Submission on:

New Zealand Productivity Commission (2017) Low-emissions economy: Issues paper.

From

Ballance Agri-Nutrients Limited

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COMMERCIAL SENSITIVITY

Nothing in this submission is confidential.

Introduction

Ballance Agri-Nutrients Limited ("Ballance') would like to thank the New Zealand Productivity Commission for the opportunity to make this submission on the recently issued the Low-emissions economy: Issues paper.

Company Overview

Ballance is a farmer-owned co-operative with over 18,000 shareholders and approximately 800 staff throughout New Zealand. We own and operate 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 feed 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.
- Other products important to non-farming industries include ammonia, used as a refrigerant; sulphuric acid used in the dairy, pulp and paper and power generation industries and liquid alum and hydrofluosilicic acid, both used in water treatment processes.

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.

Ballance's Engagement in Climate Change Policy Development

Ballance strongly supports New Zealand playing its part in international climate change mitigation action and fully endorses New Zealand's ratification of the Paris Agreement.

Ballance takes an active role in the development of domestic climate change policy, dating from the original industry voluntary agreements of the late 1990's through to the current New Zealand Emissions Trading Scheme (NZ ETS).

Ballance's Exposure to the NZ Emissions Trading Scheme

Ballance's operations are directly impacted by the New Zealand Emissions Trading Scheme (NZ ETS):

- The Kapuni Urea manufacturing facility is an Emissions Intense Trade Exposed (EITE) industry competing against imported Urea;

- As a manufacturer and importer of Urea, Ballance is a mandatory participant (within the Agriculture Sector), for synthetic fertiliser containing nitrogen.
- All of Ballance's operations are exposed to NZ ETS costs passed through by energy suppliers and second round impacts including freight costs and inflationary pressure.

Any change in policy that leads to an increase in ETS related costs is therefore a significant concern to Ballance.

Submission Points

A summary of our submission is provided below. Answers to the specific questions where Ballance believes it can most add value are also provided and include further detailed supporting material.

Submission Summary

1. Ballance recognises that New Zealand and the world are embarking on a transition to a lower emissions economy. However, this does not mean that it is logical to lose economic activity in New Zealand and displace emissions offshore (carbon leakage):
    a. In the case of urea manufactured at Ballance's Kapuni plant, the domestic demand for the output of that activity will remain for many decades to come.
    b. Until such time as a (more) level playing field is achieved through other nations placing a price on carbon, industrial allocation remains the most appropriate policy measure to avoid carbon leakage and negate premature closure of manufacturing.
2. Ballance recommends that the Commission be transparent in its findings on domestic emission reduction scope, identifying clearly where carbon leakage may result and recommending mitigation options.
3. Ballance strongly supports the efficient use of products, such as urea, and in the context of agricultural emissions recommends that emissions abatement measures should be recognised at the farm level.
4. In Ballance's view emissions pricing alone will not be sufficient to transition the economy at the pace required and supportive policies, in the form of R&D support policies or direct contestable research funding, are also required to accelerate the development & uptake of solutions.
5. The major uncertainty facing Ballance in considering investments relevant to a low-emissions future is the ongoing political uncertainty regarding the pace of change required and the policy instruments to be applied.
6. One aspiration for the Productivity Commission's work is that it provides a sound factual basis upon which a political consensus can emerge.

Submission Details

Q1 How can the Commission add the most value in this inquiry?

Ballance endorses the Commission's listing of areas of where it can best add value:

> *The Commission considers that it can add the most value in this inquiry in the following ways:*
> - *providing an independent and robust analysis of whole-of-economy trade-offs based on sound economic analysis;*
> - *developing ways to assess the benefits and costs of different pathways for New Zealand to transition to a low-emissions economy (rather than, for example, providing more or different scenarios of what the future might look like);*
> - *taking a longer-term perspective in identifying policies and institutions that will be required to achieve a low emissions economy that enhances productivity and wellbeing;*
> - *describing what a low emissions economy will mean for the many different businesses and households in New Zealand;*
> - *developing conceptually sound but doable recommendations for change; and*
> - *bringing its expertise and understanding of innovation, and the development, adoption and diffusion of new technologies, in the New Zealand economy to this task.*
>
> Source: Issues paper, p4

Further to this Ballance suggests that the Commission should aim to produce the definitive reference resource that educates and informs policy makers and stakeholders of the challenges and opportunities ahead, that is NZ specific, and that is widely accepted as the sound foundation for decision making.

In carrying out its work, we recommend that the Commission takes full account of the following points:

- In the stationary energy and industrial processes sector, New Zealand's emissions profile is skewed with a relatively small number of large emitters, each often carrying out a unique activity – a good example being our ammonia-urea plant at Kapuni. This has implications for any pathway assessment:
    - Modelling techniques and international studies of the assessment of the impacts of climate policy tend to assume a % reduction in output in response to an increase in carbon price, as might be expected with a multitude of production facilities;
    - In New Zealand's case, with few/single facilities facing international competition which are subject to less stringent (or no) climate change policies, the impact may be more abrupt – stay open or close. It is therefore recommended that a more focused New Zealand activity specific evaluation approach is required for such assets.

- It is understood that the focus of the Commission's inquiry is on domestic emission reduction however where this is likely to result in emissions leakage / increased global emissions, this should be clearly highlighted and evaluated.
- The role of uncertainty in climate policy should be reviewed as this can limit the opportunity for carbon pricing to support an investment business case – if policy changes will the business case be undermined?
- The assessment work should be sector / subsector based and should identify the responsiveness to emissions pricing:
    - Price elasticity of each sector – where inelastic alternate policies may be required; and
    - Asset life and value – for long lived assets such as industry (but also forestry), the speed of response is slower and need for policy certainty to enable investment is increased. The risks of premature asset closure and/or inhibited investment decisions should be evaluated.

Q3 To what extent is it technically and economically feasible to reliably measure biological emissions at a farm level?

At a science and controlled study scale emissions can be measured however at a practical farm scale level the technology does not exist to make a reliable measurement. As far as we are aware the only feasible option is to model emissions at the farm level. The tool Overseer exists which can calculate greenhouse gas loss estimations and is currently used for on farm nutrient budgeting calculations - this would be the most feasible estimating tool. As an alternative cruder look-up tables could be built but would provide a less accurate farm specific estimation. Both tools would have varying degrees of inherent error but the estimate of relative loss between farms would be stronger than the absolute loss estimate.

Q4 What are the main opportunities and barriers to reducing emissions in agriculture?

In respect of agricultural emissions, a more integrated approach where water quality and greenhouse gas emissions improvement opportunities are evaluated and researched in combination is recommended. An example is the considerable scope to mitigate emissions through increased soil carbon; dry soils typically have low carbon content but with irrigation carbon accumulates in the soil. An as yet unquantified trade off therefore exists between water allocation / charging and carbon sequestration.

The NZ ETS is potentially a barrier to emission reductions as it does not send the correct signals. This is true even at the current mandatory reporting requirement for agriculture.

Examples include:

- The regulated emissions factor (EmF) for synthetic fertilisers not being updated to reflect the current factor used in international reporting (regulations EmF is 5.72 tCO2e / t nitrogen, whereas the NZ inventory EmF is 3.20 tCO2e / t nitrogen). This may lead to inappropriate allocation of resources.
- There is no mechanism to recognise the benefits of:
    - nitrification inhibitors (DCD);
    - riparian planting; or
    - biochar.

The above points are examples of the major impediments to reducing agricultural emissions, primarily arising from the regulatory uncertainty for carbon pricing and the policy treatment of agriculture:

- Currently to develop a new product or service that can result in reduced emissions there is no ability to capture the value from the emission reductions except indirectly where there is a productivity benefit that is captured by the farmer. As a consequence there is a major deficiency in the ability to justify the investment in developing mitigation technologies (as a non-industry good party) because the business case lacks a direct revenue line from that benefit.
- The opportunity therefore is to provide a mechanism that enables businesses to create value with new or improved mitigation technologies within the context of a sector which could still remain trade exposed and therefore insulated from a direct carbon price. The mechanism would need to have a long term component as most relevant research would be multi-year in nature.

Q5 What are the issues for government to consider in encouraging alternative low-emissions land uses?

Our response to Q4 highlights that existing policy mechanisms (primarily the NZ ETS) are too narrow focused and inflexible to provide a sound foundation for mitigation uptake.

Q6 What are the main barriers to sequestering carbon in forests in New Zealand? and

Ballance suggests that the Commission should be cautious about focusing too much on the carbon price when evaluating barriers to sequestering carbon in forests. With the current NZ ETS settings, an increase in carbon price to support forestry risks rewarding incumbents who have already opted in to the ETS and may increase the reward above the marginal C-price signal that is required for afforestation, with resultant adverse economic impact on other ETS sectors and household that may not be positioned to respond to a higher Carbon price.

Instead a wider assessment of the barriers to afforestation should be made. The Commission should also be open minded as to whether a more direct forestry investment policy may be more effective than the NZ ETS.

Q7 What policies, including adjustments to the New Zealand Emissions Trading Scheme, will encourage more sequestering of carbon in forests?

Ballance supports the adoption of forestry accounting rules for Harvested Wood Products which better reflect harvesting emissions than the current instant oxidation rule.

Please also refer to our response to Q6.

Q11 What are the main opportunities and barriers to reducing emissions from the use of fossil fuels to generate energy in manufacturing?

Ballance suggests the scope for emission reductions in this area (other than through closure) may be relatively small.

Ballance's manufacturing sites already have in place the energy efficiency technologies that are quoted in the Issues paper.

> ***Opportunities and challenges for reducing emissions***
>
> *Better energy efficiency (at the same time raising productivity) and a shift away from fossil fuels are the main options for reducing emissions from energy used in industry.*
> *Manufacturers could improve energy efficiency through employing technologies such as:*
> - *integrated control systems, using sensors to adapt process conditions;*
> - *sub-metering (monitoring energy used by specific equipment or parts of a plant); or*
> - *better flue-gas monitoring for boilers and dryers.*
>
> *Yet the benefits of lower emissions will not materialise without substantial further innovation and commercialisation effort (ICF International, 2015).*
>
> Source: Issues Paper p26

We recommend that the Commission caries out an assessment of manufacturers to verify the level of technology uptake:

- For Ballance the low hanging fruit was captured a long time ago, with efforts now chasing single percentile improvements e.g. as computing power in control systems, catalysts and equipment improves.
- Smaller manufacturers may have some scope but overall we suggest there is a risk of over estimating the potential savings unless proper data is collated.

Regarding renewable fuels replacing fossil fuels for Ballance's largest site, Kapuni, this is not technically feasible. The ammonia urea plant uses ~7PJ of natural gas per annum, both as a fuel and as a feedstock in the ammonia urea process. Further details are provided in Attachment 1.

Q20 Acknowledging the current review, what changes to the New Zealand Emissions Trading Scheme are needed if it is to play an important part of New Zealand's transition to a low-emissions future?

Ballance supports the outcomes of the 2015/16 NZ ETS review as released to date.

Looking ahead the predictability of policy settings and criteria is vital:

- The Stage II Outcomes of ETS Review (released in July 2017) are a good step forward in clear signalling of future policy decision to be taken.
- The criteria for ongoing eligibility for allocation to trade exposed industry is critical to allow future investment in assets and to avoid premature loss of economic contribution:
    - While planed capital improvement expenditure can sometime be deferred, in some cases critical maintenance capital cannot:
    - An example is where a critical piece of equipment needs replacement yet policy uncertainty undermines the investment case leading to premature closure of the whole asset.

As identified in our response to Q1, it is important that the Commission evaluates the likely effectiveness of the NZ ETS across each sector. Continually pushing the carbon price up through a domestic NZ ETS may yield emission reductions through premature closure of plant and increase cost to the overall economy when a sector focused policy may be more effective.

Q21 What type of market-based instruments would best help New Zealand transition to a low-emissions economy?

Ballance supports the retention of the NZ ETS as the primary market based instrument. The scheme is in place and maturing; evolution not revolution is now required.

Q22 What type of support for innovation and technology would best help New Zealand transition to a low-emissions economy?

Ballance believes a mechanism to allocate or provide the ability to acquire carbon credits from new technologies is required.

The development of a "Primary Growth Partnership" equivalent fund, similar to that run by MPI, where private sector investment is matched by Government via emission credit guarantees or hard cash co-funding is one option. This would reflect the large public benefit from any emission reductions and the risk the private sector would have to take to develop innovative practices.

To ensure the taxpayer gets the best value for money amongst the ideas submitted, the fund should be contestable.

This approach may also be utilised to reduce the uncertainty which inhibits investment in major manufacturing plant upgrades and new plant.

Q26 What are the main uncertainties affecting New Zealand businesses and households in considering investments relevant to a low-emissions future? What policies and institutions would provide greater confidence for investors?

Q27 What approaches, such as regulatory frameworks or policy settings, would help embed wide support among New Zealanders for effective reduction of domestic greenhouse gas emissions?

Q28 Is New Zealand's current statutory framework to deal with climate change adequate? What other types of legislation might be needed to effectively transition towards a low-emissions economy?

Q29 Does New Zealand need an independent body to oversee New Zealand's domestic and international climate change commitments? What overseas examples offer useful models for New Zealand to consider?

In response to Q26-Q29 combined:

The major uncertainty facing Ballance in considering investments relevant to a low-emissions future is the ongoing political uncertainty regarding the pace of change required and the policy instruments to be applied.

Although political consensus on the need to take action has matured, the pre-election policy political party announcements highlighted significant diversity of views on:

- Ambition (2050 targets);
- The role of direct action (afforestation); and
- The market based measure (tax or trading) and sectoral coverage (agriculture in or out).

The ongoing absence of political consensus means that putting in place an independent body now would be too soon as its appointments and terms of reference will in turn be viewed to be politicised. There is also the risk that an independent body such as a Climate Commission may enable politicians to disassociate themselves from the difficult decisions to be made, potentially negating the role of parliament's checks and balances.

One aspiration for the Productivity Commission's work is that it provides a sound factual basis upon which a political consensus can emerge.

Q30 How can adaptability best be incorporated into the system supporting New Zealand's low-emissions transition?

It is clear that policy settings (including those of the NZ ETS) will need to adapt over time.

The Motu model outlined in Box 12 of the Issues Paper is a valid option however we caution against the reliance on an independent Committee for the reasons outlined in our response to Q26-Q29 above.

Q31 What types of analysis and underlying data would add the greatest value to this inquiry?

The list of gaps identified by the Commission (as shown below) is worrying:

> Gaps include data and analysis on:
> - the marginal abatement costs of different ways of reducing emissions in New Zealand (at a national and sectoral level);
> - demand and supply "elasticities" that estimate the extent to which households and firms make emission choices in response to carbon prices;
> - emissions at the level of individual firms, farms and households;
> - co-benefits arising from different abatement activities and the size of those benefits; and
> - the values and norms that are relevant to understanding whether specific emissions-related policies are likely to achieve acceptance.
>
> Source Issues Paper p56

All are substantive and need to be addressed with many of them being common to points raised in this submission.

Ballance suggests there is a significant risk of extrapolating emission reduction potentials from international studies in the absence of specific recognition of New Zealand's unique geography and energy / emissions mix.

Q32 What should be the mix, and relative importance of, different policy approaches (such as emissions pricing, R&D support, or direct regulation) in order to transition to a low-emissions economy?

As highlighted in our response to Q4, Ballance believes that R&D support mechanisms as well as emissions pricing will be important in order to transition to a low-emissions economy.

For those activities facing a carbon price where emission abatement solutions do not yet exist, or where technology is not yet recognised in emissions calculations, firms face increased costs yet have no ability to respond. The result is reduced cash-flow which makes it even harder to fund R&D to identify emissions abatement solutions. R&D support mechanisms can help alleviate this dilemma.

Q33 What are the main co-benefits of policies to support a low-emissions transition in New Zealand? How should they be valued and incorporated into decision making?

Ballance has already highlighted the interaction between water and greenhouse gas emissions in our response to Q4.

A less obvious co-benefit perhaps is the critical mass of engineering and technology skills that a manufacturing site such as the Kapuni ammonia urea plant supports in the regions. Although such industry sites may be perceived by some as "old" and not part of a green economy, the reality is that the knowledge, computer control systems and technology applied is world leading.

Implementation of New Zealand's emissions abatement pathway will need increasing amounts of these engineering and technology skills. In the specific case of ammonia, this is recognised as a potential component in a "hydrogen economy", where ammonia may be considered as a potential hydrogen carrier for hydrogen delivery and (typically) for off-board storage, such as at refuelling stations and for stationary power applications. The Kapuni site offers New Zealand this capability.

Q34 Who are the most important players in driving forward New Zealand's transition to a low-emissions economy?

Government, business and the wider society all have important roles in driving the transition forward.

Ballance cautions against city / regional actions taking a legislative approach to greenhouse gas emissions as these should be set at a national level in response to international agreements.

Q35 What measures should exist (and at what scale and duration) to support businesses and households who have limited ability to avoid serious losses as a result of New Zealand's transition to a low-emissions economy?

For trade exposed industry:

- Industrial allocation remains the most appropriate policy measure to avoid carbon leakage and negate premature closure of manufacturing, until such time as a (more) level playing field is achieved through other nations placing a price on carbon.
- To enable ongoing investment, the criteria for withdrawal / phase out of industrial allocation should be clearly defined. This needs to be assessed on an activity by activity basis and not be a blanket "all EITE activities" politicised decision. For each activity (urea production), the assessment of trade competitor jurisdictions (Arab Gulf States, Malaysia,..) should take into account:
    - The level of carbon-pricing, through trading or a carbon tax
    - The level of allocation/subsidy
    - Other support mechanisms including non-tariff barriers
- Phase out of allocation should only commence when a material proportion of competitor trade incorporates an auditable and internationally acceptable carbon price in-line with the New Zealand.

Ballance recognises that other sectors, including low income households and Maori will also need support and that a suite of transition support policies may be required.

Q36 What are the essential components of an effective emissions-mitigation strategy for New Zealand that will also be economically and politically sustainable?

Ballance proposes that an effective emissions-mitigation strategy must be flexible and retain "optionality". The world, its politics and technology is rapidly changing so we need to ensure that New Zealand does not head down single paths that may be regretted through unnecessary loss of economic activity and jobs and/or dead-end technology selection.

- The strategy should give long term signals on policy direction and be prepared to set out clear boundaries for future emission source development.
- The strategy should avoid picking winners - instead let sound economics determine outcomes, but it should be prepared to remove barriers to uptake and /or initiate critical enabling infrastructure
- The strategy should be paced so as not to take too early action which may lead to a loss of critical capacity ahead of other nations, and impose a higher cost of uptake of technology prior to it becoming truly cost competitive.

Q37 Should New Zealand adopt the two baskets approach? If so, how should it influence New Zealand's emissions reductions policies and long-term vision for the future?

Ballance is aware of the two baskets approach and supports ongoing work to better understand the differing impacts on long–term warming that short-lived gases, such as methane, may have.

Should the international science community reach consensus on the two baskets approach and should it be adopted in international agreement greenhouse gas accounting methodologies, then (and only then) it would make sense to recognise it in domestic policy.

Until such a time Ballance would favour a single basket approach:

- As farm systems work in a single holistic system, isolating one gas/emission from another could result in unexpected or perverse outcomes e.g. differential treatment of nitrogen versus methane could result in a reduction in N fertiliser use but the benefit could be displaced by an increase in imported feed having no net emissions benefit.
- Equally a farmer/grower needs to weigh up emission reductions and water quality outcomes and this needs to be done in an integrated holistic way especially given the financial impact of water quality or emissions could dominate the other and promote negative outcomes of the other if they are treated in isolation.
- In the absence of international acceptance, domestic implementation e.g. through the NZ ETS risks creating a liability for New Zealand where surrender of units for domestic methane emissions are based on a lower warming potential than that applied in our international agreement obligations.

Q38 How should the issue of emissions leakage influence New Zealand's strategy in transitioning to a low-emissions economy?

Ballance strongly believes that it would be ethically inappropriate for New Zealand to simply export its emissions (and in many cases increase global emissions) by shutting down efficient domestic production.

It would also be economically irrational if in the absence of support mechanisms, domestic production becomes uncompetitive when facing international firms with no or low effective carbon prices, leading to premature closure.

Q39 What do you see as the main benefits and opportunities to New Zealand from a transition to a low-emissions economy?

Ballance suggests the main opportunities are through:

- increased economic resilience against higher imported fossil fuel prices;
- maintaining New Zealand's international reputation;
- increased competitiveness of New Zealand produced goods, utilising our largely renewable electricity generation to produce lower emissions goods than those manufactured in countries more heavily reliant on fossil fuels.
- avoiding stranded asset investments through clear policy signals; and
- If global action eventuates, avoidance of some of the adaptation costs may result.

We note that the Issues Paper (p63) highlights that economic growth from carbon emissions has occurred in other major economies. We caution against a simplistic comparison with New Zealand as in some of the example cases quoted this has been enabled through a switch from coal to gas and export of manufacturing (carbon leakage).

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.[1] It was envisaged that the plant would help New Zealand's

[1] Other Think Big projects included the Methanol plant at Waitara, the Synthetic-petrol plant at Motunui, Expansion of the Marsden Point Oil Refinery, Expansion of the New Zealand Steel plant at Glenbrook, Electrification of the Main Trunk Railway between Te Rapa and Palmerston North, A third reduction line at the Tiwai Point aluminium smelter, The Clyde Dam on the Clutha River.

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.

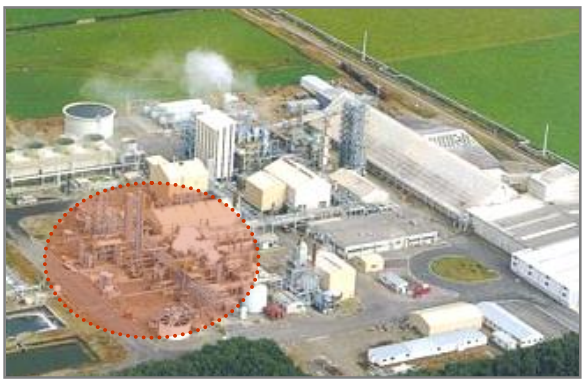
Figure 2 – Ammonia Production Step

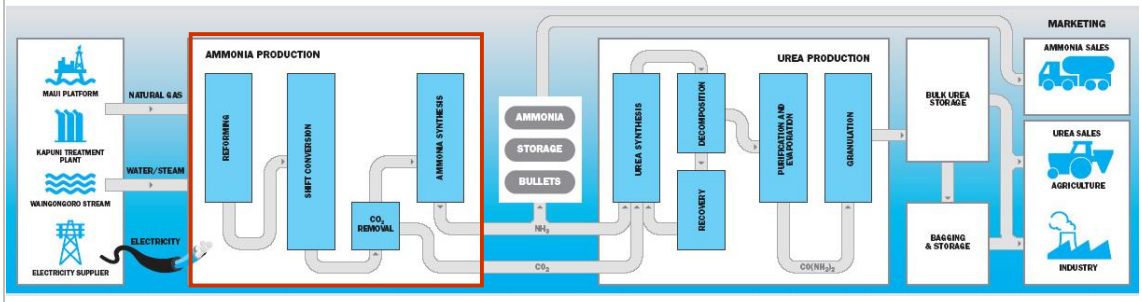
$CH_4 + 2H_2O \Leftrightarrow 4H_2 + CO_2$

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.*

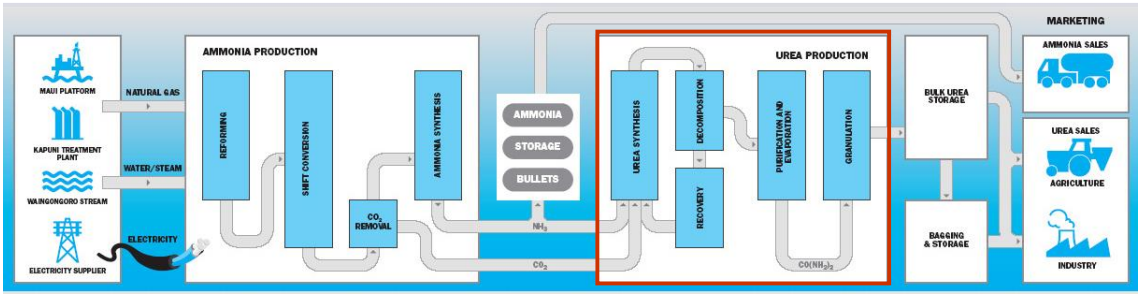
Figure 3 – Urea Production Step

$2\ NH_3 + CO_2 \Leftrightarrow NH_2COONH_4$

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