Submission on:

"A Vision for Hydrogen in New Zealand" Green Paper

from

Ballance Agri-Nutrients Limited

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	NGO	☐	
	Business / Industry	☒	
	Local government	☐	
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	Iwi	☐	
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Commercial Sensitivity

Nothing in this submission is confidential.

1 Introduction

Ballance Agri-Nutrients Limited ("Ballance") would like to thank the Ministry of Business, Innovation & Employment for the opportunity to make this submission on the "A Vision for Hydrogen in New Zealand" Green paper, released September 2019.

Ballance is actively involved in enabling the establishment of Green Hydrogen infrastructure through our partnership and Joint Development agreement with Hiringa Energy. Refer to Appendix 2 for details of our project and press release

Company Overview
Ballance is a farmer-owned co-operative with over 18,000 shareholders and approximately 800 staff throughout New Zealand. Ballance owns and operates super-phosphate manufacturing plants located in Tauranga and Invercargill, as well as New Zealand's only ammonia-urea manufacturing plant located at Kapuni, South Taranaki. The Company also owns and operates 'SuperAir', an agricultural aviation company; 'SealesWinslow', a high-performance compound stock food manufacturer. Ballance has a network of fertiliser storage and dispatch facilities across the country.

As well as supporting New Zealand farmers, Ballance also supplies products to a range of domestic industrial businesses including the domestic wood processing sector:

- Urea, is used in the production of formaldehyde based resins, a key ingredient in the manufacture of particleboard and MDF.

- In addition, an extremely high purity urea solution is used to produce GoClear at the Kapuni plant. GoClear is an exhaust system additive and scrubbing agent that reduces harmful nitrogen oxide (NOx) emissions from diesel engines, breaking the NOx down into harmless water vapour and nitrogen gas.

Ballance places a strong emphasis on delivering value to its shareholders and on the use of the best science to inform and deliver sustainable nutrient management.

2 Ballance's interest in Hydrogen

2.1 Description of Ballance use of hydrogen and process heat

Ballance is one of New Zealand's largest producers and consumers of hydrogen, annually we use 31,000T of hydrogen as a feed stock in the manufacturing of ammonia. We currently produce hydrogen via Steam Methane Reformation which is the standard industry method employed around the world including our international competitors.

- **Energy use at the Kapuni Site:**
  - The Kapuni site uses 7PJ – 7.5PJ of natural gas annually.
  - 53% of natural gas use is as the raw material in the manufacture of Ammonia and Urea. Natural gas provides Hydrogen used in the production of ammonia and carbon used in the production of urea.
  - High grade heat is used in the reformer to crack natural gas at temperatures greater than 600 °C. The reformer accounts for 20% of total site natural gas use. Extensive heat integration, is used to recover waste heat which is used elsewhere in the process.
  - Kapuni operates 3 large compressors which are powered by natural gas; these compressors use 14% of total energy.
  - The balance (9%) of the natural gas at Kapuni is used for steam raising and electricity generation which is produced from an integrated cogeneration plant.
  - Electricity is used for motive power (for pumps, small compressors, air cooling fans) which is sourced internally from the cogen plant and from the national grid.

Carbon dioxide produced during the reforming process is recovered and used in the manufacturing of Urea together with additional carbon dioxide sourced externally.

Table 1 presents an overview of the fuel switch potential for the Kapuni Site.

Table 1 - Kapuni Ammonia Urea Plant Fuel Switch Potential Overview

Service	Current Fuel	Annual Consumption	Alternatives
Feedstock and Reforming	Natural Gas	5.1PJ	Partial substitution of natural gas for hydrogen manufacture is possible, e.g. through electrolysis. Electrolysis is not yet commercially viable at scale.
Compression	Natural Gas	1PJ	Hydrogen substitution within the technology constraints of the current plant is not possible
Cogeneration	Natural Gas	0.7PJ	Hydrogen substitution within the technology constraint of the current boiler equipment is not possible.

Please see Attachment 1 for an overview of the Kapuni plant.

Ballance is evaluating a project to produce 'green' hydrogen and incorporate with our existing facility. Ballance recognises we have an important role to play in enabling the establishment of hydrogen infrastructure, through our existing infrastructure, corporate knowledge and people capabilities which allows us to safely and reliability manufacture and consume hydrogen produced from alternative methods like electrolysis.

Our partnership with Hiringa Energy is aimed at establishing a supply of Green Hydrogen which can be used as a low carbon fuel support in heavy transport. The initial supply of green hydrogen will be used in the Kapuni Plant to produce urea.

As scale and electrolyser technology develops the cost of producing green hydrogen is expected to reduce and become commercially competitive with Steam Methane Reforming. Our partnership with Hiringa will mean Ballance (and New Zealand) will be well placed to be leaders and early adopters of these technologies as they develop and become competitive with conventional hydrogen manufacturing processes.

While playing a leading role in establishing green hydrogen in New Zealand and utilising this hydrogen for the manufacturing of urea, it is important to acknowledge that the Kapuni Urea manufacturing facility must be able to compete directly against imported Urea. Production from the Kapuni Urea Plant meets approximately one third of New Zealand's demand for urea. Remaining demand is imported primarily from the Middle East, Far East and China. Ballance urea (produced from hydrogen via natural gas reforming and in the future via green hydrogen) is therefore in direct competition against manufacturing plants and countries with less stringent international climate change ambitions and which solely utilise coal or natural gas.

2.2 Future of Urea and other Products

- Demand for urea, and Ballance's other product lines, is expected to continue to grow in both agricultural and industrial applications. The use of electrolysis at scale for the production of hydrogen and nitrogen fertilisers is a goal manufacturing companies (like Ballance) and the industry technology providers.
- With the right policy settings, domestic manufacturing will continue to make a strong economic contribution to New Zealand and support the establishment of low carbon technologies.

3 Submission Points

3.1 Commentary on Green Paper

Ballance has some broad comments:

The establishment of hydrogen demand for domestic purposes such as transport and industrial use is restricted by the lack of supply, while supply is limited by the lack of a domestic demand. Breaking this interdependence is a critical challenge for hydrogen and the potential for hydrogen to play an important role in decarbonising the New Zealand economy.

Regions such as Taranaki and Northland are well placed to lead the establishment of hydrogen infrastructure due to the presence of existing manufacturers and the supporting capabilities which exist within these regions.

An overarching requirement of Government in the energy sector is predictable energy policy and carbon policy to provide investors and lenders confidence and certainty to commit to capital assets which will have a >20yr operating life. The sustainability and wellness of the New Zealand economy is dependent on the competitiveness of our products in international markets, policy decisions therefore cannot be made in isolation if we are to avoid leakage of skills, knowledge and capabilities overseas.

The Green Paper is at a low level of detail when compared to the Australian Government's *"National Hydrogen Roadmap – Pathways to an economically sustainable hydrogen industry in Australia",* published in August 2018 by CSIRO and developed with considerable industry input.[1] Furthermore the Green Paper "Indicative Hydrogen Roadmap" is very simplistic and risks understating the challenges ahead. Ballance was surprised that the significant work carried out by our major trading partner was not referenced in the Green Paper and encourages the Government to engage closely with the Australian Government and its advisors going forward. As a small nation, New Zealand will be a technology adopter and it is likely that suppliers will take a regional Oceania focus as is the case for many industrial and consumer goods.

Response to Specific Questions:

[1] https://www.csiro.au/en/Do-business/Futures/Reports/Hydrogen-Roadmap

- Question 2a – what is the role of government in developing the complementary role of electricity and hydrogen?
    - The paper focusses on green hydrogen as a pathway to decarbonise the New Zealand economy, this should be complemented with blue hydrogen where carbon emissions from production are captured and stored (CCS). Government policy is needed which enables consideration of CCS solutions.

- Question 2b – what are the challenges for achieving this complementary role of electricity and hydrogen?
    - Extensive investment in renewable electricity generation coupled with hydrogen generation will disrupt the current transmission network (and grid pricing models) with increased distributed generation and 'off' grid consumption.

- Question 2c – what are the opportunities for this complementary role of electricity and hydrogen?
    - Ballance strongly agrees with suggestions that hydrogen has a complementary role in a renewable electricity system. Electrolyser technology allows hydrogen to be produced and stored during periods of excess electricity generation. In periods of high electricity demand, hydrogen assets would be able to load shed supporting a resilient renewable electricity network.
    - The use of hydrogen produced from excess electricity can be utilised in multiple applications which are difficult to achieve directly with electricity such as decarbonising heavy transport or use for industrial process feedstock.
    - New Zealand currently exports a significant amount of renewable electricity through base load industrial processes. A key advantage of a hydrogen export industry over base load export industrials is the ability for hydrogen technologies to release power to the grid during periods of supply scarcity.

- Question 3b – what are the challenges when using hydrogen for mobility and transport?
    - New Zealand is a small market and is likely to find it difficult to secure priority supply for technologies such as vehicles and refuelling stations without a considered national road map. Individual investment is unlikely to be supported by vendors
    - Establishing a network of refuelling stations is a key challenge for hydrogen as a transport fuel.

- Question 3c – what are the opportunities for using hydrogen for mobility and transport?

- New Zealand's heavy freight network is concentrated north of Taupo with a large number of fleets operating from a central hub, this means a small strategically located refuelling network could support a fleet of hydrogen fuel cell trucks.
- The paper misses the importance of green ammonia (produced from green hydrogen) as both an energy carrier and directly as a fuel. The CSIRO National Hydrogen Roadmap report recognises liquid ammonia (produced from green hydrogen) as an energy density fuel which is easy to store, transport and benefits from existing global infrastructure. Ammonia is an attractive fuel for decarbonising maritime transport.[2][3] Adoption will occur first in vessels which already carry ammonia as a cargo.

- Question 4a – what is the role of Government in encouraging the use of hydrogen for industrial processes including process heat supply?
  - NZ manufacturing companies compete internationally and domestically against international manufacturers. A forced "unjust" transition for domestic producers risks the leakage of knowledge skills and manufacturing jobs offshore.
- Question 4b – what are the challenges for using hydrogen in industrial processes?
  - Ballance is concerned the green paper adopts the Hydrogen Cost Model prepared by Concept Consulting ($NZ7.5/kg) without investigating the significant difference compared with the Australian "National Hydrogen Roadmap – Pathways to an economically sustainable hydrogen industry in Australia" cost model $AU3/kg.
  - The opportunity for hydrogen as a solution for process heat is limited by technology and suitable infrastructure networks. Hydrogen has different characteristics to natural gas which prevents direct substitution as a fuel. Process heat equipment (such as boilers) are long life assets designed and operated for >20yrs before replacement An example challenge is that using hydrogen for process heat, either as a mix with natural gas or in isolation, can lead to higher NOx emissions due to its higher flame temperature. NOx emissions are typically a resource consent restriction.
- Question 4c – what are the opportunities for the use of hydrogen in industrial processes?
  - Green hydrogen has the potential to supplement hydrogen produced from hydrocarbons in industrial plants which require hydrogen for feedstock. The rate of adoption will be influenced by the existing technology employed, the market in which the products compete, and the speed at which scale and manufacturing efficiencies progress.

[2] MAN Energy Solutions: an ammonia engine for the maritime sector – Jan 2019
[3] Reducing CO2 Emissions to Zero: The 'Paris Agreement for Shipping' – International Chamber of Shipping https://www.ics-shipping.org/docs/default-source/resources/reducing-co2-emissions-to-zero-the-paris-agreement-for-shipping.pdf

Attachment 1 – Kapuni Ammonia–Urea Plant Details

Ballance owns and operates New Zealand's only ammonia-urea plant located on a 32.4 hectare site at Kapuni in South Taranaki.

Using some 7 petajoules (PJ) of natural gas, the plant produces 150,000 tonnes of ammonia per year, over 99% of which is converted to 265,000 tonnes a year of premium grade granular urea. The high quality granular urea product is used as a nitrogen-rich fertiliser in the agricultural, horticultural and forestry sectors, and as a component in the manufacture of other products (primarily resins).

The Kapuni plant production meets approximately one third of New Zealand's demand for urea. Remaining demand is met through imports sourced primarily from the Middle East, Far East and China. Ballance is therefore in direct competition against countries with less stringent international climate change obligations.

The company makes a significant economic contribution to the local economy and employs 130 permanent staff and 17 full time contractors.

The Kapuni Ammonia-Urea Plant

1) The location and scale of Kapuni site is show below (Figure 1).

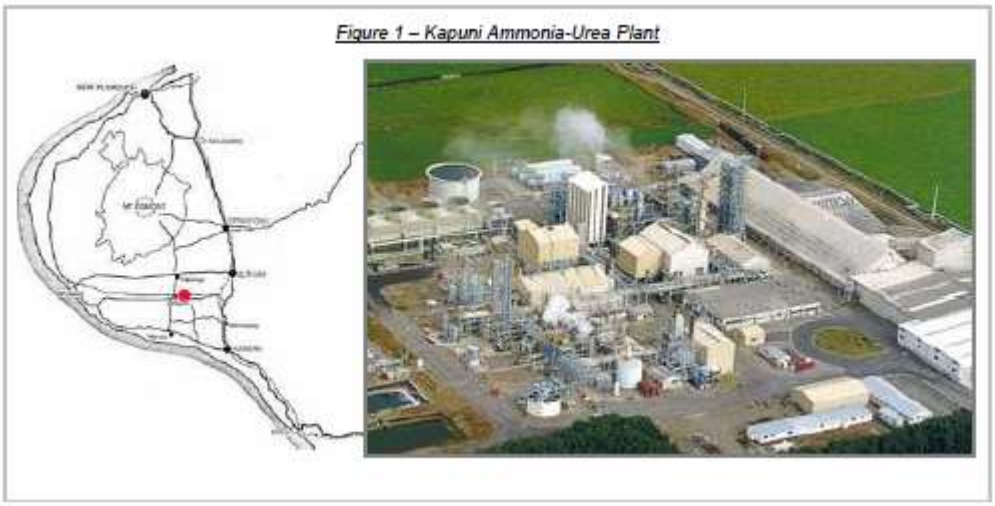


Figure 1 – Kapuni Ammonia-Urea Plant

2) The plant, which commenced operation in 1983, was built to make use of the Government's "take or pay" gas contract arrangements at the nearby gas fields.

3) The plant was designed from the outset as a single site integrated ammonia-urea plant, ammonia being an intermediate product in the conversion of natural gas to urea.

4) The plant was one of a series of "Think Big" projects instigated by the Muldoon led National Government. It was envisaged that the plant would help New Zealand's balance of payments by exporting urea, however New Zealand's current demand of 850,000 tonnes now exceeds plant production resulting in all sales being domestic.

5) The plant was revamped in 1996 to increase production and reduce energy use through closer heat integration of the ammonia and urea sections of the plant.

6) The process is described in detail in Attachment 1 and is summarised in Figures 2-3 below, which show the primary chemical reactions and the location in the plant of the activities.

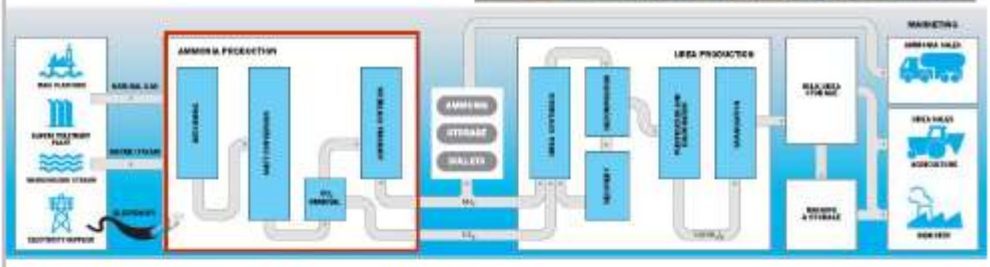
Figure 2 – Ammonia Production Step

$CH_4 + 2H_2O \Leftrightarrow 4H_2 + CO_2$

gas + steam ⇔ hydrogen + carbon dioxide

$N_2 + 3H_2 \Leftrightarrow 2\,NH_3$

nitrogen + hydrogen ⇔ ammonia



Notes (typical production statistics shown):

- *Natural gas feedstock is predominantly specification gas (7PJ).*
- *Ammonia production is 150,000 tonnes per annum.*
  - *There is a small intermediate storage capacity of 450 tonnes ammonia (1 days production if full). This is primarily to allow sequential (ammonia then urea) start up of the plant and to provide a buffer for any minor upsets.*
- *Carbon dioxide production is 195,000 tonnes per annum.*
  - *There is no intermediate storage of carbon dioxide.*

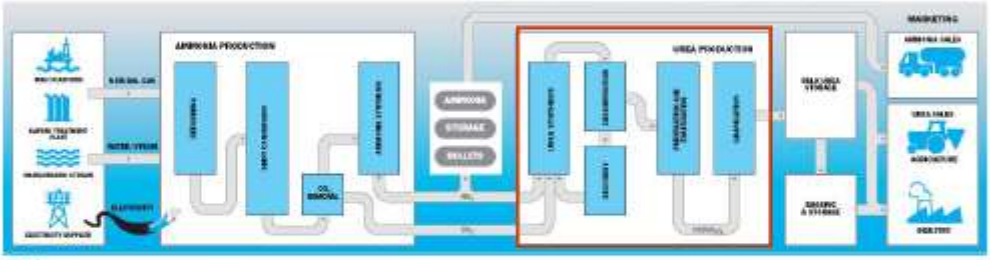
Figure 3 – Urea Production Step

$2\ NH_3 + CO_2 \Leftrightarrow NH_2COONH_4$

ammonia + carbon dioxide ⇔ ammonium carbamate

$NH_2COONH_4 \Leftrightarrow H_2O + NH_2CONH_2$

ammonium carbamate ⇔ water + urea



Notes:

- *All of the ammonia and carbon dioxide from the ammonia production step is converted to 265,000 tonnes of urea per annum.*
- *The urea is produced in granular form allowing easy transportation with no hazardous chemical shipping requirements.*
- *The urea is shipped in bulk and packaged form by road or by rail.*
- *Approximately 5 million litres of GoClear urea solution is produced per annum – GoClear is an exhaust system additive and scrubbing agent that reduces nitrogen oxide emissions from diesel engines, enabling truck operators to run low-emission and efficient vehicle fleets.*

7) As an integrated ammonia-urea plant, there is common infrastructure which yield energy efficiency gains and cost savings:

- Cogen (Electricity and Steam)
- Steam mains + heat integration
- Demineralised water for boilers
- Clarified water + cooling water system
- Control Room & Services
- Effluent Treatment
- Utility air supply

Appendix 2: Ballance Hiringa Energy Press Release

Kapuni 'green' hydrogen project seen as catalyst for NZ market

19 June 2019 – Ballance Agri-Nutrients and Hiringa Energy today confirmed a Joint Development Agreement for a major clean-tech project in Taranaki to produce 'green' hydrogen using renewable energy.

The $50 million showcase project of Taranaki's new energy future will be based at Ballance's Kapuni ammonia-urea plant, and is seen as a catalyst for the development of a sustainable green hydrogen market in New Zealand to fuel heavy transport – as fleet operators push to reduce carbon emissions ($C0_2$-e) in response to Zero Carbon legislative change.

INDUSTRIAL-SCALE HYDROGEN PRODUCTION

The renewable hydrogen hub will be a perfect marriage of industrial scale renewable energy and hydrogen production, providing a model for other industrial operations and future decarbonisation of the New Zealand's agricultural inputs by substituting green hydrogen to replace the current natural gas (CH_4) feedstock.

Ballance Agri-Nutrients CEO, Mark Wynne, says this "flagship green hydrogen project is a collaboration of national significance" – bringing together world-leading hydrogen technology and the specialist technical capabilities in the region, to leverage existing infrastructure for the benefit of New Zealand.

"Working with Hiringa we have a truly unique opportunity to create a hydrogen ecosystem at Kapuni – powered by renewable energy – that we can grow and develop as a template for New Zealand's leadership in what is an exciting space globally."

Andrew Clennett, CEO of Hiringa Energy, described the project as "an innovative concept developed locally, which takes advantage of our built and natural resources".

"This will create a foundation for a hydrogen market in New Zealand so that we can start more aggressively taking carbon and other pollutants out of heavy transport, and develop other high-value uses for green hydrogen in our economy as part of our low-emissions future. We are delighted to be working in true partnership with Ballance Agri-Nutrients on such an enabling project"

POTENTIAL FOR ZERO-CARBON TRANSPORT

The Kapuni Green Hydrogen production alone is expected to generate sufficient 'green' hydrogen to supply up to 6,000 cars, or 300 buses and trucks per year.

Mr Clennett says the project has national significance and is linked with the Hiringa's development of a hydrogen supply and refuelling network in New Zealand to enable use of hydrogen fuel cell technology for zero-emission heavy transport – displacing imported fossil fuels with home-grown clean energy.

This is a key regional project outlined in the H2 Taranaki roadmap launched by the Prime Minister, Jacinda Ardern, and Minister of Energy & Resources, Dr Megan Woods, in March this year.

This comprehensive report into the opportunities presented by hydrogen for Taranaki and New Zealand's energy future is one of the first under *Tapuae Roa: Make Way for Taranaki – Taranaki's Regional Development Strategy*, and was developed in partnership between Hiringa Energy, New Plymouth District Council and Venture Taranaki, with support from the Provincial Growth Fund. It also supports the Draft Taranaki 2050 Roadmap that is building upon the Tapuae Roa Strategy.

HARNESSING THE POWER OF WIND

Under the Joint Development Agreement the two companies are planning the construction of up to four large wind turbines (with a total capacity of 16MW) to supply 100% renewable electricity directly to the Kapuni site, and also power electrolysers (electrolysis plant) to produce high-purity hydrogen – for feedstock into the ammonia-urea plant or for supply as 'zero-emission' transport fuel.

Mr Wynne says this enables Ballance Kapuni to use almost entirely renewable electricity for its electricity needs, and hydrogen can be produced with wind-power that exceeds the manufacturing plant's baseload electricity requirements.

The project is a key step for the energy sector transition in Taranaki, with the region already having two large-scale hydrogen users – Methanex and Ballance Kapuni that can potentially provide baseload demand for green hydrogen. The existing core competency in hydrogen production and use at Ballance's Kapuni site is an excellent platform, Mr Wynne says.

GREEN JOBS AND GREEN NUTRIENTS

Ballance's Kapuni plant is one of the largest employers in South Taranaki, contributing hundreds of millions of dollars to the regional economy in wages and contracts work.

The plant relies on natural gas for its feedstock so this project represents a way to not only future-proof a large employer but also provide additional employment opportunities, during construction and as the hydrogen market develops.

While the hydrogen fuel-cell market develops, the supply can be fully utilised in the Kapuni Ammonia-Urea plant to manufacture 'green' nitrogen fertilisers that will have an extremely low emissions profile. Mr Wynne says, "We'll be able to offer a new choice of nitrogen fertiliser for New Zealand farmers who have sustainability front-of-mind".

The manufacture of green ammonia-urea will offset up to 12,000 tonnes of carbon emissions and avoid the import of 7,000 tonnes of urea from the Middle East and Asia. Production of green urea would eliminate the equivalent amount of CO_2 as taking 2,600 cars off the road.

"We're thrilled to be able to bring this opportunity forward for our farmer-shareholders, for Taranaki, and for New Zealand – to create a renewable hydrogen energy hub that could enable deep cuts in emissions from our heavy transport fleets and also produce an alternative green nutrient source to help keep New Zealand growing," Mr Wynne says.

Ballance and Hiringa are looking forward to sharing the plans with Government stakeholders, Iwi and other local community and commercial stakeholders – along with discussions with potential hydrogen customers, to help realise this "tangible example of 'Just Transition' for the Taranaki region into a new energy future".

QUICK FACTS – GREEN HYDROGEN

- Green hydrogen is produced from renewable electricity and water, through the process of electrolysis (producing hydrogen and water).
- Hydrogen has the highest energy content of any common fuel (by weight). A hydrogen fuel cell car can refuel in 3-5 minutes and travel up to a range of 600-800km.
- When used in a fuel cell – hydrogen can enable zero-emission transportation (and recombines hydrogen and oxygen to make water).
- For commercial and heavy transport – hydrogen is a zero-emission solution that enables high availability, payloads and range.
- Green hydrogen is complementary to the electrification of transport in New Zealand, with the potential to reduce emissions from heavy transport, industrial processes and chemical production.

ENDS