment Lack of government support "Think Bigger" Community support for increased oil and gas exploration activity Nimbyism for new industry Land/resource access Complexity of export scale industry Timeframe for new exploration to development ~10 years Global ammonia market highly competitive - subject to commodity price fluctuations with new capacity coming online. Around 12% of globally produced ammonia is traded internationally every year. Based on preliminary estimates, global ammonia trade slightly shrank to 17.9 million tonnes in 2015.	Large scale transport of hydrogen is still under development (LH and Spera projects by Kawasaki and Mitsubishi) Removal of high voltage infrastructure at Port Taranaki Reluctance to be leader in technology (avoid bleeding edge) Economics around transport of hydrogen are challenging - technology demonstration required Lack of government support "Think Bigger" Nimbyism Land access Complexity of developing export scale industry Risks - tech failure, industrial accidents at early stage may hinder acceptance Risk that hydrocarbon market slows and other areas don't pick up as quickly and capability slowly drifts out away Large capital and likely foreign investment. Need to ensure that NZ retains control of resources and spin-off benefits.	Access to large scale natural gas resource uncertain - dependent on individual oil and gas company exploration decisions and success. Discoveries may not be in Taranaki region. Requires very large capital investment and scale Community support for increased oil and gas exploration activity Community support for LNG processing facilities Timeframe for new exploration to development ~10 years Risk that hydrocarbon market slows and other areas don't pick up as quickly and capability slowly drifts away Price uncertainty - global LNG markets are competitive with significant production capability coming online. By 2020, when the global LNG market is forecast to reach about 400m metric tonnes annually LNG capacity growth between 2015 and 2020 is projected to exceed demand growth by nearly 50 percent, causing utilization rates at export terminals to fall below 90 percent next year (Wood MacKenzie)

Building Blocks	Ammonia	Hydrogen	Natural Gas
			
Who will we link in with?	Ballance Oil and Gas companies Crown PEPANZ Govt - MBIE, MFAT, NZTE Potential offtake companies	Hiringa Energy (Hydrogen) Renewable energy generators Callaghan Innovation Govt - MBIE, MFAT, NZTE Potential offtake companies Existing NP engineering design companies Universities Engineering Taranaki Consortium (ETC)	Oil and Gas companies Crown PEPANZ Govt - MBIE, MFAT, NZTE Potential offtake companies overseas
Funding support required	Encourage exploration? Modelling Feasibility studies	NZ benefit modelling to support economic assistance for industry development Industry development support Feasibility studies Demonstration projects and pilot facilities	Encourage exploration?

Reducing GHG emissions from Taranaki's energy intensive industries (future proofing)

Vision	**Grow Taranaki as the leading region for low emissions heavy industry**		
Building Blocks	**Energy Efficiency**	**Carbon Capture & Storage/Use (CCS/CCU)**	**Alternative low carbon energy sources**
Benefits - the "Why"			
• Quantitative Benefits	• The region's heavy industry currently consumes ~47 PJ annually in process energy which includes 3.61 MTCO2e in GHG emissions • Application of carbon capture and alternative industrial processes has the potential to lower the region's GHG annual emissions by 2-3MTCO2e. • Extension of the solutions/strategies developed beyond the region to similar industries in other regions of NZ has the potential to achieve significant national reductions		
• Qualitative Benefits	• Increased competitiveness when done right • Gain brand advantages for products nationally and globally • Potential for lower operating and maintenance costs • Grow skills that underpin energy futures • Develop technologies/business capabilities that create new opportunities		
Activities required	Understand current state vs national vs global performance Identify highest impact opportunities in region	Identify potential application in Taranaki • Energy generation • Industrial processes • Heavy transport Understand technology solutions & maturity	Identify potential application in Taranaki eg • Industrial processes • Heavy transport Understand technology solutions & maturity
Capability & Resources			
• What is required?	• Business analysis, • Business networking • Process & mechanical engineering, • Power engineering, • Technology networks, • Pilot & scale up fabrication capability	• Business analysis, • Business networking • Process & mechanical engineering, • Power engineering, • Technology networks,	• Business analysis, • Business networking • Process & mechanical engineering, • Power engineering, • Technology networks,

	• Interconnected infrastructure
	• Energy grids (electricity, gas)
	• Access infrastructure (roads, port, airport)
	• Access to alternative energy sources
	• Integrated energy thinking
	• Access to capital
	  ○ Seed capital
	  ○ R&D capital
	  ○ Project capital
		• Pilot & scale up design & fabrication capability
		• Interconnected energy infrastructure
		• Access to alternative energy sources
		• Hydrogen strategy/roadmap
		• Hydrogen infrastructure
		• Integrated energy thinking (across silos)
		• Storage requires suitable reservoirs
		• Carbon use requires markets
		• Access to capital
		  ○ Seed capital
		  ○ R&D capital
		  ○ Project capital
			• Pilot & scale up design & fabrication capability
			• Interconnected energy infrastructure
			• Access to alternative energy sources
			• Hydrogen infrastructure
			• Integrated energy thinking (across silos)
			• Access to capital
			  ○ Seed capital
			  ○ R&D capital
			  ○ Project capital

• What do we have?	• Energy intensive industries
	  ○ Ammonia/Urea plant
	  ○ Methanol plant
	  ○ Oil & gas production & processing
	  ○ Large scale dairy processing
	  ○ Resin manufacturing
	  ○ Heavy transport
	• Strong technical engineering base
	• Engineering fabrication capability
	• Business analysis capability within individual enterprises
	• Energy generation:
	  ○ Existing gas thermal
	  ○ Wind generation potential
	• Interconnected infrastructure:
	  ○ Electricity network
	  ○ Gas network
	  ○ Port infrastructure
	  ○ Roading
	• Strong B2B networks (VT, Chamber of Commerce, Tapuae Roa, CEO forum)
		• High GHG emission industries
		  ○ Ammonia/Urea plant
		  ○ Methanol plant
		  ○ Oil & gas production & processing
		  ○ Large scale dairy processing
		  ○ Heavy transport
		• Strong technical engineering base
		• Engineering fabrication capability
		• Business analysis capability within individual enterprises
		• Energy generation:
		  ○ Existing gas thermal
		  ○ Wind generation potential
		• CO2 market (Methanex)
		• Interconnected infrastructure:
		  ○ Electricity network
		  ○ Gas network
		  ○ Port infrastructure
		  ○ Roading
		• Strong B2B networks (VT, Chamber of Commerce, Tapuae Roa, CEO forum)
			• High GHG emission industries where alternative technologies are maturing
			  ○ Ammonia/Urea plant
			  ○ Methanol plant
			  ○ Large scale dairy processing
			  ○ Heavy transport
			• Strong technical engineering base
			• Experience with industrial hydrogen
			• Engineering fabrication capability
			• Business analysis capability within individual enterprises
			• Energy generation:
			  ○ Wind generation potential
			• Interconnected infrastructure:
			  ○ Electricity network
			  ○ Gas network
			  ○ Port infrastructure
			  ○ Roading
			• Strong B2B networks (VT, Chamber of Commerce, Tapuae Roa, CEO forum)

• What are our gaps?	• No cross energy industry body in region to provide regional analysis and champion strategy • Base load alternative energy in region (relies on grid access)	• No carbon market beyond Methanex • Experience in CCS/CCU • Hydrogen storage and distribution infrastructure • No cross energy industry body in region to provide regional analysis and champion strategy	• Hydrogen storage and distribution infrastructure • Lack of actual renewable energy production in region
Initiatives Underway		NZ ETS Methane "Cracking" technology commercialisation High CO2 gas to Methanex	EECA LEV Contestable Fund RUC rebates for EVs (needs to more clearly extend to hydrogen FCEVs) Other?
Enablers	Financial enablers Iwi economy - capital with alignment to theme	Financial Enablers • Iwi economy - capital with alignment to theme • Early stage seed funding (Callaghan, central govt) Emerging technologies: • Hydrogen for Methanation (CO2 into CH4) • CO2 for enhanced oil recovery • Waste gas to liquids (eg Lanzatech) Regulatory Enablers • NZ ETS - ensure all CO2 treated equally	Financial Enablers Emerging Technologies: • Commercialisation of Battery and Fuel Cell Electric Vehicles (BEV / FCEV) • "Green ammonia" technology utilising hydrogen (www.carbonrecycling.is) Regulatory enablers: • RUC rebates for BEV / FCEV heavy vehicles • Renewable hydrogen injection into gas network
Disablers, Barriers & Risk	• Investment inertia - companies heavily invested in status quo • Potential loss of high power infrastructure at Port Taranaki	• Legacy gas contracts preventing CO2 CCS/CCU opportunities • Investment inertia - companies heavily invested in status quo • Perceived lack of financial incentive to reduce GHG emissions • Potential loss of high power infrastructure at Port Taranaki • New technology risk • Risk that initiatives have negative impact on industry competitiveness	• Investment inertia - companies heavily invested in status quo • Perceived lack of financial incentive to reduce GHG emissions • Potential loss of high power infrastructure at Port Taranaki • New technology risk • Risk that initiatives have negative impact on industry competitiveness • Perception that BEVs and FCEVs are in competition (EVs in EECA definition are defined as plug in BEVs only)

Who will we link in with?	Associations: ● Business Energy Council ● PEPANZ ● Gas Industry Company Government ● VT ● MBIE ● Callaghan Innovation ● EECA ● Ministry of Transport ● Regional and District Councils Private Enterprise ● Oil & gas companies ● Electricity generation & distribution companies ● Petrochemical manufacturing companies (Methanex, Ballance, Vector, Technix, AICA etc) ● Hydrogen companies (Hiringa Energy) ● Dairy ● Gas network owners ● Transport companies ● Engineering & project management companies ● Fabrication companies Iwi ● Iwi chairs forum ● Taranaki region Iwi trusts		
Funding support required			

Taranaki as a Test Bed

Benefits - the "Why"			
● Quantitative Benefits	● Opportunity for Taranaki become the New Zealand leader for commercialization of *New Energy Technology* Development, bringing new, expandable business to the region. ● Ability to exploit current talent base into new industries ● Direct employment of people in new industry with direct spend across Taranaki business. ● Indirect employment of people within services environment with spend across Taranaki business.		
● Qualitative Benefits	● Branding Taranaki as the New Zealand's Energy Technology "Incubator" rather than Research focus ● Expanding Taranaki quality of life by brining good talent and investment to the region ● Energising Taranaki to be the "smart place" to live		
Vision	**Become the Energy Technology Development region for the future of New Zealand Energy**		
Building Blocks	**Talent**	**Investment**	**Partnership**
Activities required	● Total alignment with Regional Economic Strategy with setting of bold milestones ● Secure funding and set up a Centre for New Energy Development responsible for planning, funding and delivering an integrated technology development program ● Development of the New Energy Opportunity Funnel – a list of technologies that have the maturity for test/pilot deployment. ● Create a Technology Maturation Roadmap, aimed to mature researched technology into pilot/full scale development. ● Identify and resource regional competence gaps in supporting New Energy Opportunity Funnel. ● Sign up commercial partnerships for deployment of technology testing		
Capability & Resources			
● What is required?	● Demonstrated path to commercialization and scaleup ● Strategic and Leadership talent initiating an Energy Technology Incubator. ● Research screening for opportunity identification	● A risked investment appetite and acceptance of all outcomes. ● Long term vision on Technology Development ● Business Case Development	● Linkages to technology research centers ● Technology Maturation Process that moves technologies from the development center into (multi) business environment

	● Commercial/legal proposition development ● Project Screening/Management capabilities. ● Project Delivery Capabilities ● Operational Capabilities		● Inter-company win-win collaboration behaviours ● The ability to accept non-successful outcomes

• What do we have?	• A strong Private sector, with Energy and Manufacturing foundation (project delivery, operations, commercial) • A strong skill set in applied sciences, technology and engineering • Acceptance of technological development as a future • Digital linkages • Strategic new energy consultants – Advisian and Elemental • Global, national and local engineering and fabrication capability based in region – Worley Parsons, BECA, Fitzroy Engineering, Wells, Logicams, BTW. • Agile new energy innovators ie MetOcean (modelling), Ecoinnovation (micro-hydro), emhTrade (NZs 1st peer to peer retailer transactive grid project lead) are based in Taranaki. • Significant power infrastructure asset owners – 1st Gas (Transmission and Distribution) and Nz's 2nd largest electricity and gas distributor with HQs here. Powerco specifically has recently stepped up its future energy/ network transformation capabilities.	• Global Majors present (Fonterra, Methanex, Shell) • Public/Private grants (Callaghan Innovation, New Zealand Trade & Enterprise) • Alternate funding environments (Iwi, Venture Capital, Angel Investment Funds, Private Equity)	• Strong networking links through existing industry groups that have or are in process of transitioning to new energy hubs • Strong (Global) Engineering support basis • Major Project Delivery capabilities • International research and pilot project networks through local innovators and product development/ research teams. For example, Massey works with a number of companies within the region. Powerco works with Canterbury, Massey and Otago (and has links to Auckland). emhTrade (that has NP representation) is talking with Otago re a significant transactive grid pilot. MetOcean is well connected….. Advisian/ Worley Parsons sponsors globally significant new energy and transport research centres in Australia. Hringa Energy has links to international research and development institutes in Australia and Europe.

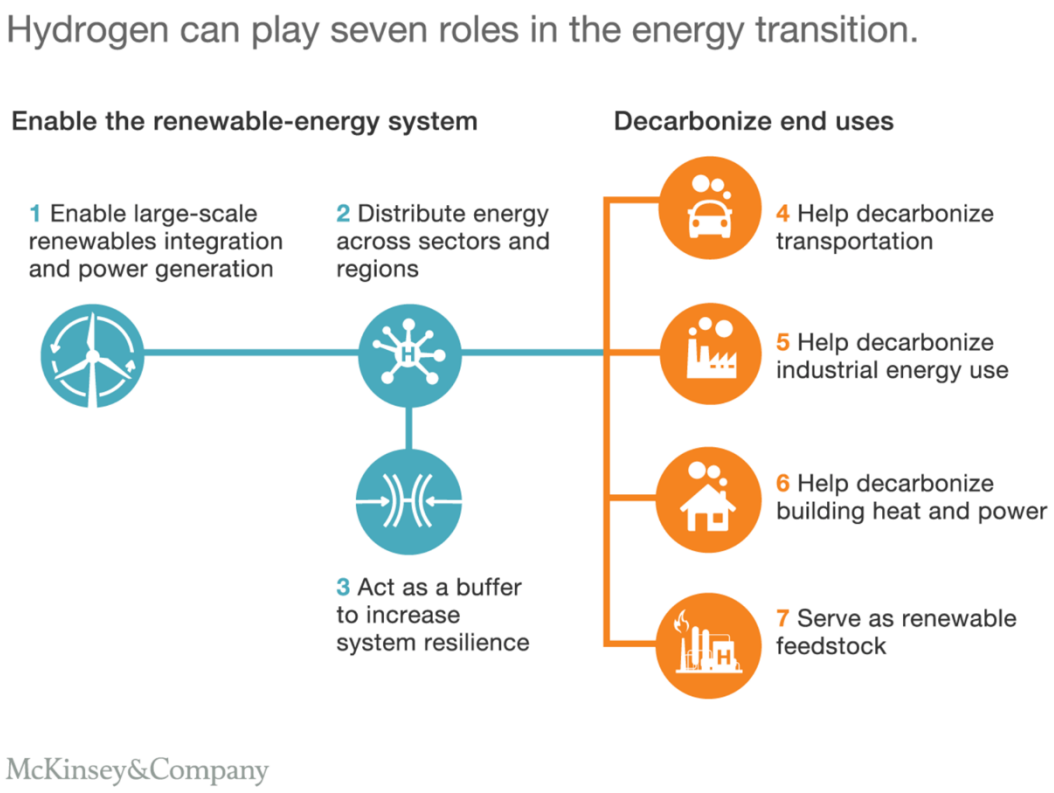
• What are our gaps?	• Specialist capabilities related to new technology maturation • Ability to attract enterprise to "small town".	• Robust funding mechanisms • Industry downturn has reduced existing industry's investment and discretionary spending • Emerging new energy industry participants are smaller SMEs and startups with limited financial support.	• Weak local sharing or syndication between operating companies and innovators who often strong one of one connections with university/ research environments. • A "place" where we can locally syndicate these and turn them in to meaningful, scalable programmes. • Large players have tended to directly acquire research and development capabilities from global networks when they have a perceived requirement so may not recognise the need to use Taranaki based development services.
Initiatives Underway	• Central Landfill • Waste to Energy • EV Charging Stations • Company electric car fleets • Integrated standalone off-grid (micro-grid) product development (multi- year Powerco RAPS programme – previous Deloitte's Energy Innovation of the Year award winner recently redeveloped to a 2nd generation product) • Multi-year smart grid/ future homes research and pilot programme (Powerco) • Mass market transactive grid product development/ piloting (emhTrade includes NP based element)		• Venture Taranaki/Chamber of Commerce

	• Micro-hydro product development (Ecoinnovation – also award winning) • Multi-year Maori sustainable community research programme including energy (Parihaka/ Massey)		
Enablers	• Supportive District Plan • New Energy Technology Development Center Funding • Industry Collaboration and Drive		• Bold partnerships to take on risky initiatives • Willing approach to inter-company/industry partnerships
Disablers, Barriers & Risk	• A research mindset – "we must invent it here" • A small operator mindset – "we can't do this here" • Small market environment – not big enough to be material • Perceived Geographical Isolation • Competition from other national/international areas vying for the opportunity • Policy/Regulation Limitations • Short Term Horizons	• Access to Capital / Funding	• Perceived competitiveness/strategic advantage issues • NIMBY threats • Existing business/infrastructure comfort
Who will we link in with?	• Iwi, Community Groups • Schools • Universities and training institutes • Local Industry • Industry associations	• Callaghan • Private Equity Interests	• Local industry • MBIE • ECCA • Ministry of Transport • Ministry for the Environment • Universities (National, International) • Callaghan Innovation • National Research Centres:

			• Centre for Energy Research, Massey • EPECentre, Canterbury • CSAFE, Otago • NERI, Victoria AUT and Otago • HERA ● Leading international research centres for relevant research themes ● Industry bodies • Sustainable Electricity Association New Zealand, SEANZ • Electricity Network Association, ENA • Electricity Authority • Business NZ, World Energy Council • Energy Management Association of NZ • Bioenergy Association • Drive Electric • New Zealand Wind Energy Association
Funding support required	● Major funding initiative required to initiate New Energy Technology Development Centre		

Why Hydrogen?

Hydrogen is a versatile energy carrier and can be produced with a low carbon footprint. A recent McKinsey white paper (https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/hydrogen-the-next-wave-for-electric-vehicles) highlights that hydrogen can play seven major roles in the energy transformation, which span from the backbone of the energy system to the decarbonization of end-use applications:



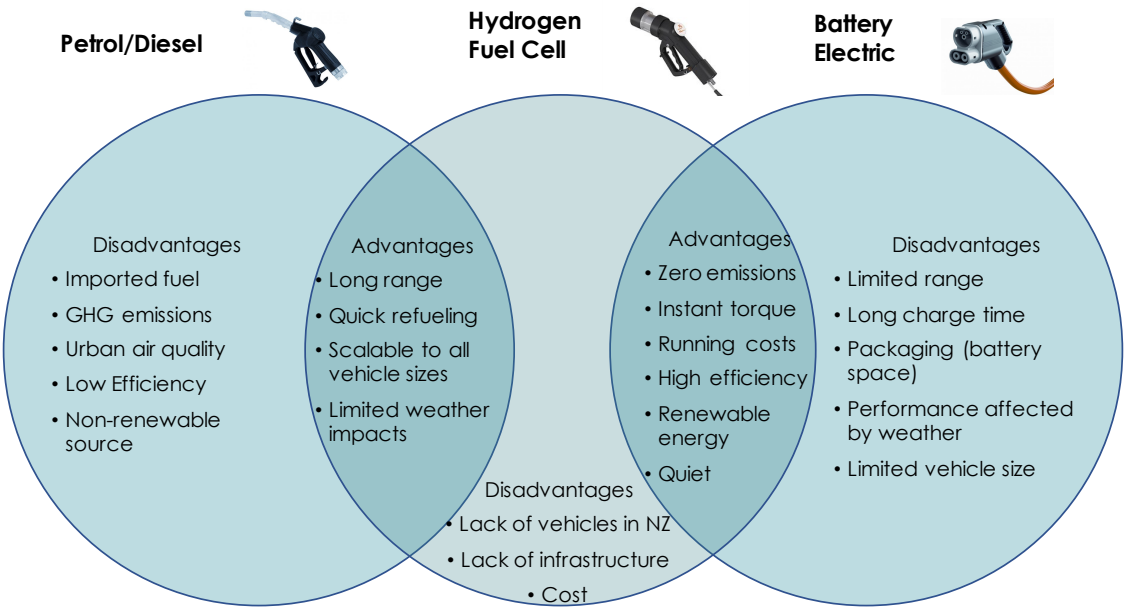
New Zealand and Taranaki has a history of producing and using hydrogen in the energy industry. It is mainly produced industrially through steam reforming of natural gas to produce methanol and fertiliser at Methanex and Ballance respectively.

Hydrogen can also be produced from electrolysis of water. This involves running an electrical current through water in an electrolyser to split the water (H_2O) into hydrogen (H_2) and oxygen (O_2). By using electricity from renewable sources, electrolysis can provide a zero-emission energy source.

Hydrogen acts as an energy storage medium. It can be stored until it is needed for a wide range of uses, including being converted back to electricity through a fuel cell in vehicles, generators or in principle, anything that requires electrical energy to operate.

When the electricity that is generated from intermittent renewables such as wind is used to produce hydrogen, it can have the effect of taking the energy that cannot be fed into the electricity grid and storing it for use as required. As a result, hydrogen can be used to help balance supply and demand for renewable electricity and enable intermittent renewable energy to play a bigger part in a low carbon future.

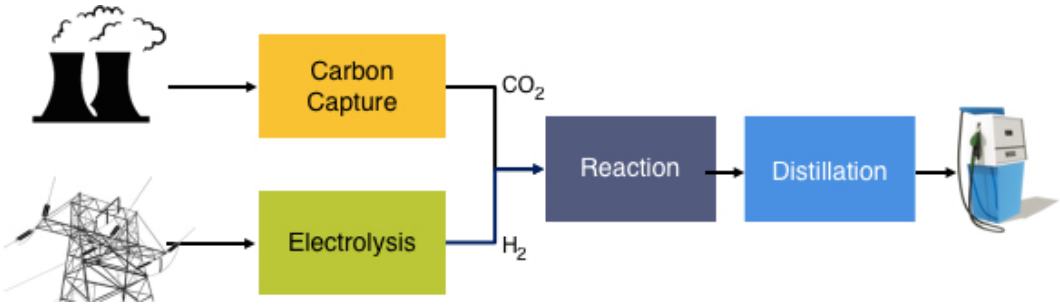
Hydrogen in transport has the potential to significantly extend the electrification of a broad range of transport. It combines many of the advantages of conventional petrol/diesel transport with the advantages of battery electric vehicles, while avoiding the disadvantages of each, as per the diagram below. The disadvantages of the technology adoption, namely, lack of infrastructure, vehicles and high early technology adoption costs are addressable through investment initiatives and technology maturation.



Original source: Hyundai Motors

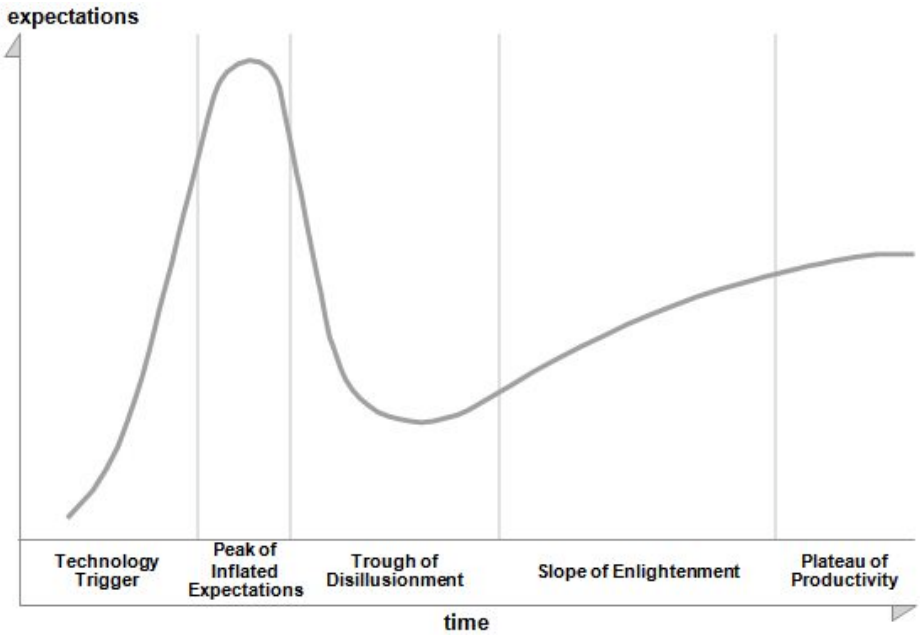
As a feedstock for Taranaki industry, renewable hydrogen can also help to decarbonise our food-producing agribusiness sector by reducing the carbon intensity of our fertilizer industry. The use of renewable hydrogen can also reduce the carbon intensity of our natural gas network and existing energy exports.

Combining renewable hydrogen with captured CO_2 can be utilised to create “green methanol”. This in turn can be utilised in conventional methanol applications and as a net zero emission fuel.



Technology development is required to reduce the cost of renewable hydrogen production to make it competitive with steam reformation and find new solutions to carbon emissions.

With the strong benefits of hydrogen recognised for many years, the natural question is "why has this technology not been adopted already?" The answer is perhaps best described using the concept of the Gartner Hype Cycle.



The Gartner Hype Cycle for emerging technologies

Modern hydrogen fuel cell technology owes its origins to the famous "Technology Trigger", the Space Race, where it enabled recycling of electricity, oxygen and water – significantly extending mission durations. This technology was explored early by General Motors in the 1960s with the development of the Electrovan. It utilised super cooled hydrogen and oxygen to feed a 5 KW fuel cell, had a top speed of 100km/h, and a range of 200km. However, the technology wasn't adequately robust and was far too bulky and dangerous to be a commercial product. The true commercial "Technology Trigger" for hydrogen emerged from the drive to find a replacement for the internal combustion engine, with its requirement for fossil fuels, and its GHG emissions. This really gained momentum in the 1990's on the back of the Kyoto Protocol, with companies

such as Ballard developing more robust, compact and safe PEM fuel cells and hydrogen storage solutions. Things were looking positive for hydrogen.

During the 2000's hydrogen went through a strong "Peak of Expectations" with high profile demonstration projects such as the Whistler Olympic village buses and a number of vehicle projects in Europe and UK. However, the technology ultimately failed to live up to these expectations. This was influenced by a number of factors:

- Very high costs due to hydrogen being early both on the technology development curve and the manufacturing scaling curve.
- The "Chicken and Egg" quandary produced by the requirement for hydrogen infrastructure to be available before vehicle manufacturers would develop products, and the need for vehicles to be available to encourage infrastructure development. Notably, the original plug in battery electric vehicles did not experience this barrier for the urban commuter market.
- The late 2000's also saw the emergence of lithium battery electric vehicles (BEV's) - primarily the high-profile Tesla Roadster and Model S. The emerging BEV industry then received a $2.4 billion USD stimulus package from the Obama administration on the back of the GFC.

This was the start of the "Trough of Disillusionment" for the hydrogen sector, which was seen by many as the Beta technology in the battle between VHS and Beta. The investment needed for growth largely dried up. However, the industry did not go away: technology development and commercialisation continued, products improved, and costs started to drop. The range, weight, recharging time, and fast charge grid limitations of BEV technology have proved a major hurdle in achieving decarbonisation for transport beyond the urban commuter vehicle. This has helped highlight the transport models that play to hydrogen's strengths, namely improved range, reduced weight and refuelling times, and infrastructure scalability.

On the back of COP21, the widespread realisation is emerging that hydrogen is going to be a vital tool in combatting climate change and enabling sustainable energy systems. While it will play a key role in decarbonising heavy transport, it also has a significant part to play in the broader energy transition challenges as highlighted above. The industry has experienced a major turning point as countries such as Japan and Korea strive towards "Hydrogen Societies", Germany commits $3.4 billion Euros infrastructure development spend, cities and regions create Hydrogen Roadmaps and strategies and major global bodies such as the Hydrogen Council are formed. The technology is now very much entering its "Slope of Enlightenment".

Hydrogen strategies and roadmaps from other regions

Aberdeen hydrogen strategy

Published in 2015. Builds on earlier work in 2013 and earlier hydrogen initiatives.

Link: http://www.aberdeeninvestlivevisit.co.uk/H2-Aberdeen/H2-Aberdeen.aspx

Opportunity:
"With the transferable oil and gas expertise in the North East of Scotland, as well as a capacity for renewable energy generation, there is an opportunity to further enhance our economic competitiveness by being at the forefront of a hydrogen economy."

Vision

"The Aberdeen City Region Hydrogen Strategy will focus on promoting hydrogen technologies as a low carbon alternative to fossil fuels and as an energy vector to facilitate the deployment of renewable energy sources. Hydrogen has a number of different applications such as transport, stationary power and as an energy storage medium. The main focus will be on transport applications however other uses will be considered within this strategy."

Aim:

"To reinforce our place, now and in the future as the energy city by further enhancing the region's economic competitiveness, maximising the capacity and value of renewable energy and giving greater energy security by being at the forefront of a hydrogen economy."

Objectives:

- Promote vehicle deployments by a range of stakeholders in the region;
- Expand production and distribution of renewable hydrogen;
- Develop hydrogen refuelling infrastructure;
- Explore the roll-out of other tried and tested or innovative hydrogen uses;
- Encourage the development of the hydrogen economy's supply chain, seeking opportunities for the region's existing energy expertise to diversify and bene t from this growing industry;
- Promote a greater understanding and acceptance of hydrogen technologies through communication and education activities;
- Ensure strategy and policy development at all levels of government are supportive of hydrogen technologies.

A hydrogen roadmap for South Australia

This roadmap was prepared by the South Australian Government and published in September 2017.
Link: www.ourenergyplan.sa.gov.au/hydrogen.html

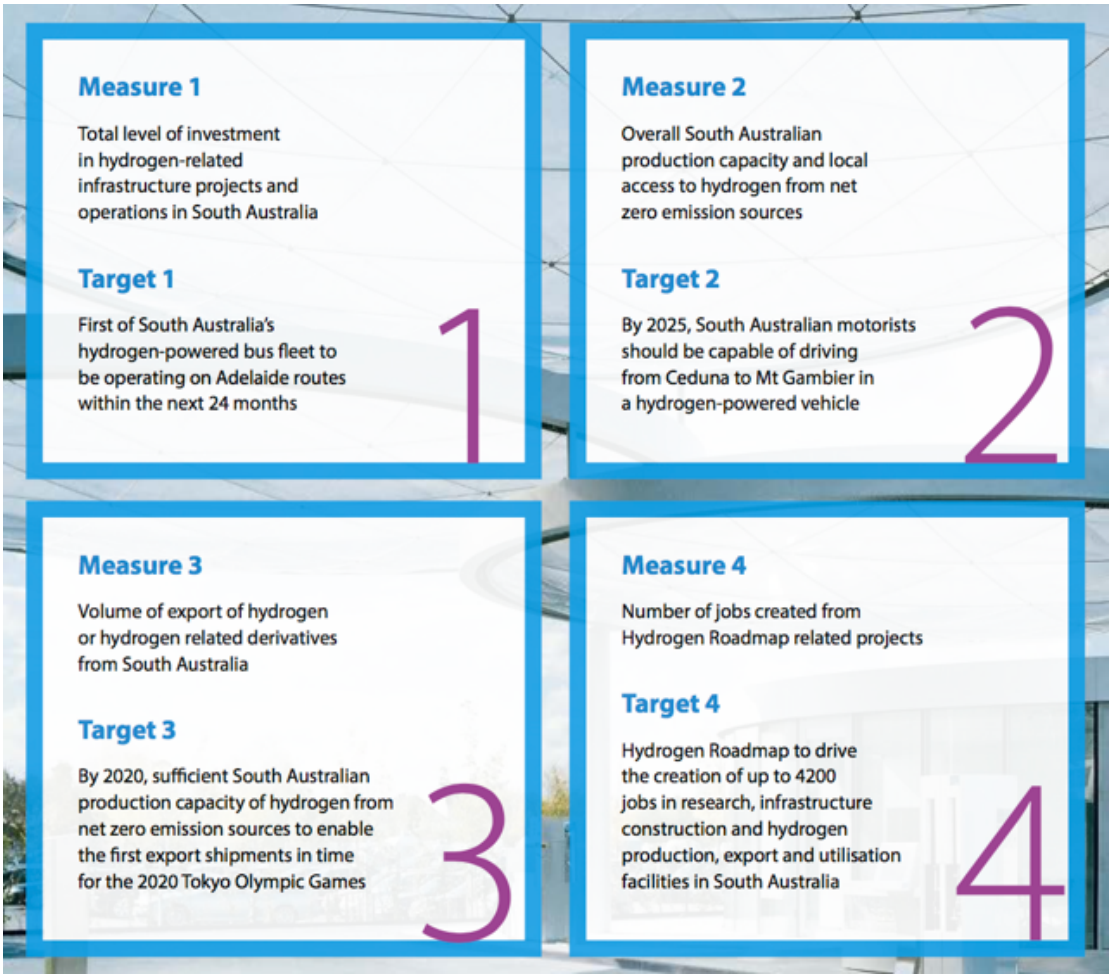
"This nation-leading strategy sets out clear pathways to capitalize on our State's competitive advantages and accelerate South Australia's transition to a clean, safe and sustainable producer, consumer and exporter of hydrogen" SA Premier

Vision

"To accelerate South Australia's transition to a clean, safe and sustainable producer, consumer and exporter of hydrogen"

Objectives

- Attract investment in hydrogen production using our renewable energy assets
- Accelerate local demand for hydrogen as a low carbon input for transport, energy and industry
- Unlock export markets for South Australian produced hydrogen
- Establish South Australia as a testbed for cutting edge hydrogen technologies



New Energy Centres from other regions

Models for similar Centres include Catapult in the UK,
https://es.catapult.org.uk
https://ore.catapult.org.uk/resources/case-studies/

ORE Catapult is the UK's flagship technology innovation and research centre for advancing wind, wave and tidal energy.

"Our mission:

We help to reduce the cost of offshore renewable energy, transforming the industry and delivering UK economic benefit.

We do this by:

- Being an independent and trusted partner;
- Working with industry and academia to develop and introduce new technologies and ways of working to reduce risk and cost and deliver business growth;
- Having world-leading test and demonstration facilities and an engineering and research team with deep knowledge and expertise; and
- Improving technology reliability by developing tests which are more representative of real-life conditions.

Our value proposition:

- Government - Sector leadership to focus and optimise the impact of the Government's investment in offshore renewables.
- Industry - Independent partner with expertise and experience in reducing cost and risk associated with offshore renewable energy technology development and operations by improving reliability of new technology through representative testing.
- Academia - Strategic partner with extensive industry knowledge, access, and world-leading test and demonstration assets, turning applied research into products and services for the offshore renewables sector.
- SMEs - World-leading expertise and advice, facilitating access to industry and funders, to develop, de-risk and support the journey of bringing new technologies to market."

Marketing and promotional ideas

State of Green – Danish initiative including physical premises, hosting international envoys, and a website showcasing Danish new / clean tech projects and capabilities. www.stateofgreen.com

Copenhagen New Tech Cluster – Energy Cluster www.copcap.com

SA government renewables – showcasing SA renewable energy capability www.renewablessa.gov.au

Renewable energy art design competition - Land Art Generator Initiative (LAGI) a global competition which connects to designers all over the world who develop designs of future energy forms as an attractive art form for Taranaki (http://www.landartgenerator.org/project.html).

Article from Energy News:

Truly beautiful power stations - Trust the Nordics
John Hancock - Fri, 15 Sep 2017
Having finished my posts based on the Abandoned Engineering TV series, I've been bombarded with counter-offers to the magnificent Art Deco Kelenfold Power Station in Budapest.

Last week we were in Christchurch but this one takes the biscuit. It's back to Northern Europe but not Soviet Russia this time. The Øvre Forsland power station is in Northern Norway, just south of the Arctic Circle. This is a very long way from anywhere – it's a 6 hour drive from Trondheim which itself is miles from anywhere else.

Like our kiwi and Tasmanian offerings, this is a small hydro but the remoteness of this plant hasn't done anything to reduce the owner's ambition - "The plant has been designed to reflect the characteristics of the landscape, which is located on the river bed in a clearing at the edge of a spruce forest," say the architects. "The main inspiration for the design was the verticality and the irregularity of the spruce trees."

The plan was to attract tourists and hikers as an architectural destination - and teach them a bit about

hydropower in the process. It certainly seems to have worked and shows real imagination on the part of the owner - interviewed in *The Guardian* last year, the generation manager said:
"Øvre Forsland does not only serve hydropower to people in the region. Its purpose is also to bring attention to hydropower, the history around it and the benefits … You can say that hydropower will play a main role in renewable society in the future, so we want more attention on the hydropower business."
"The community around us has built up because of the energy resources in the area, but many people have forgotten, because it was another generation that built them. We want to educate Norwegians and also [foreign] tourists about the story of hydropower in Norway, and how it can work in harmony with nature"

What a fantastic initiative – it's surprising we haven't seen more like these.
Got any more energy engineering stories for the blog? Just drop me a note with ideas – this has been fun. Back to another series interview next week with a worldwide exclusive.
John Hancock consults to the utility industry and its suppliers with a focus on technology, market reform and incentive. You can read about him at http://www.linkedin.com/in/johnhancocknz and contact him at john@hancock.co.nz or simply by commenting below. His blog usually comes out on Friday.