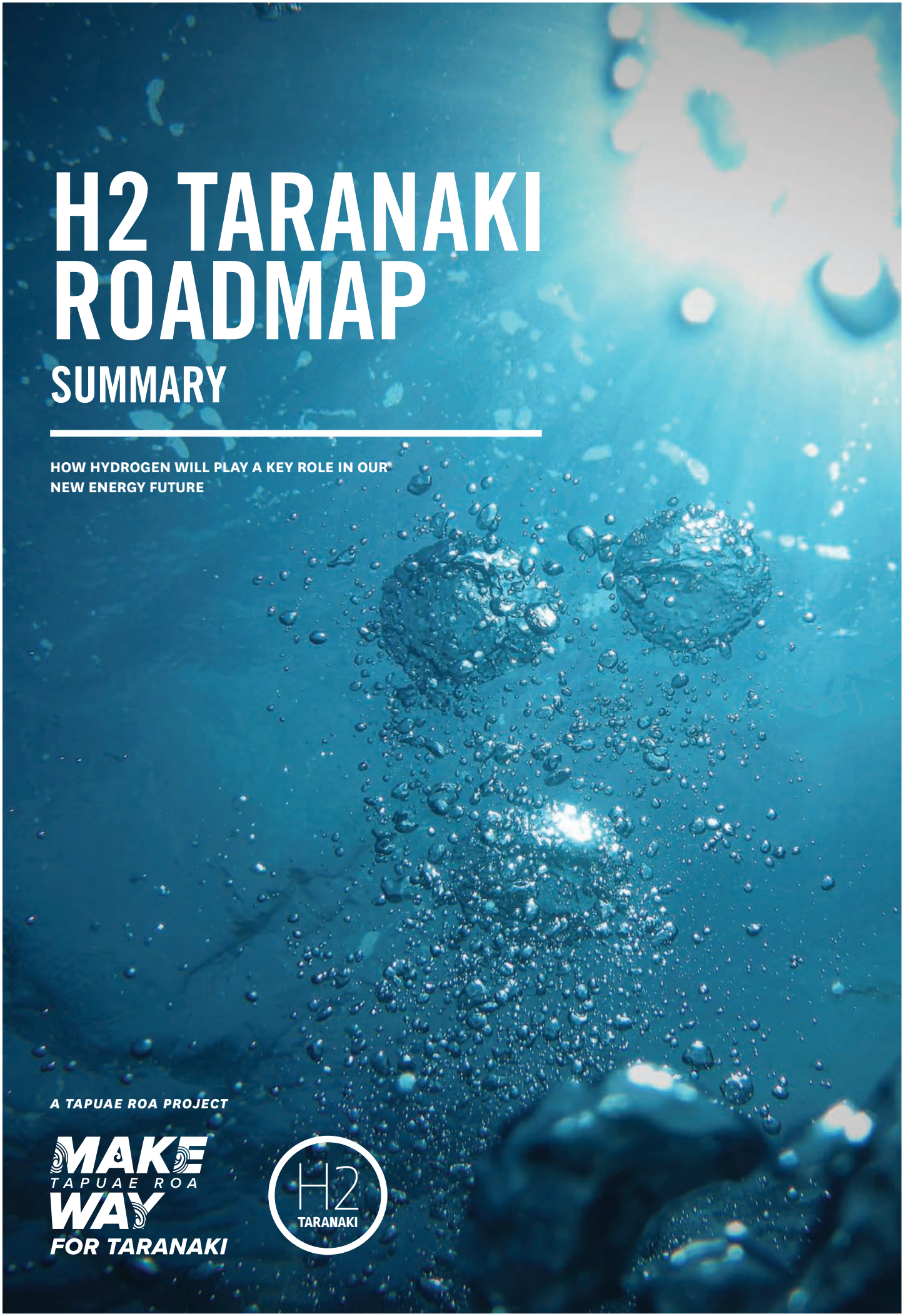


# H2 TARANAKI ROADMAP

## SUMMARY

**HOW HYDROGEN WILL PLAY A KEY ROLE IN OUR NEW ENERGY FUTURE**

*A TAPUAE ROA PROJECT*

MAKE WAY TAPUAE ROA FOR TARANAKI

H2 TARANAKI

# NEW ZEALAND'S NEW ENERGY FUTURE

New Zealand is moving into a new low-emissions future that will substantially alter our current energy ecosystem.

The New Zealand Government has set national targets of:

- A 30% reduction in greenhouse gas emissions by 2030 compared with 2005 levels,
- 100% renewable electricity by 2035, and
- Net zero emissions by 2050.

Currently, only 40% of the country's total energy supply is met from renewable sources.

While electricity production is largely from renewable sources (around 80%), the rest of our energy needs are met from a mix of fossil fuels, both domestic and imported. These are used for generating electricity to meet periods of peak and dry year demand, fuelling the majority of our transport fleet, supplying heat for households and industrial processes and as feedstock for products such as urea fertiliser and methanol.

There is now widespread agreement that in future the energy currently provided by fossil fuels in New Zealand will be progressively replaced by lower-emission alternatives.

New Zealanders can expect to see significant investments in wind, geothermal and solar electricity generation over the next three decades; while new sources of renewable generation such as marine are under development.

Renewable electricity however, is only part of the solution for achieving our low-emissions targets. There will be an ongoing demand for molecules (of gas or liquids) as well as electrons in the energy ecosystem for the foreseeable future.

These molecules will be necessary to:

- Form the products we need (e.g. ammonia , urea, resins and methanol).
- Provide light convenient energy carriers to help power our commercial and heavy transport.
- Store our surplus energy for later use (e.g. via hydrogen, biogas, synthetic gas and ammonia).

Therefore it is critical we explore opportunities to develop hydrogen, and products made using hydrogen, as part of the future mix of options available to deliver our long-term energy future.

**Neil Holdom**
**Chair Tapuae Roa Steering Group**
**Mayor of New Plymouth District**

## WHAT IS HYDROGEN?

**Hydrogen is the smallest and lightest element. It is the most common element in the universe but is not readily available on earth as pure hydrogen as it rapidly combines with other substances to create compounds such as water, hydrocarbons and carbohydrates.**

**Hydrogen is produced commercially from:**

- **Hydrocarbons, and classified as either:**
  - **'Brown' hydrogen – when carbon dioxide is released**
  - **'Blue' hydrogen – when carbon dioxide is captured and stored**
- **Water, and classified as:**
  - **'Green' hydrogen when produced with zero emissions using renewable electricity.**

# THE CASE FOR HYDROGEN

## ENERGY STORAGE AND USE

Achieving New Zealand's energy targets will be challenging. The main challenge is balancing supply with demand – both within days and between seasons and years (particularly in dry years). It will be very difficult for New Zealand to meet electricity demand peaks if 100% of electricity is supplied from renewable sources such as hydro, wind, solar and marine as these cannot be turned on and off when needed. Storage of electrical energy will therefore be required to meet demand peaks.

Batteries will likely perform an important role in short-term electricity storage, but they are not the solution to storing electricity from month-to-month and year-to-year as scaling up is expensive and batteries lose power over time. Hydrogen offers excellent potential for medium-to-longer term energy storage when produced using renewable electricity. This green hydrogen can then be captured, stored and used later either in a fuel cell[1] or peaker power plant (as hydrogen, or transformed to ammonia or synthetic natural gas) to generate electricity as needed. The storage of hydrogen (and related products) is scalable and does not degrade over time. Hydrogen production plants, coupled with renewable energy, can also perform the role of providing 'virtual' energy storage over the short-term, whereby hydrogen production can be turned off within seconds and the resulting excess power from the renewable generation can be fed into the grid to meet demand peaks.

## VEHICLE FUEL

Hydrogen has clear advantages over battery-powered vehicles for the electrification of New Zealand's heavy transport and commercial fleets. Commercial freight vehicles look to carry as much commercial payload as possible but batteries are a heavy form of energy storage compared to hydrogen. This extra weight limits payload capacity of battery-powered vehicles. In addition, commercial vehicle fleet owners often require high utilisation i.e. vehicles are driven long distances or continuously for long time periods and refuelled quickly. Hydrogen powered vehicles have a similar range to current petrol or diesel-powered vehicles and can be refuelled rapidly, enabling efficient fleet optimisation.

Major advancements in battery-powered electric vehicles are occurring and will enable emissions reductions across the entire transport sector, including light vehicles. This has the potential to save the equivalent of 7.4 million tonnes of $CO_2$ emissions across New Zealand[2]. Light hydrogen fuel cell electric vehicles are already being commercially produced, while hydrogen powered heavy and commercial vehicles are in development.

While there is an argument that battery electric vehicles are more energy efficient from charging through to the wheels, it is in the broader system efficiency that the business case for hydrogen fuel cell technology lies. Hydrogen's ability to capture excess renewable energy without requiring large stationary battery storage or major grid upgrades, combined with the scalability of production and supply infrastructure, translates to total system efficiencies that will lower the cost of low-emissions transport.

It is anticipated that hydrogen fuel cell vehicles will be more competitive than the incumbent diesel technology within the next five to seven years. To remain competitive, fleet operators will need to have plans in place to convert their fleets by this time.

## INDUSTRIAL FEEDSTOCK

A number of industrial processes including the production of methanol and urea currently use natural gas as a feedstock to source hydrogen. Green hydrogen produced from renewable electricity can instead be used as a clean feedstock to reduce emissions. This approach is referred to as "Power to X", as the hydrogen molecules produced can be applied to a number of applications.

## EXPORT POTENTIAL

Both green hydrogen and/or related products such as methanol or urea can be exported. Hydrogen has the potential to become a major export earner for New Zealand. Japanese companies have already shown interest in procuring hydrogen from New Zealand, and there is current exploration into the use of liquid hydrogen, hydrogen in combination with a liquid organic hydrogen carrier (LOHC)[3] or as ammonia to facilitate international transportation.

*1 A fuel cell combines hydrogen and oxygen to produce electricity. The electricity from a fuel cell can be used in vehicles to power an electric motor. A fuel cell's only emissions are water.*

*2 Assumes 100% of heavy trucking is supplied by hydrogen and 33% of light duty vehicles.*

*3 LOHCs are hydrocarbons that can bond with hydrogen. The resulting compounds are stable at ambient temperature and pressure for safe, cost effective transportation. At destination the hydrogen can be removed and the LOHC returned to source for carrying more hydrogen.*

## THE OPPORTUNITY FOR TARANAKI

For Taranaki, a region whose prosperity has been built on the abundance of natural hydrocarbons, the imperative to be part of the transition to new energy systems is particularly pressing. This transition offers a once-in-a-generation opportunity for the region to leverage its human and natural resources to take a leading role in delivering a low-emissions future.

As the centre of New Zealand's energy sector, Taranaki is ideally placed to underpin and enable advancements in renewable energy through:

- The establishment of hydrogen production and refuelling infrastructure to build upon the region's existing energy sector skills and distribution networks. This will enable Taranaki to grow new business opportunities across New Zealand and deliver integrated hydrogen networks for the whole country.
- Storage of hydrogen or synthetic natural gas in depleted gas fields.
- Electricity generation using green hydrogen in Taranaki's gas-fired peaker plants. These plants can be rapidly powered-up to produce vital electricity during periods of peak need, typically supplying the crucial final 15% of electricity demand.
- Development of significant new design, construction and operations capability around the region's natural offshore wind and wave resources, onshore wind, geothermal, hydro, and solar resources, to combine with an integrated hydrogen gas and electricity system.
- Development of hydrogen refuelling infrastructure throughout the region and networked to neighbouring regions and across New Zealand to allow heavy vehicle freight movements.
- Development of a low-emissions hydrogen ecosystem in Taranaki's vital industrial chemical sector[4] to enable major decarbonisation – leveraging existing skills and infrastructure, and ensuring the sector remains viable in the future. This includes use of renewable electricity to produce green hydrogen as a feedstock for methanol and urea production.
- The supply of green hydrogen. Taranaki could become one of several New Zealand regions exporting renewable energy to meet global demand.
- Port Taranaki becoming a key hub for hydrogen export. The Port is already experienced in handling industrial chemical products. Utilising gas infrastructure already centred on Taranaki will allow hydrogen produced elsewhere to be moved cost effectively to the region.

There is potential for integration with international supply chains already in existence through the oil and gas industry, supporting the transition of the region's energy services sector and creating new opportunities for New Zealand businesses.



*4 Most significantly, Methanex produce methanol and Ballance Agri-Nutrients produce urea fertiliser in Taranaki.*

## WHY TARANAKI?

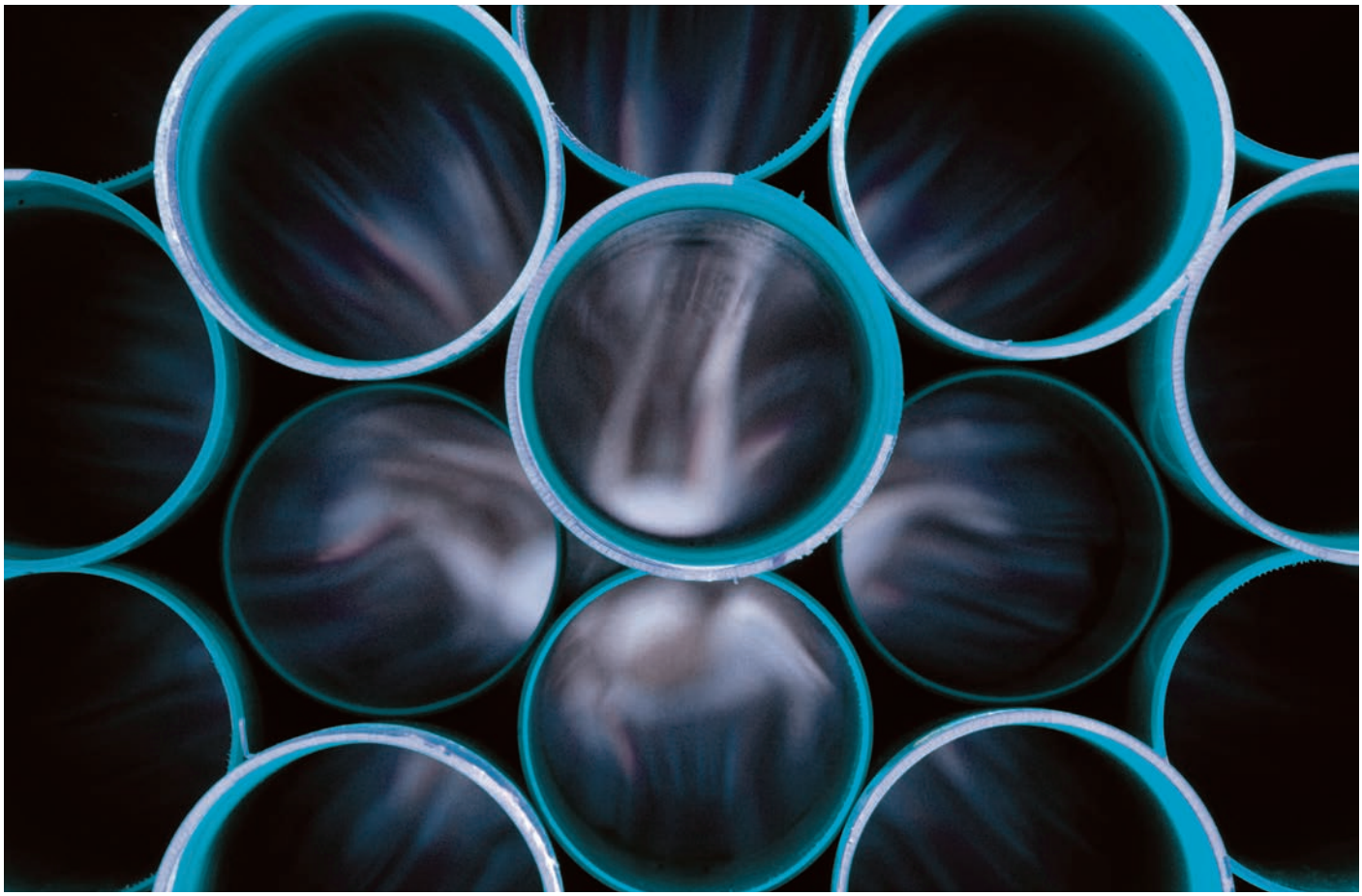
While hydrogen initiatives will occur across New Zealand, Taranaki has a unique collection of strengths that position the region as the major player in the New Zealand hydrogen opportunity.

- Significant water, wind and solar resources
- Already home to large producers and users of hydrogen
- Hydrogen infrastructure design and engineering expertise
- Deep-water port
- Geographically close to Australia and Asia
- Established energy generation and electricity and gas distribution infrastructure
- Local and regional government support
- Significant industrial chemical, engineering and manufacturing capability
- Manufacturing, on and off-shore fabrication and construction expertise
- Supporting service industry including pipeline integrity, very high pressure test facilities
- Operation & maintenance of gas plants
- Leading safety culture with experience of working safely with hazardous materials, gases, drilling for oil and gas, and high voltage power


# POTENTIAL INTEGRATION OF HYDROGEN INFRASTRUCTURE

**THE MAP SHOWS HOW FUTURE HYDROGEN AND RENEWABLE ELECTRICITY DEVELOPMENTS WOULD INTEGRATE WITH TARANAKI'S EXISTING ENERGY INFRASTRUCTURE.**


Offshore Gas Platform
Fixed Offshore Wind and Wave Generation
H2 Powered Heavy Transport
H2 Powered Bus
H2 Production
Green methanol production
NEW PLYMOUTH
Gas Pipelines
Gas Peaker Plant
Blue H2 Production
Remote Stationary Power for Farms
Mount Taranaki
Gas Peaker Plant
STRATFORD
KAPUNI
Onshore Wind
Underground Storage
Green H2 Production
Synthetic fuels
H2 gas storage
Green ammonia
H2 Refuelling Depot
KAPUNI
H2 Powered Milk Tanker
HAWERA
Dairy Factory
H2 Refuelling Depot
H2 Powered Train
Fixed Offshore Wind and Wave Generation
Onshore Wind
WAVERLEY
PATEA





## THE H2 TARANAKI ROADMAP[5]

The *H2 Taranaki Roadmap* was developed by Hiringa Energy with support from Venture Taranaki, New Plymouth District Council and the New Zealand Government's Provincial Growth Fund. It is an initiative of Taranaki's Tapuae Roa Regional Economic Development Strategy and Action Plan.

The Roadmap outlines a series of projects that together with leveraging the existing heavy energy industry skills and infrastructure in the region, will help seed the establishment of a low-emissions hydrogen sector. The opportunities have the potential to become multi-billion dollar development projects, create significant employment opportunities, and generate billions of dollars in domestic and export revenue.

At its heart and to start the journey, a critical mass of near-term public and private sector projects are proposed to create the ecosystem and establish a hydrogen industry in New Zealand, including:

- Establishment of a New Plymouth refuelling station and out-of-region connecting hubs, to service buses, trucks, light commercial, waste and contractor specialised vehicles.
- Development of a green ammonia project at Kapuni, establishing hydrogen production to support the growth of hydrogen transport and provide the foundation for transition to a low-emissions chemical industry.
- Implementation of hydrogen into a stationary energy application within regional infrastructure such as one of the region's aquatic centres, council buildings or district health facilities, providing combined heat and power, energy storage and resilience.
- Deployment of near-term projects with Japanese and other international partners that enhance business and regional relationships and create the basis for future export developments.
- Studies and trials for hydrogen injection into the gas grid, including 100% hydrogen scenarios.
- Investigation of carbon capture and storage using the Taranaki gas fields together with carbon capture utilisation options, including synthesis of fuels and industrial chemicals.
- Exploration of opportunities to use hydrogen-based fuels in peaker electricity generation plants.

5 *The full version of the H2 Taranaki Roadmap can be found at http://about.taranaki.info/tapuae-roa/h2*

## H2 TARANAKI



H2 Taranaki will coordinate delivery of the Roadmap.

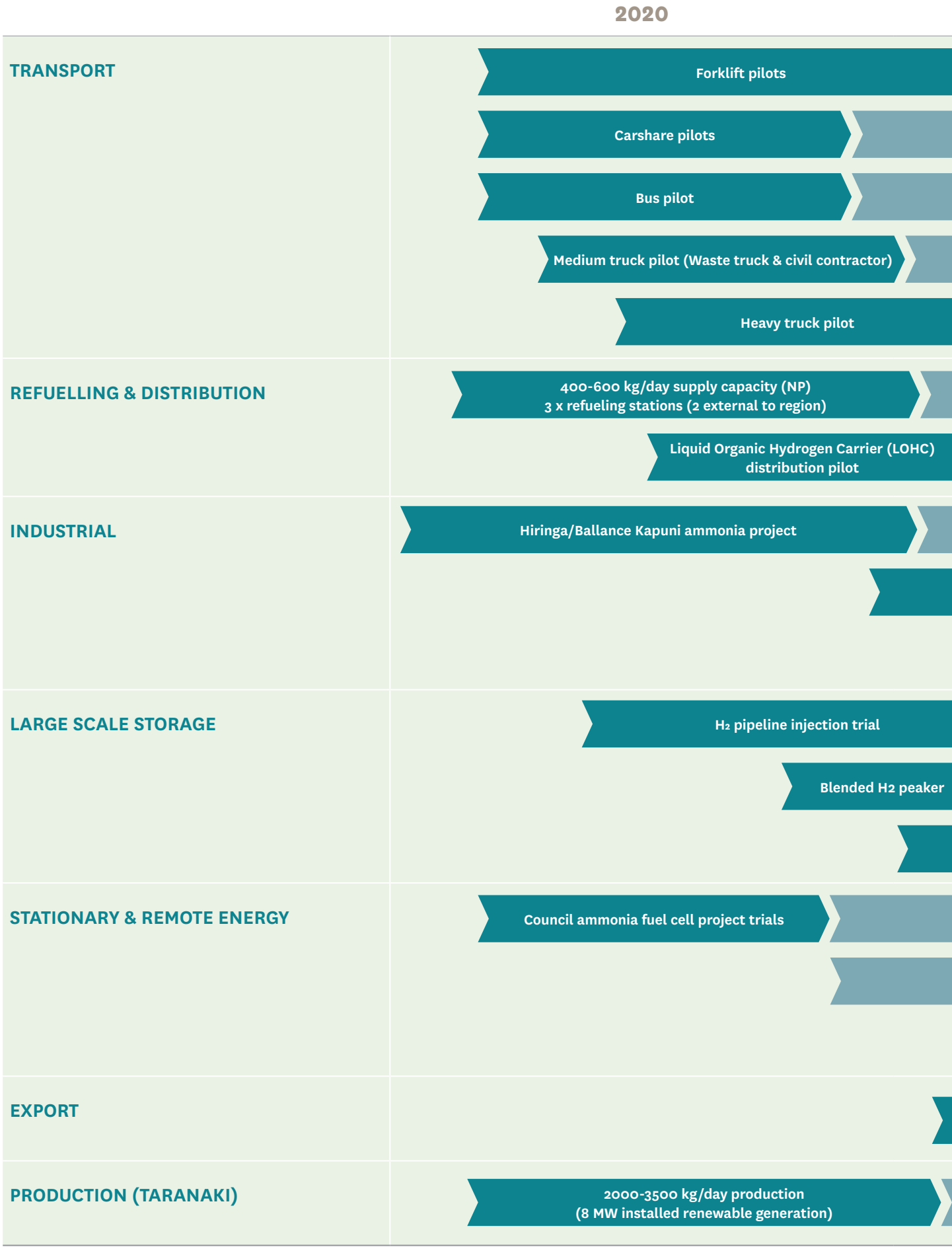
H2 Taranaki will initially be a public-private partnership between New Plymouth District Council, Venture Taranaki and Hiringa Energy, with the inclusion of formation partners Taranaki Regional Council, Stratford District Council and South Taranaki District Council.

Participation of local businesses and organisations will be highly encouraged, with the expansion of activities beyond the initial partners a key objective.

H2 Taranaki will support the development of a hydrogen ecosystem in the region, aiming to:

- Attract investment in hydrogen production, leveraging existing energy industry capability and access to renewable energy.
- Accelerate local demand for hydrogen as an economic, low-emissions, renewable and secure input for transport, energy and industry.
- Position Taranaki businesses to participate in a growing international industry.
- Nurture and enable the development of a hydrogen export industry.

## THE ROADMAP ENVISAGES A SERIES OF PROJECTS THROUGH TO 2030:




2025
2030
Scale up forklift fleets
Light vehicle public refueling access and fleet expansion
Scale up light fleets
Intercity bus pilots / expand regional fleet
Scale up light fleets
Full waste fleet adoption
Scale up medium truck fleets
Heavy long haul and short haul fleet trials
Fleet conversion and expansion to dairy, forestry
800-2000 kg/day supply & expansion outside region. Light vehicle public refueling access
Scale up existing refueling stations, additional stations in Taranaki and across NZ
LOHC full commercial
LOHC for domestic & export
New-build green ammonia production
Green ammonia export
Carbon capture and synfuel pilot
Scale up of synfuel
Synthesised methanol pilot
Scale up methanol
H2 pipeline injection blending/storage
100% H2 pipeline conversion
plant trials
100% H2 peaker plant trials
100% H2 peaker plant conversion
10MW methanation plant pilot
100MW methanation plant
Multiple distributed methanation plants
Trial large backup fuel cell applications for infrastructure
Large scale integration of fuel cells with district infrastructure for backup and grid stabilisations
Large FC system suitable for all council remote applications
Implement fuel cells in all applicable remote applications
Grid stabilisation
Pilot export technology (LOHC or Liquid)
500-1000 MW export facility
12,000 kg/day production (50 MW installed renewable generation)
700-2,000 T/day production (3-8GW installed renewable generation)

*The H2 Taranaki Roadmap was prepared with support from:*

HIRINGA

Te Kaunihera-ā-Rohe o Ngāmotu
New Plymouth District Council

PROVINCIAL GROWTH FUND

*Project managed by:*

Venture TARANAKI
Te Puna Umanga

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**Venture Taranaki is an initiative of**

Te Kaunihera-ā-Rohe o Ngāmotu
New Plymouth District Council

TARANAKI
like no other