Norske Skog Tasman / Z Energy
Stump to Pump Project

Final Report

Date: 30 September 2014

Acknowledgements

Norske Skog and Z Energy would like to acknowledge the support and guidance of the Ministry for Primary Industries (MPI). The Stump to Pump feasibility study could not have been undertaken without the support provided through the Primary Growth Partnership (PGP). The partners would like to particularly acknowledge the advice and guidance provided from both MPI PGP staff and the Investment Advisory Panel.

Norske Skog and Z Energy recognises the significant contribution made by the respective members of the Stump to Pump team, Scion, engineering consultants and the biofuels technology providers who have all contributed to the study with a professional and open exchange of technical information.

The partners look forward to the opportunity for forestry biofuels in New Zealand to be realised in the near future.

Table of Contents: Page No.

1. Executive Summary

Over the last 12 months the Stump to Pump (S2P) programme team has undertaken a very thorough technical and commercial feasibility study of the options for the conversion of forestry residues to liquid fuels. Key industry parties involved in the study were Norske Skog Tasman (NST) and Z Energy. Technical support was provided by Scion, as well as a number of local and international engineering companies and technology providers. The feasibility study focused on four key outcomes;

i) A review of internationally available technologies, ensuring the best fit that could be implemented for the New Zealand context
ii) A calculation of the economics of producing biofuels from waste forestry biomass based on the preferred technology
iii) A review of the path to market for produced fuels
iv) A review of the expansion potential for the business.

The study achieved the following outputs;

- The economic returns were evaluated for converting forest waste into biofuel products using a comprehensive financial model with the key inputs being, fibre pricing, capex, opex, fuel product values, exchange rate assumptions plus financial information
- Preliminary engineering work was completed to a defined scope with accepted design for a Modular Test Plant at the Norske Skog Tasman site for a plant of capacity of 170,000 MAF Tonnes/yr. (Moisture and Ash Free Tonnes)
- End user products were defined as well as the completion of a "Path to Market" analysis which encompassed product quality and assurance and the specific requirements for fuel testing
- A comprehensive understanding of what the key risks would be for the new business and potential mitigation strategies
- A review of the expansion potential for the business.

The study determined that;

- A sufficient volume of forest residues is available to support biofuel production in New Zealand, and the volume is predicted to grow over time. The total estimates for New Zealand are in the vicinity of 3.9 million m^3 in 2014 increasing to 5.8 million m^3 by 2025
- Technology exists that converts forestry residues to hydrocarbon liquid biofuels. Whilst the current data shows that the product does not yet fully meet New Zealand fuel specifications, there is considerable effort underway to enhance the process and improve the quality of both the petrol and diesel fractions
- The partners believe that the establishment of a viable biofuels business from forest residues will have a significant positive influence on investment elsewhere and particularly upstream in the forestry and wood processing sector.

In conclusion, S2P has established that a technically feasible path for New Zealand has been identified to convert forestry residues to liquid fuels. However the study team has determined that achieving commercial viability and path to market will require time to progress fuel certification and the testing requirements necessary to determine if the product can meet NZ fuel equivalency. As this process mainly involves further research and development to consider the New Zealand situation and will take some time to complete it has been agreed that the next stage is completed by industry alone.

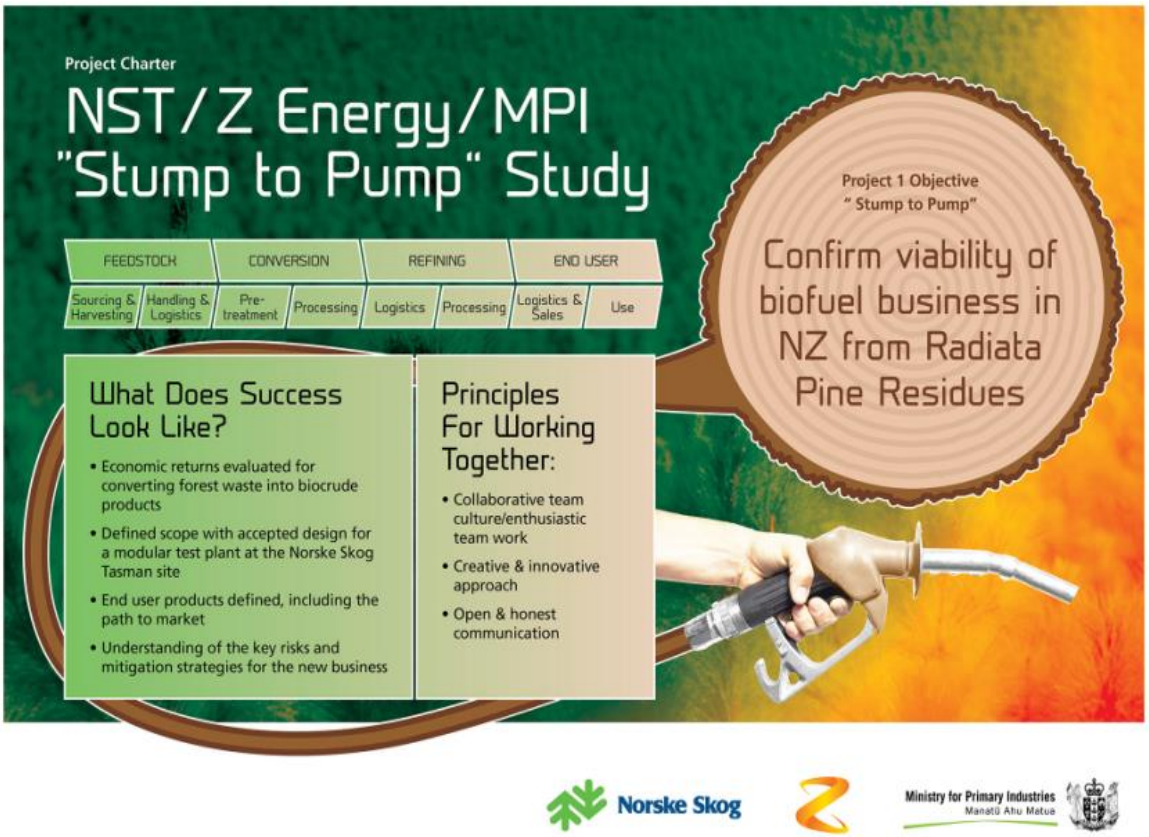
Overall S2P still has the potential to create a biofuels industry for New Zealand and to deliver the broader benefits that government is seeking. However it may take longer to achieve these than originally envisaged particularly the establishment of the test plant, given that the global energy outlook has softened in the last 18 months and made biofuels development more challenging in the near term.

However, the work undertaken by the S2P programme means that when conditions are favourable and once the fuel certification and testing is complete, then all the key elements are in place for commercialisation.

2. Overview of the Stump to Pump Programme

In 2013 Norske Skog and Z Energy made a successful application to the Primary Growth Partnership. The primary objective of the programme was to confirm the viability of creating a biofuels business in New Zealand from Radiata Pine residues and a defined scope for establishing a test plant at the Norske Skog Tasman (NST) site in Kawerau.

The programme therefore was to determine whether it is technically feasible and commercially viable. Focus was initially for Kawerau and then other potential locations in New Zealand. A forestry based biofuels industry is estimated to generate more than $1 billion GDP and 200 direct and 1000 indirect jobs.



The commercialisation strategy for S2P envisaged the construction of the first commercial plant at NST Kawerau and subsequently expansion to eight commercial plants across New Zealand. Ultimately, the programme's objective was to determine the feasibility of the conversion of a total of 1.6 million tonnes per annum of low-value forest and wood processing residuals into 4 million barrels of high-value transport biocrude or drop–in renewable transport fuels that displaces fossil fuel imports.

From the perspective of Norske Skog Tasman, the programme aligned with their strategy for Kawerau to develop new renewable energy businesses.

For Z Energy, the programme aligned with their stated objective to produce and sell renewable fuels products in the New Zealand fuel retail market.

The Stump to Pump programme was supported through MPI's Primary Growth Partnership (PGP). The PGP is about "boosting productivity and profitability, and delivering long-term economic growth and sustainability across the primary sectors, from producer to consumer".

MPI recognises that the forestry sector is particularly challenged due to a lack of investment, scale and integration and that the forestry industry could be contributing substantially more to the economy. A key part of achieving this is to create diversified income streams for forestry and processing residues.

From the perspective of the industry partners, government assistance was sought for the S2P programme for the following reasons;

- Benefits for the programme will extend across the entire forestry sector and the New Zealand economy as detailed in the Outcome Logic (Appendix 4).
- The creation of a completely new value chain is required to support faster growth in the forestry sector. This requires the development of partnerships between unrelated industries and is a significant extension of core capability and business for both Norske Skog and Z Energy
- The current state of conversion technologies is developmental and proving this technology to a commercial scale is outside the normal level of risk for a single business. This also means there is significant room to innovate as the technology is scaled-up, creating the opportunity for greater benefits to New Zealand

The work programme and lead responsibilities were approximately delineated as follows;

Norske Skog Work Programme

- Define Opex and Capex for the modular test plant at NST Kawerau
- Define Radiata feedstock sources and pre-processing requirements
- Validate and select best conversion technology path
- Determine environmental and conversion process requirements
- Determine conversion yields, energy balance and oil quality
- Design Test Module for Tasman site specific plant conditions
- Undertake Techno economical models and risk analysis
- Programme management (e.g. administration, reports, budget, schedule, consultant selection and control).

Z Energy Work Programme

- Define bio-crude required for upgrading/refining and/or fuel product characteristics for blending based on a realistic range and nature of Radiata feedstock
- Ensure best product conversion and upgrading technology fit for NZ
- Evaluate oil refining options via New Zealand Refining or independent refining
- Establish economic baselines and cost of end product production
- Determine the energy balance of the product processes
- Determine the impact in greenhouse gas profile over fossil fuels considering life cycle and processing options
- Establish freedom to operate for product path to market.

In July 2013 the Stump to Pump (S2P) programme team was established to undertake the feasibility study. From July through to December 2013, the focus was on establishing and resourcing the project and the review of available technologies. From January 2014, following a detailed techno-economic evaluation, the study team selected the technologies most likely to succeed. Information was compiled, on capex, opex, product quality, and financial data to allow a decision on the next steps.

3. Contracted Programme

3.1. Programme Vision and Outcome Logic

Stump to Pump's vision is to contribute to the rejuvenation of the New Zealand forest and wood processing industry by generating a new high value-market pathway for woody biomass residues. This vision will be achieved through;

a) Investment in creating a fully integrated value chain from forest to pump
b) Concentrating around key forestry centres in New Zealand
c) Co-ordination with investment elsewhere within the forestry sector e.g. solid wood processing
d) Retention of knowledge within New Zealand both in terms of scale up know-how and the science around the resource.

During the development of the business case for the programme the partners developed an Outcome Logic Model (refer Appendix 4). The model provided a schematic representation of the activities required to progress the findings of this programme through to beneficial outcomes for the industry and New Zealand. The short, medium and long term outcomes sought for the S2P programme as detailed in the Outcome Logic Model align with the New Zealand Forest and Wood Products Strategic Plan.

In the longer term (over the next 15 - 20 years) the outcomes sought are; a) Greater forest productivity and sustainability b) Increased solid wood processing and resilience, and c) Established high value markets across the value chain including under-utilised residues.

3.2. Specific Outcomes

The programme was contracted to achieve the following outcomes:
Economic:

- Confirm the capital and operating costs of a test plant
- Determine the costs of forest residual recovery and returns to the forestry sector
- Determine the economics of the path to market for biofuels from forestry residues.

Sustainability:

- Identify any environmental impacts and mitigation strategies to limit these
- Identify the impact on the forestry industry to support a forestry based biofuels industry.

Capability:

- Validate technologies and provide solutions to mitigate risks associated with biomass conversion
- Identify the market acceptance requirements of biofuel end products.

3.3. Contracted Achievement Measures

During the assessment of conversion technologies, it was determined that further evaluation was required which resulted in the original contracted completion date being extended from 30 September 2014 to 31 May 2015. The study was however substantially completed by 31 August 2014. To support the delivery of the outcomes above, the programme was contracted to deliver on a number of specific and measurable outputs.

The contracted outputs were;

- Completion of the validation of technologies by 31 May 2015
- Scale up issues identified by 31 March 2015
- Test plant design completed by 30 March 2015. This included the following four workstreams;
    i. Solutions for collection and processing of feedstocks identified
    ii. Solutions for biomass conversion to biofuel identified
    iii. Solutions for biofuel logistics and storage identified
    iv. Test plant equipment requirements identified
- Reference testing and optimising trials on biofuel completed by 31 December 2014
- Waste stream and by-product processing assessed by 28 February 2015
- Validation of biofuel processing and downstream products completed by 31 May 2015
- Final report and recommendations for Norske Skog Tasman and Z Energy by 31 May 2015.

These were completed with the exception of the reference testing and biofuels trials which will continue beyond the scope of the PGP-funded programme.

4. Feasibility Study

4.1 Study Organisation and Participants

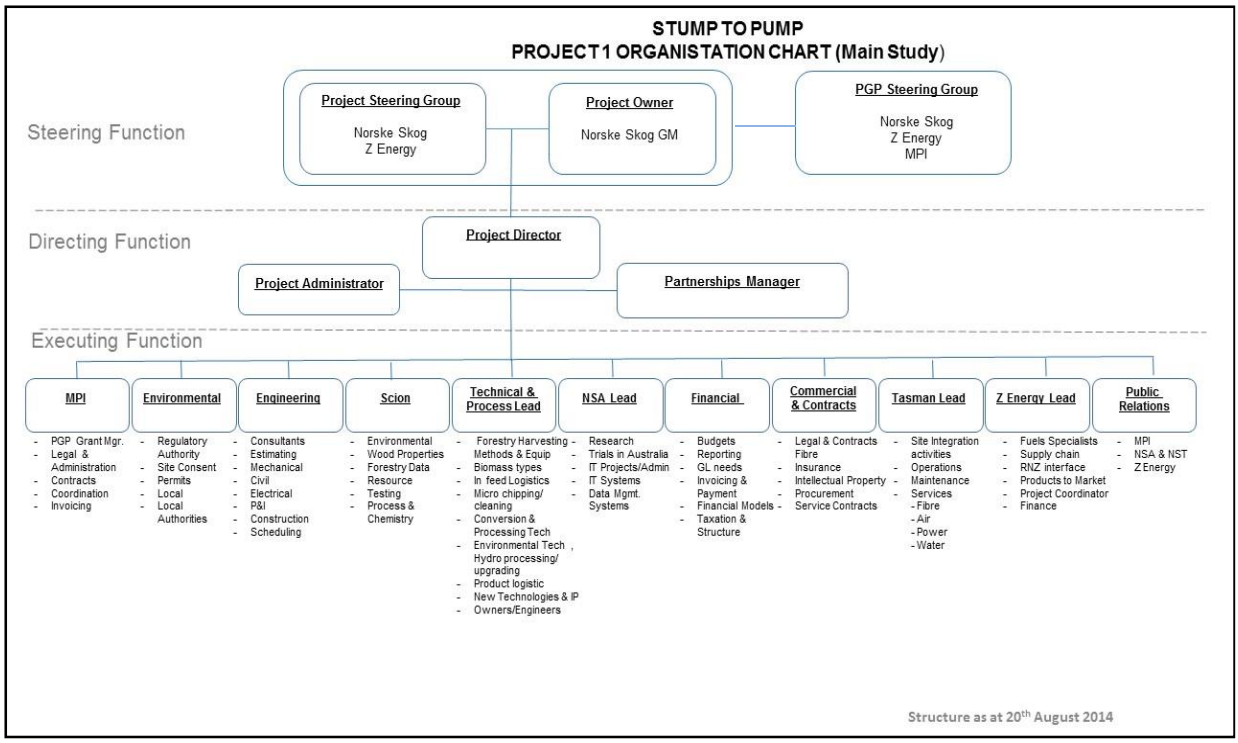
A team was assembled for the Stump to Pump programme that comprised up to 40 people (part or full-time) including staff from Norske Skog and Z Energy as well as scientists, engineers and consultants sourced locally and internationally.

Norske Skog Tasman's project management protocols and systems were adopted for programme governance, management and execution. Norske Skog has used this project model for many years on a wide range of initiatives, from relatively small to multi-million dollar projects and covered the range of project functions from scope, schedule, structure, costs and budget controls, reporting, governance and decision making.

The overall programme required a coordinated management plan to cover the phases and decisions steps associated with the projects. A key part of the programme was the management organisation structure which comprised three functional levels:

1. **A Steering Function**, whose task involves responsibilities and duties in setting direction and governance for the programme. Theses duties include, commercial responsibility, providing resources as necessary, responsibility for handling stakeholders and other interested parties, responsible for approving changes, making decision at toll or stage gates.
2. **A Directing Function**, who have overall responsible for the execution and reaching the project goals and objectives. Also reporting and risk management that may impact projects business goals. Reports to the project owner and are in charge of the project executing organisation.
3. **An Executing Function**, who have the responsibility to complete the sub project work, tasks and routines to deliver the goals and activities and for the project.

The organisation chart for the Programme was as follows.



4.2 Review of Conversion Technologies

A detailed review considering the technical aspects and economic aspects of various biomass to liquids conversion technologies was conducted as part of the programme. This was completed in December 2013. The assessment of the various technologies considered the key criteria for the S2P programme which included the fit to various New Zealand issues: economics, the forest industry (with respect to location to biomass and plant capacity matching available resource) and the fuel supply chain. The technologies were assessed against criteria that included technical robustness, technical risks and products. These were then ranked with appropriate weighting for each criteria as follows;

Fit with high-level criteria	How well does the process fit the high level criteria (Radiata pine, NZ forestry landscape, NZ fuel supply chain)? Come back and determine after techno-economic assessment.	%
Products	Does the process make the breadth & quality of products that fit the NZ market?	%
Technology	How well is the technology documented, is it well known, how robust is the information?	%
Technology risks	Are there significant feedstock, product, process or environmental risks associated with the technology?	%
State of technology development	How well is the technology developed with respect to proven technology, production scale, production run length, engineering design? Have key elements been used in other industries or processes?	%
Technology provider	Does the technology provider have sufficient depth of experience & R&D resources in developing & commercializing technology, and are they financially robust? Partnerships - maturity & strength of relationship and capability of the partners. Provider capability and interest in delivering improvements on yield and products.	%
Technology provider's IP	Are the intellectual property arrangements compatible with the S2P project's strategic direction?	%
Future prospects	Does the technology provide a framework/foundation for further improvements in yield, product optimization & diversification into other products in the future?	%
Similar technologies	Are there similar technologies against which to compare & which could compete or overtake at some point in the future?	%

Note – Weighting percentages have been removed as this information commercially sensitive

The preferred technology, which remains confidential to the partners, was chosen as having the best fit against these criteria. In particular the preferred technology most closely matched the criteria with respect to capital cost and minimum economic plant size being congruent with biomass availability in the various forest industry clusters. Further reasons were the quality of the hydrocarbons produced and the fact that the basic unit processes for the conversion were derived from reasonably well established and related refinery processes.

Key factors in evaluation of conversion technologies

The comparative assessment (but not absolute assessment) of the biomass to biofuels conversion technologies established a clear preference but highlighted that further rigorous investigation was required to be able to determine the viability of the S2P pathway. The preferred technology;

- Scored highest across most factors
- Had products that mostly appear to comply with current fuel specifications and appear to be similar to mineral fuels so they would integrate well with current fuel handling processes
- Was backed by highly capable companies with proven track records
- Could demonstrate ongoing improvements to both process and catalyst performance.

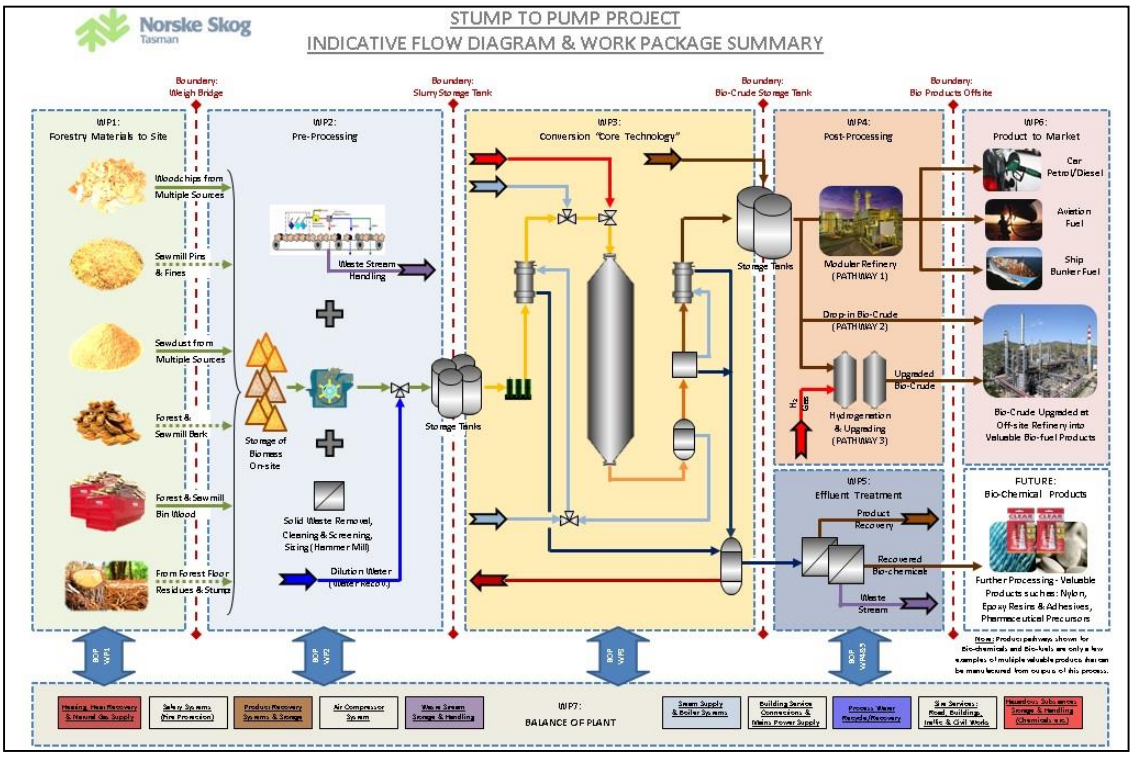
The test plant required for the preferred technology was a much larger scale than originally anticipated when the business case was developed. This was largely due to the minimum size requirements for some key components within the process. The review established that still more refinement was required around the following;

- Capex and Opex Costs
- Product Quality (including fitness for purpose, engine testing and no harms testing) and Value
- Commercial Readiness.

4.3 Capital Costs and Engineering for a Test Plant

During the first half of 2014 Norske Skog Tasman (NST) engaged international and local engineering companies to undertake a front end engineering study and to prepare a capital cost estimate for a test plant capable of converting 500 moisture and ash free tonnes (MAFT) per day of forestry and industry processing residues. Estimated end products were 65 – 75 million litres of biofuels comprising renewable gasoline and diesel and potentially renewable aviation fuel.

The programme was split into seven work packages. The boundary for the capital estimate was the forest residues arriving at the Norske Skog Tasman site (WP1) in Kawerau as per the following indicative flow diagram.



The core conversion technology process was modelled using a proprietary estimating package with the remaining areas estimated using standard Norske Skog Tasman estimating techniques. Budgetary estimates for larger items were obtained from vendors.

Capital Cost Estimate

The total installed cost (TIC) estimate for the S2P plant was established for the test plant and included all major equipment items such as the core conversion technology and associated processing units, wood pre-processing and other contributions such as mechanical, civil and structural, electrical and instrumentation.

The capital cost estimate remains confidential to the partners however it was in the range of NZ$250 – 350 million which is in line with other biofuels installations of a similar size. The capital cost estimate was based on an overall programme duration of 26 months from the beginning of detailed design to the end of start-up and commissioning.

The capital costs for the expansion of greenfield and brownfield sites were extrapolated from the base case of 170,000 tonnes/year and for 200,000, 400,000 and 800,000 tonnes/year using industry standard scaling factors. Greenfield costs were higher due to consenting issues, land purchase, water supply and treatment, effluent disposal and treatment, energy infrastructure, road and rail access, site landscaping and security.

Engineering Risk, Planning and Consenting

As part of this work a detailed review of engineering risks was undertaken as well as an assessment of the planning and consenting issues associated with the building of a test plant. Several existing consents would require modifications and new air discharge consents would be required. This follows normal practices.

4.4 Product Quality, Fuel Certification and Logistics

S2P Liquids Product Assurance

The review of available biomass conversion technologies by Norske Skog and Z Energy in 2013 identified a preferred technology process as the 'best fit' for the New Zealand situation that produced a petrol and diesel fraction. Information was gathered from initial fuel samples to compare with New Zealand fuel standards which are based on European standards and by global measures are quite stringent.

The initial data review and subsequent laboratory testing demonstrated that both the renewable petrol and renewable diesel fractions produced from the preferred technology needed further improvements before they could be directly blended into New Zealand petrol or diesel. A number of strategies involving process and catalyst technologies are being pursued to improve the biofuel quality. To meet the requirements for sale as a fuel in New Zealand biofuel must meet the New Zealand specifications and must also be fit for purpose. These strategies and the analysis of resultant products are expected to continue and will be progressed by the industry partners over the next several years.

A testing programme has been developed that will run concurrently with the process upgrading steps to ensure fuels are fully understood from an environmental, health and safety and performance perspective.

The key steps which are likely to take approximately 2 – 3 years are;

- Further understand how the petrol and diesel compare against NZ fuel specifications
- Ensure that the process can be modified and optimised to consistently produce petrol and diesel that meets New Zealand's quality requirements. Preferably the biofuel will comply with the critical fuel specification properties such as octane, cetane, stability, acidity and the physical properties, etc.
- Knowledge of the qualitative and quantitative composition of the biofuel, including a detailed understanding of the chemical compounds present in the biofuel, and how they compare with the chemical compounds present in mineral fuel
- Engine test results confirming that the biofuel is fit for purpose and has no unintended negative effects on the engine and fuel systems
- Testing to confirm that the fuel has no unexpected negative environmental or health impacts.

S2P Product to Market

The results from the product quality assurance programme above will inform the capacity to blend and make marketable fuels with identical performance and operational characteristics as in existing mineral fuels. The following is a brief summary of how products are envisaged being introduced into the market:

- Kawerau is within reasonable reach to the existing oil terminal locations of Mount Maunganui and Auckland where blending of the produced biofuel with mineral fuels would occur. Under the base case, biofuels would be shipped from the Kawerau plant by road tanker and taken to oil terminals for blending. The quantity of fuel that would be produced is in the range of 65 – 75 million litres, this can potentially be accommodated within the Z Energy terminal facility at Mount Maunganui.
- A range of other blending options are possible which depend upon the final plant size, fuel quality and whether biofuels are spread over a wider pool of mineral fuels which would necessitate industry involvement. A single Wiri blending option is a possibility, but transport costs are a significant disincentive.
- For the biofuels to be economically competitive they need to match the price of imported mineral fuels into oil terminals, taking into account transport and blending costs and adjustments made for quality differences to mineral fuels.
- Increasing the size of the biofuels plants will give an economic benefit, but this needs to be done taking into consideration plant locations to optimise access to wood waste and the delivery of biofuels for blending to one or more oil terminals.
- From a market perspective other locations in Northland and the lower South Island are possibilities, however these do not support large fuel demand centres. For these locations to be viable a 200,000 tonnes/year plant would require the introduction of biofuels into the broader fuels supply chain.

4.5 Feedstock and Expansion Study

An independent study was commissioned as part of the S2P programme to confirm availability of suitable biomass in the Central North Island to support the decision to site the first commercial plant in Kawerau. This was further reinforced by Scion report "Analysis of Wood Processing Opportunities in Kawerau using the Woodscape Model" published in September 2013 which confirmed Kawerau as an ideal site for wood and biomass processing due to its location and logistical advantages.

An expansion report was written as a reality check on the scalability of the programme and a key question was to determine if there was sufficient feedstocks available for the planned expansion. There has been considerable work undertaken in New Zealand over the last 10 years to establish whether there is sufficient biomass to support scalable renewable transport fuels production from forestry biomass. Much of this work was based on significant new afforestation particularly on marginal land, the most notable being Bioenergy Options work undertaken by Scion for the New Zealand government as part of the EnergyScape programme from 2007 to 2009 which developed a number of scenarios.

However, these future scenarios require considerable investment, industry cooperation and government intervention to be realised. S2P expansion is therefore based on current biomass availability and projections based on known harvest availability from 2010 to 2030 and established demand.

In early 2013, during the development of the S2P Business Plan Norske Skog commissioned a report, "Central North Island Biomass", to research fibre availability and other potentially available lower value biofibre. The findings of this report confirmed that fibre at an economically viable price could be secured for the Kawerau project and that expansion of up to a further seven sites could be supported. The assumption is that each commercial plant will require 200,000 tonnes/year of woody residual feedstock. Appendix 1 details where the fibre residues are available regionally.

The key findings from this report and the updated report in September 2013 are;

- Costs for feedstocks and transport have been steadily rising over the last several years but sufficient fibre is still currently available within the Central North Island.
- The price for fibre depends on location and the nature of fibre. The study assumed collection within a 100 km radius of the processing plant. The net cost for fibre for a specific plant size comprises a range of lower cost and medium priced fibre.
- Stumps and bark have been identified as possible fibre sources that require further investigation.
- There is sufficient fibre for expansion to seven additional plants but previous assumptions needed to be amended. In particular Nelson is tight on feedstock supply, but in the Lower North Island there is availability to support a plant as well as sites in Southland, East Coast, Northland and several within the Central North Island.

In summary, there is believed to be sufficient forestry residues for expansion. From work undertaken by Scion, there is an estimated 3.9 million m^3 of available residues within New Zealand in 2014 which is expected to increase to 5.8 million m^3 in 2025. This correlates with the above S2P evaluations.

A key opportunity that will impact expansion is the availability of substantially greater volumes of residues arising from further domestic processing of export logs (by and large utility K and A grade logs), particularly within the Central North Island and Northland, into high value engineering wood products for New Zealand (Christchurch rebuild and Auckland housing intensification as well as export to Australia, Japan and China).

In 2013, New Zealand exported a total of 16.6 million m^3 of logs, of which 11.9 million m^3 went to China. If these logs were to be processed into wood products, with the majority of residues available for S2P, this would be a significant source of affordable feedstocks.

5. Findings from the Feasibility Study

5.1 Key Outputs from the Study

The feasibility study was required to determine four key outputs as defined by the Project Charter;

1) Economic returns evaluated for converting forest waste into biofuel products:

- A comprehensive financial model was produced with the key inputs being, fibre pricing, capex, opex, fuel product values, exchange rate assumptions plus financial information.
- Project Internal rate of return (IRR) and NPV were determined from the model based on a design capacity for the plant.
- The key financial drivers remain the international petroleum product price and the NZ to US exchange rate.
- Feedstock cost was determined to have a relatively low impact on the Internal Rate of Return (IRR). The study determined that there is sufficient affordable residues available to support a Test Plant located at the Norske Skog Tasman Kawerau site.
- Uncertainty of the capital costs for a Test Plant remains a significant project risk and further investment in detailed engineering design is required to refine the capital costs.

2) Defined scope with accepted design for a Modular Test Plant at the Norske Skog Tasman site:

- Capacity of plant studied was 170,000 MAF Tonnes/yr. (Moisture and Ash Free Tonnes)
- The test plant process and engineering design work was undertaken by Norske Skog Tasman and international and local engineering design partners.
- The Capex for the Test Plant was determined to a ±30% level of accuracy.
- Scaled factor estimates were also completed for 200,000, 400,000 and 800,000T/yr. plants as well as for brownfield vs greenfield applications.
- Planning and consent requirements plus New Zealand standards were reviewed and no major issues were identified. The plant would require normal approval processes.

3) End user products defined, including Path to Market:

- Key end products produced from the preferred technology are biofuels in the form of renewable petrol and renewable diesel.
- Based on the current product quality information these bio-fuels do not currently meet NZ standards, and could not be readily blended for the New Zealand fuel market.
- A range of possible upgrading options have been proposed by the technology provider to improve quality and deliver test results closer to the NZ fuel specification requirements.
- A proposed product certification and approval programme has been developed to ensure confidence in fuel equivalency and fit for purpose. This is expected to take 2 - 3 years.
- The path to market for the fuels produced from the Test Plant would be via blending (assuming quality is met) at Mount Maunganui. A similar model would be adopted for other commercial plant locations in New Zealand serviced by existing fuel storage and distribution facilities.

4) Understanding the key risks and mitigation strategies for the new business

The main risks identified thus far in the study are;

- Product fuel quality remains below the New Zealand fuel specifications. Product assurance and compliance with operability as well as health and safety considerations needs to be confirmed
- Overall economics remain marginal, driven largely by the crude oil price forward projection. This affects the likely IRR for the project
- Upscaling and integration of the technology for the first “Pioneer Plant”. International experience indicates that the first commercial scale plants require patience and a broader perspective to achieve success prior to additional plant expansion.

5.2 Conclusions

S2P has established that whilst a technically feasible path for New Zealand has been identified to convert forestry residues to liquid fuels. To achieve commercial viability and a path to market, the study team has determined that additional time will be required to progress fuel certification and the testing requirements necessary to determine if the product can meet NZ fuel equivalency. As this process mainly involves further fuel research and development and will take several years to complete, industry will continue to progress this at the end of the PGP programme.

Overall S2P still has the potential to create a biofuels industry for New Zealand and to deliver the broader benefits that government is seeking. However it may take longer to achieve these than originally envisaged particularly the establishment of the test plant, given that the global energy outlook has softened in the last 18 months and made biofuels development more challenging in the near term.

However, the work undertaken by S2P programme means that when conditions are favourable and once the fuel certification and testing is complete, then all the key elements are in place for commercialisation.

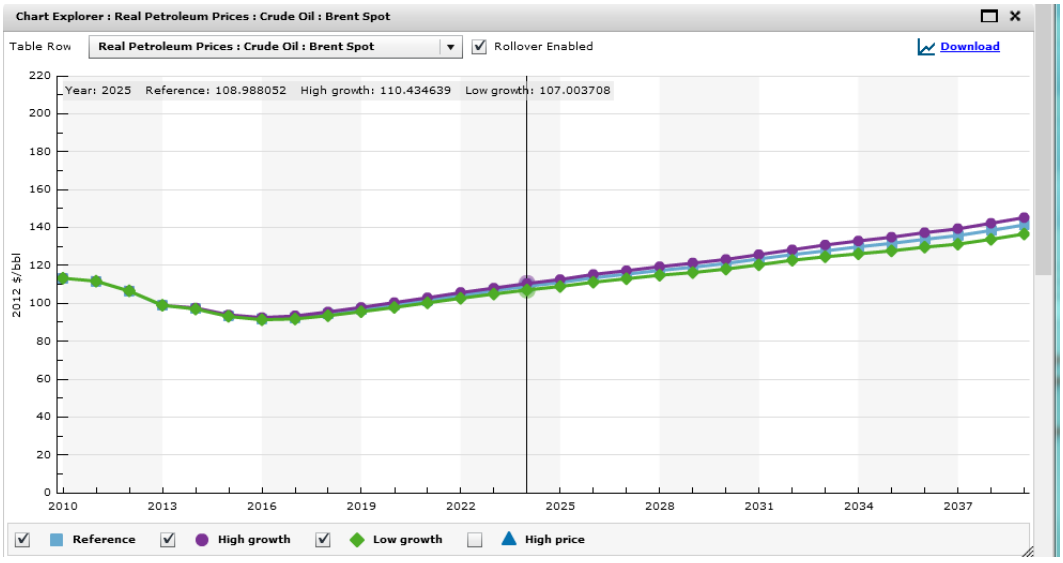
5.3 Global Perspective

In recent years, the oil industry has developed technologies to recover more mineral based oil through fracking and other "tight oil" recovery processes that will keep increasing available supplies in the near to medium term. The resultant oil price is projected to the downside of forecasts and be relatively stable for a prolonged period.

Currently crude oil prices are going through a period of stability in the US$100-110/bbl. range, due in large part to the production balancing position that Saudi Arabia has adopted in the market. Barring geopolitical events, most of the risk to price is on the downside with economic growth anticipated to be below average, a greater use of gas in the future and increasing improvements in energy efficiency. At an oil price level of about $80/bbl. marginal oil production would come under intense operating pressure, including the tight oil producers in United States. This price level is likely to represent a floor for the oil price.

Longer term, with potential oil supply constraints, upside pressure to price will emerge although this will be on a slowing oil demand growth trajectory. This will be reflective also of a declining level of non-OPEC oil production from a decreasing resource base and an ever growing requirement on OPEC production that will be challenged with some of its own members experiencing declining oil production. Nevertheless it is expected that prices will remain at a level to prevent a wide scale retreat from the demand side.

The following graph of future oil prices is typical and is one of a number of predictions reviewed by the Stump to Pump team.



US Energy Administration is the projected oil price for Brent for next 20 – 25 years

Lignocellulosic Renewable Fuels Programmes around the world

In spite of several years and several billions of dollars of research and development activity, it is only recently that the first commercial-scale plants for the production of biofuels from wood and other lignocellulosic materials have been starting up and entering the commissioning phase. Examples include the 30 Million Litres/year Beta Renewables plant in Italy, the DuPont (95 Million Litres/year), Poet-DSM (75 Million Litres/year), Abengoa (95 Million Litres/year) and Ineos-BIO cellulosic ethanol plants in the United States, and the KiOR plant in Columbus Mississippi, which converts woody biomass to a drop-in hydrocarbon.

As expected with such first-of-a-kind plants, significant scale-up challenges have been encountered in getting these plants to meet the operational and financial metrics demanded by the owners. For example the KiOR plant which has noted Cleantech Venture Capitalist Vinod Khosla amongst its investors, has recently shut down with purported losses of US $347M because of challenges encountered in this last phase of scale-up.

KiOR was one of the technologies that S2P evaluated. It is important that S2P take the learnings from the KiOR experience as well as reviewing what is working elsewhere around the world. There are companies that appear to have a successful formulae. The European based projects in particular seem to have achieved a viable mix of investment from public and private sector sources.

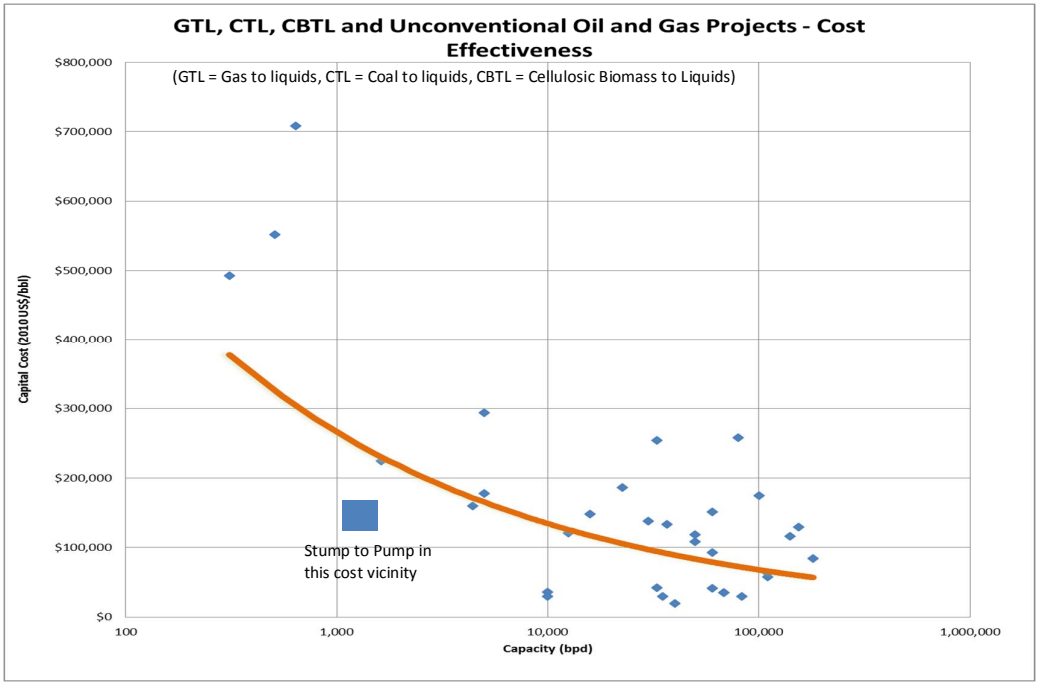
The projects undertaken by UPM (a European Pulp and Paper company) have managed to bring a diverse but complementary set of partners together to help navigate the early stages of development. As one example their Wood to Green Gasoline project involves the US Department of Energy, Catalyst developer Haldor Topsoe, GTI, Pulp and Paper Specialist Carbona as well as Refinery and Fuels Company Phillips 66.

The Biofuels Digest recently summarised 5 success strategies that some companies are employing. These are;

i) Building from existing business and operational base;
ii) A graduated series of development steps e.g. first building a sustainable ecosystem for harvest and delivery of biomass;
iii) Looking to produce chemicals and other bio-products to generate revenues before taking the business “down the cost curve and up in scale” in order to make competitively priced biofuels
iv) Adding renewable fuels at this stage once other fundamentals in place; and
v) Adding algae to monetise the CO2.

Most of these strategies are currently part of, or are available options, for the Norske Skog Tasman site.

Whilst commercialisation of biofuels is challenging due of the relative immaturity of the industry, on a capital cost efficiency perspective projects such as S2P compare favourably with unconventional oil and gas projects and other biofuels developments.



5.4 Achieving the Broader Outcomes for Stump to Pump

The government has set a target of increasing exports from 30 to 40% of GDP by 2025 – a doubling of the value of exports. The potential for the forestry sector to make a significant contribution to this through significantly increased domestic wood processing is recognised by the Ministry for Primary Industries. By only using a limited percentage of the harvest and wood processing residuals, and not adding value to export logs, New Zealand is currently not extracting the full value of its forests.

To help rejuvenate the industry, the Stump to Pump programme has aimed to create a new market pathway that links low-value forestry and wood processing residuals to new high-value fuel markets. Whilst renewable transport fuels from forestry may take longer to realise, the programme has reconfirmed the opportunity and imperative to identify and commercialise opportunities for this resource.

With this stage of the S2P programme completed, industry now has a comprehensive understanding of the feedstock availability and characteristics, including the nature and location of the resource, costs and methods for recovery and delivery to processing sites and chemical composition. This will not only help Stump to Pump progress to the next stage but also facilitate the commercialisation of other residue based product opportunities.

5.5 Next Steps

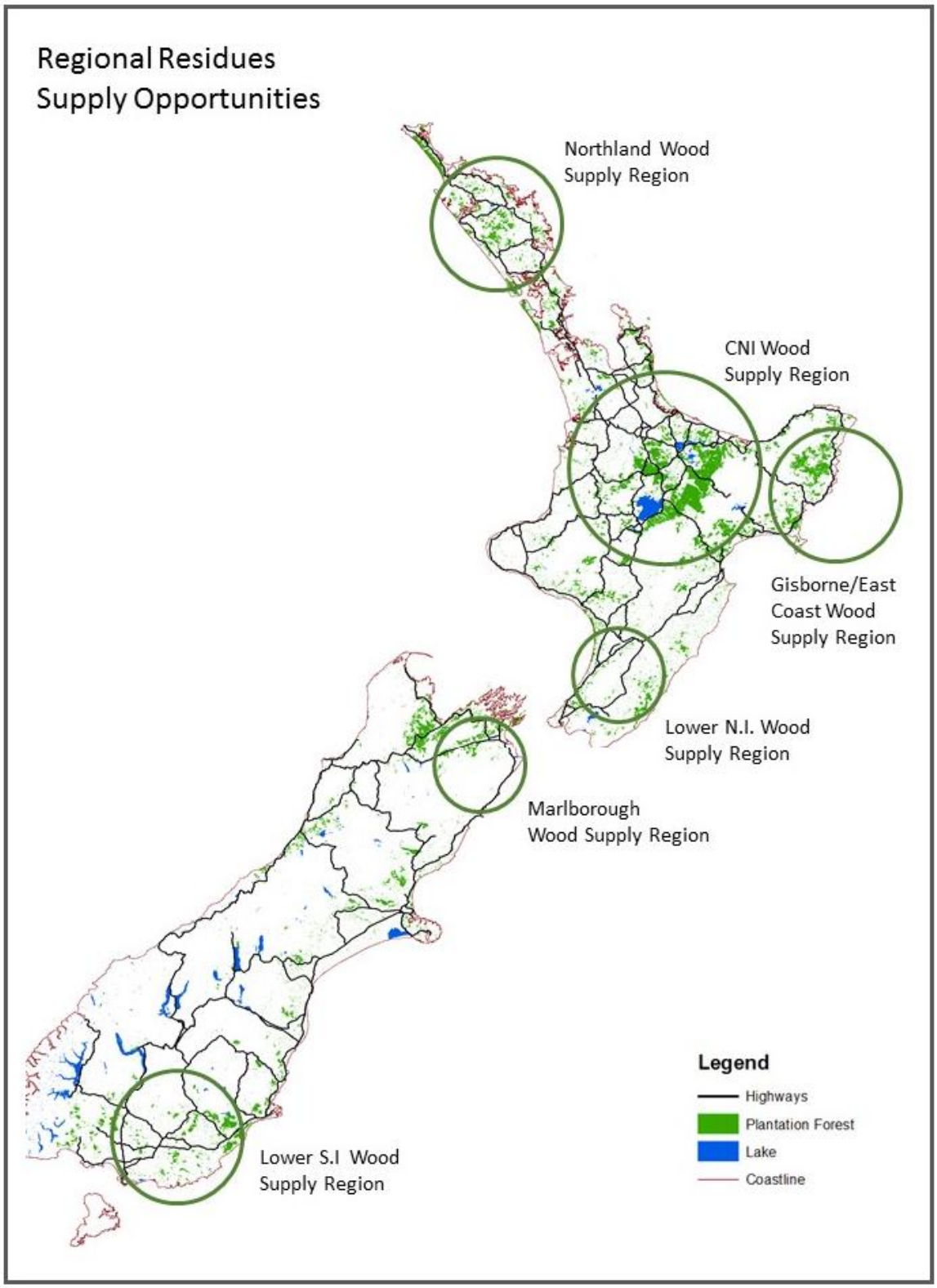
Over the next 2 – 3 years the industry parties Norske Skog and Z Energy will continue to work on the commercialisation of the Stump to Pump programme.

The next steps are;

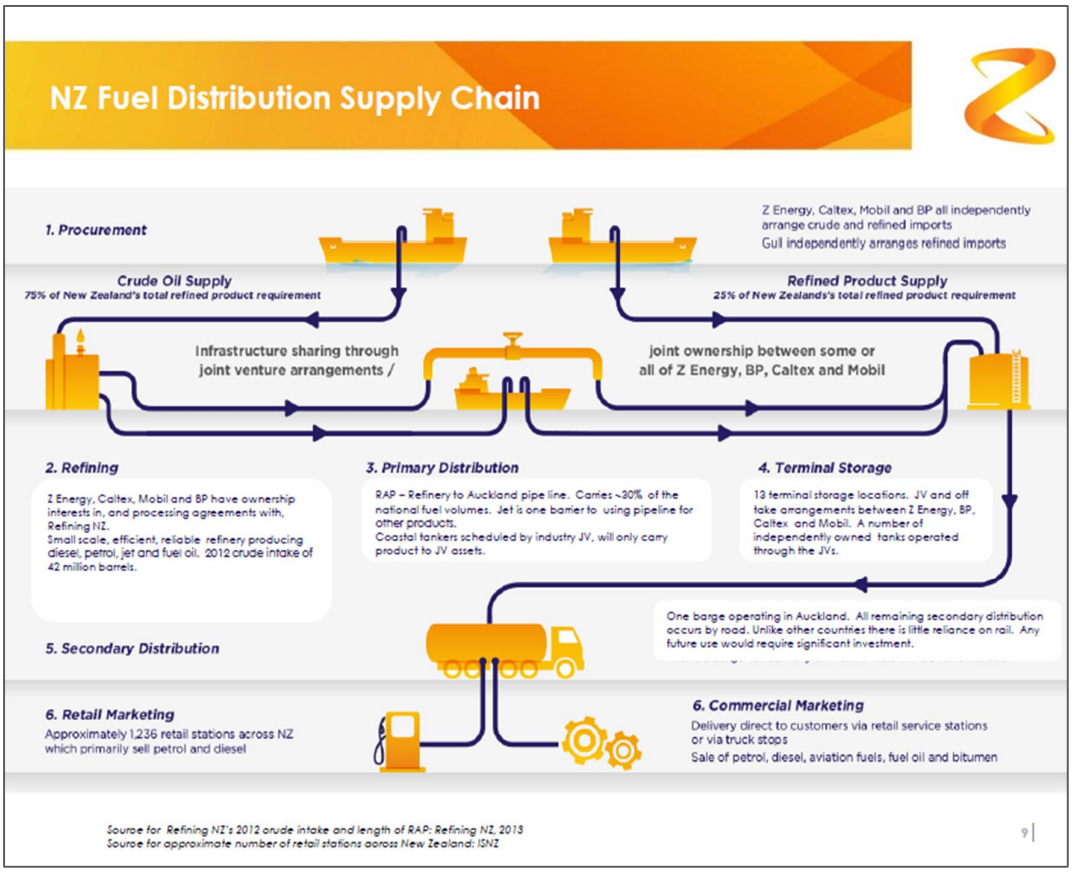
1) Continue to investigate fuel quality and product assurance from the selected technology. A product acceptance timeline and plan has been developed which details the necessary product testing and fuel certification requirements for the New Zealand market.
2) Continue to work closely with the preferred technology provider or providers to monitor progress on process improvements, product quality and yield from the proposed technology and catalyst upgrading strategies as well as commercial progress towards the first Pioneer plant.
3) Continue to monitor the overall economic environment as well as the global biofuels situation, in particular any technical or other developments that could influence the pathway forward for Stump to Pump.
4) Continue to engage with government on the broader ambitions and strategic issues for Stump to Pump and explore ways to accelerate the pathway forward for Stump to Pump.

APPENDICES

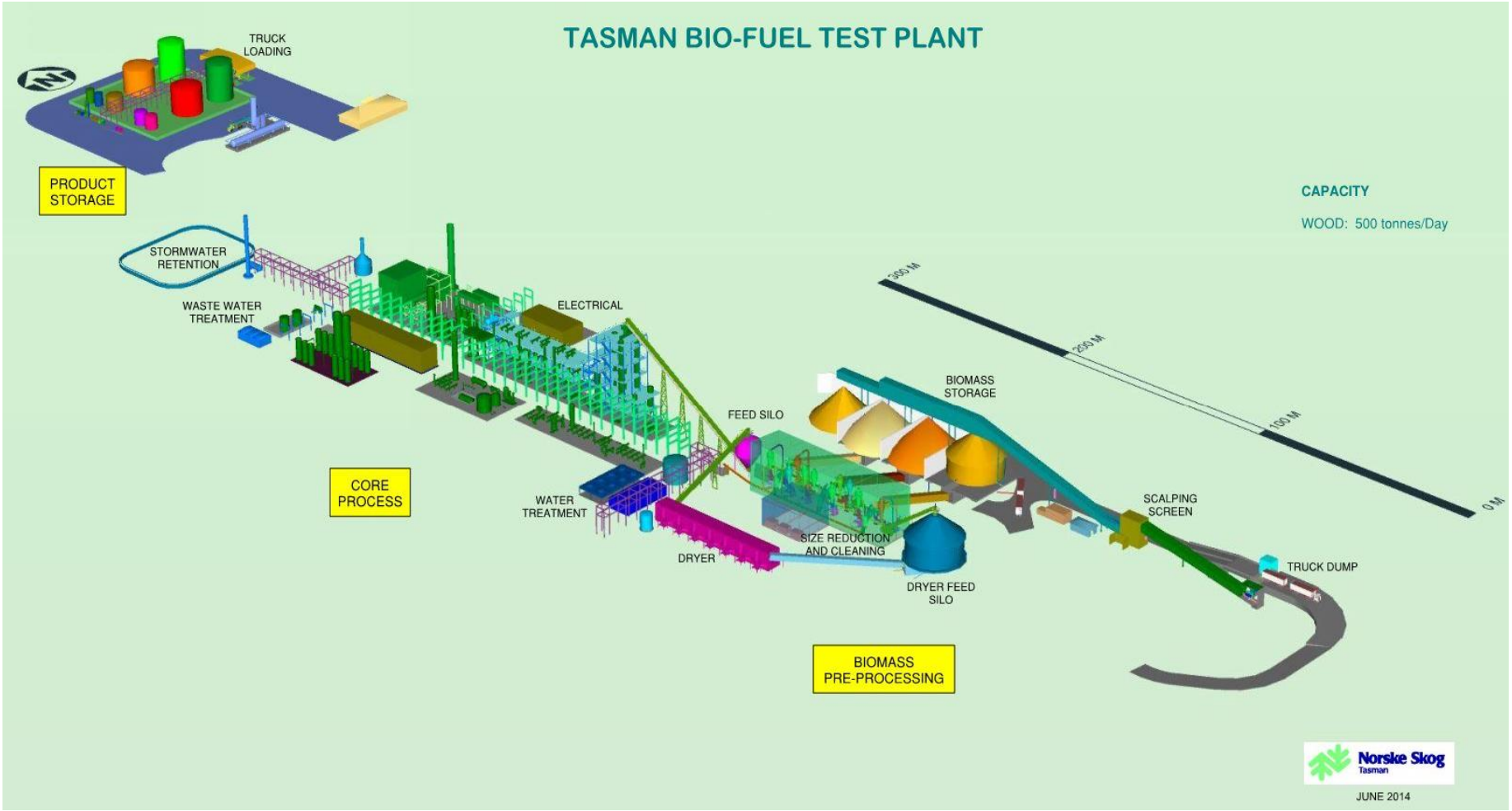
Appendix 1 – New Zealand Regional Wood Residues Supply



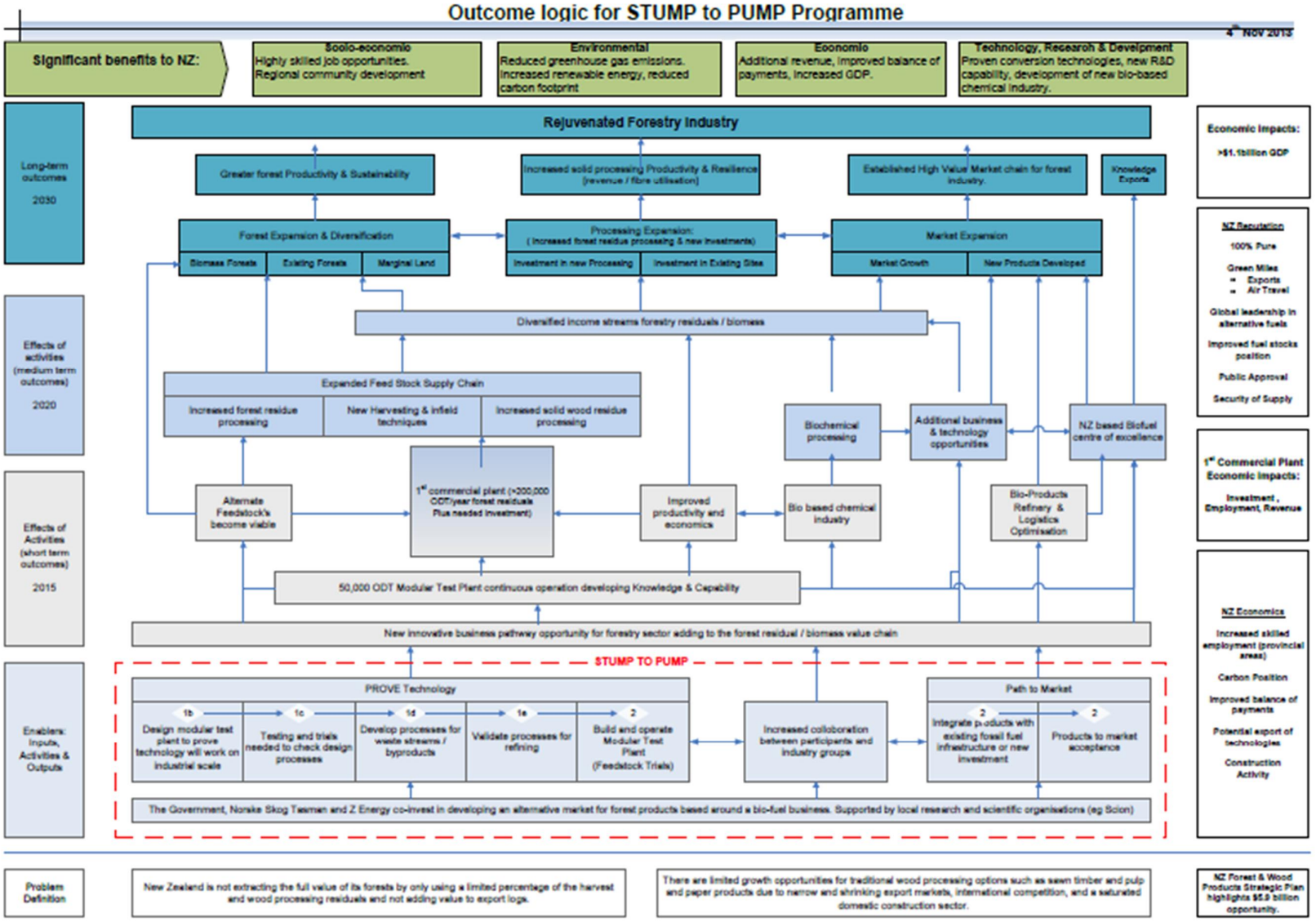
Appendix 2 – NZ and Z Energy Fuel Supply Chain and Logistics



Appendix 3 – Proposed Layout for Tasman Test Plant



Appendix 4 – Outcome Logic



Appendix 5 – Stump to Pump Brochure