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NORTHERN RIVERS BIOHUBS PROJECT

A project looking to optimise the position of the Northern Rivers Region in the emerging Bio-economy

'First Order' Pre-Feasibility Study

Stage 1 – General Biomass/BioHub Potential in Northern Rivers Region (Kyogle to the Coast of NSW) focusing on the identification of Potential Projects for short, medium and long term Development in the Region

Issued May 2016

Preface

The Role and function of a Pre-Feasibility Study

Attachment (A) – Generic Project Development Process (EW-PIS-13-010) describes the generic process of progressing an entirely new project concept from initiation to final commissioning and steady state operations.

Projects as advanced as this Northern Rivers BioHub Project (NRBP) are potentially complex to design, finance, construct and operate. They are also based on an entirely new business model that itself has emerged from first principles R&D, problem solving and opportunity exploration. As such, it is important to understand:

a) where the NRBP sits in the logical project development process; and

b) what the realistic expectations for this Pre-Feasibility Study (PFS) are.

On completion of a PFS it would be quite normal to undertake further general or specific investigations to continually revise and refine the original PFS work until an agreed and viable BPD stage is reached.

PFS Objectives

The BioHub concept has been incrementally developed over some 5-10 years (Figure 1 – Stage 1) and has more recently (2013) been the subject of an initial 'Options Review' type study (Figure 1 – Stage 2a) that has now provided the platform for this NRBP PFS.

The immediate goal for this PFS work is to achieve Basic Project Definitions (BPD) for BioHubs in the Northern Rivers, that have fully explored all the primary project viability issues, such as:

i) The secure availability of sufficient and appropriate biomass sources;

ii) The identification of viable local, regional, national and international markets for the proposed range of 'bio' products and services that could be generated;

iii) The preparation of a viable transport, logistics, process flow and technology identification phase;

iv) A first order economic (regional) and financial (plant specific) analysis; and

v) A first order 'Project Completion' risk analysis.

If the PFS demonstrates a viable project, it must be sufficiently detailed to justify the allocation of much more significant funding to undertake subsequent and much more detailed feasibility work (Figure 1 – Stage 3) and provide a considered platform from which to undertake such work.

Executive Summary

The BioHub concept optimises development of the biomass economy; biomass is once-living material. The Northern Rivers region is an area of high rainfall, high sunshine and rich soils that are ideal for biomass production. For this study the Northern Rivers includes: Tweed Shire Council, Byron Shire Council, Ballina Shire Council, Lismore City Council, Richmond Valley Council and Kyogle Shire Council.

Potential biomass "supply" sources in the study area are wastes, residues and by-products from existing primary activities. Different forms of biomass are suited to different processes, products or energy manufacturing – in response to market demand. Pre-treated materials can be transported to sites specialising in product manufacture or can be traded. Producer Biohub sites are proposed to form part of an integrated network over time.

Biomass as a sustainable source of carbon addresses climate change by avoiding release of 'fossil' CO_2, and addresses natural resource depletion and sustainable economic practices. Products and services from a BioHub will be enhanced where the sustainability status of the yield can be verified, confirmed or certified.

Assessments of biomass sources in this study come from interviews with owners and generators of potential biomass sources, reference materials and specific research tasks. Biomass in original form is low value; transport distance for value-adding is required to be minimised. Five distinct categories emerge for Northern Rivers biomass sources:

1. Dry lignocellulosic (woody) materials such as forestry residues, cane trash, tea tree mulch

2. "Wet" effluent materials such as manure slurries, abattoir wastes and waste water treatment plant flows

3. Poultry litter materials which are listed separately due to their unique potential benefits as sources of valuable fertilizing minerals

4. Urban waste stream sources – these potential biomass materials are categorised separately due to the more socially complex processes that would need to be observed to actually make such materials available

5. Camphor Laurel, included as a preliminary proposal.

All available sustainably yielded biomass materials in the study area are currently managed for least cost disposal; they are spray irrigated, spread to land, left uncovered on site or lost to the atmosphere. This deals with disposal compliance requirements but, in return, has only limited benefits. In a Bio Economy these same materials are a potential industrial input – prime raw materials for products or services currently supplied from fossil resources.

The full range of highest value "bio" products were researched and scoped, and they include:

a) Biochar material for sale to third parties, as specialist ingredients;
b) The blending and manufacturing of finished, speciality fertilizer, biochar extended fertilizer products;
c) Saw mill products;
d) Metallurgical charcoals and reductants;
e) Bio/essential oil extracts;

f) Supply of pre-treated lignocellulosic feedstock to highly capitalised upstream “bio refinery” style projects (liquid jet fuels and other petrochem platform chemicals);
g) Bio energy, as an important “by product” from every project; and
h) Locally valued service functions.

If primary industries, energy supply, transport and waste management sectors in the Northern Rivers receive Highest Net Resource Value (HNRV) outcomes from biomass inputs, these sectors are supported and potentially new businesses are attracted. Realising HNRV means streaming input materials towards production for the most suitable, valuable end market, translating to maximum value and revenue.

BioHub – Casino

An operational node at Casino is the most viable and immediately actionable of the facilities proposed, and would have “anchor” potential for the Northern Rivers BioHub network. The strength is the practical involvement of Northern Cooperative Meat Company (NCMC). There is also potential to supplement/upgrade these basic effluent flows with primary piggery manure slurries from Mondoro Pty Ltd and all or any part of the gross effluent supply from Richmond Valley Council sewage treatment plant.

A Casino specialist regional facility that could accept these waste streams, untreated, to extract maximum energy value and negate further capital expenditure on compliance measures is supported. General abattoir effluents and render plant effluents are ideal inputs to a proposed Anaerobic Digestion facility. A Casino site, behind Riverina Stockfeeds, is proposed .

For the abattoirs, waste/effluent compliance upgrade costs would be avoided. NCMC acknowledge highest net value for a biomass resource is specialist activity and best done collaboratively. For Richmond Valley Council, raw sewage treatment plant inflows could be processed via the proposed Anaerobic Digestion with bio energy and nutrient recovery outcomes.

For Mondoro least cost disposal practices could be replaced with tailor-made pasture productivity improvers. Lignocellulosic (woody) amendment materials would be acquired to provide the primary energy source for the Casino facility. It would also supply biochar for helping to create products for a proposed bio fertilizer blend plant.

The BioHub project is fundamentally an energy and fertilizer production activity. The key characteristics that drive the Casino project are: NCMC has a significant 24-hour x 7-day energy demand requirement due to operation of chillers; NCMC generates significant amounts of waste product currently treated and sent to polishing ponds; and there are significant capital expenditure requirements to ensure compliance of waste/effluent systems.

Project configurations will need further and more detailed analysis. NCMC effluent has been estimated to produce a power supply of 1.5MW on a reliable basis. The inclusion of the Mondoro piggery slurries would meet NCMC required power supply of 2MW, it would also greatly improve the quality of the digestate volumes for subsequent fertilizer manufacture. Potential to process the Richmond Valley Council sewage treatment plant effluents (in full or in part) could be justified on the basis of all the collateral regional, bio economy benefits that could accrue.The project might be best developed in three distinct stages over time. On site activites and volumes for such a node flow through a sequence (Figure 5.1).

A viability summary for the Casino node (Section 5.2) uses a full scenario and minimalist scenario (two extremes of project implementation). This summary indicates profit contribution as just more than $17.38 million (almost 58% return on investment) and in excess of $1.66 million (just over 13% return on investment) for the two scenarios, respecitvely. The first set of figures rests on a fully developed project with an established market for the large volume of biochar product.

BioHub – Murwillumbah

In this "surplus biomass" catchment are numerous dairies, some piggeries, industrial food processors, a brewery and several "behind the meter" potential energy customers. Behind the meter systems generate renewable energy for on site use. Anchored by wet waste supplies, Murwillumbah would therefore be an anaerobic digestion (AD) facility.

Three sites were suggested during the stakeholder interview process. However, a site adjacent to the existing sewage treatment plant might also have logistics advantages since much of the potential facility inputs are wet wastes.

Unlike Casino, this proposed operational facility has no specific "anchor" waste generator. For the proposed regional slurry collection system the cost of net inputs to the plant may well equal or exceed the potential value of the bio-products and bio-energy. Also, waste materials from the Stone & Wood Brewery would need to demonstrate a commercial benefit. Inputs for proposed onsite activities would be predominately wet waste, as well as brewery effluent, dry woody supplements and chicken litter. Products are energy and fertilizer ingredients for local use, (proposed activities, Figure 4.3)..

A Murwillumbah viability summary indicates profit contribution of just more than $5.4 million (with 28.46% return on investment) and a loss of about $3.98 million for, respectively, a full scenario and a much-reduced power-only configuration. The viability summary table is in Section 5.4.

The comparison between scenarios demonstrates the crucial need to recover the Highest Net Resource Value to capital justify the significant extra expense collecting/aggregating instead of direct piping. If the Anaerobic Digestion plant was located adjacent to the existing sewage treatment plant, the existing piping could be used to completely overcome the collection/aggregation costs, and provide a strong incentive to attract similar food processing industries to the region.

As with Casino, the project could be staged to allow the crucial fertilizer sales to also be ramped up in appropriate module sizes.

BioHub – Bora Ridge (speculative/proposal)

An undeveloped site at Bora Ridge has been secured by Richmond Valley Council with a view that it could be ideal for a regional landfill and/or urban waste processing facility. This proposed facility is an opportunity in the event of a fully integrated Bio Economy in the region. The facility, however, could be located at another suitable regional site or several linked sites.

The Bora Ridge site could be ideal for municipal solid waste processing and is central for tea tree mulch processing. The site is suited to receive forest residues, poultry litter and process bagasse and cane trash. Products would be energy, specialist regional blended fertilizer for the cane growing and permanent horticulture sectors, and essential oils (proposed on site activity in Figure 4.4.)

Concepts are not developed enough for detailed viability analysis. An early "first order" assessment led to figures showing profit and return on investment (see Section 5.5). However, the installed capacities would be developed in incremental stages, and in the case of the finished bio fertilizer production capability it may take some time to establish local, regional, national and even international markets.

On site activities for the Nimbin location are being progressed by others and are not part of this current study.

At a higher “Regional Bio Economy” level the networking of the inherently profitable Casino and of Bora Ridge facilities could allow the viability of Murwillumbah and even Nimbin, to be reconsidered in the context of a regionally viable “network” rather than independent operations.

In terms of potential risks for the BioHubs project, this includes ensuring there is detailed and professional management of the projects’s complexity. In one respect, this complexity could present as a barrier to entry to those not engaging with the issues, but a sustainable competitive advantage to those who do.

Garnering full support from the wide range of stakeholders is perhaps the largest single project completion risk issue. In addition, detailed discussions will need to be undertaken will all the wet and dry contractable biomass generators. Momentum could be assisted by provisional memoranda of understanding.

Supply certainty, process risk and market risks were reviewed with proposed mitigation measures shown to be appropriate (Chapter 6). Social Licence to operate is an issue that the local Steering Committee has addressed in considerable detail and the community has participated in initial consultation (Report referred to in Section 6.5).

The viability projections that have emerged should provide confidence to raise the additional funds necessary to progress. With so much available biomass identified and such high value markets for bio products in prospect, the broader regional bio economy opportunities could match or exceed the most advanced initiatives of this type anywhere in the world.

This options or scoping work identifies in excess of $1B worth of accumulative economic benefit to the region over the next 50 years, if these concepts are progressed systematically. No absolute barriers have been identified if project defining principles and processes are followed with diligence.

A specialist project development entity may well be required for the next phase.

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Glossary

BAU	Business as usual
Biomass	Once living material, preferably <100 years old
BFD	Block Flow Diagram
BPD	Basic Project Definition
CAPEX	Capital Expenditure
C&I	Commercial and Industrial
CEC	Cation Exchange Capacity
Contractual customer	Capable of being a certain or contracted source of biomass (see Merchant)
Db	Dry basis
D/T/P	Drying/Torrefying/Pyrolysis as a thermal gradient
EOI	Expression of Interest
FEED	Front End Engineering and Design/Development
GHG	Greenhouse Gas Emissions
GPT	Gross Pollutant Traps
HNRV	Highest Net Resource Value for a particular biomass resource
HSCW	Hot Standard Carcass Weight
IEA	International Energy Agency
INS	Invasive Native Scrub
Merchant customer	Likely to be a valuable customer of a BioHub, once it is operational, but not having sufficient need to be relied upon for initial project financing
Mt	Million tonnes
OPEX	Operating Expenditure
SCA	State Conservation Area
SPU	Standard Pig Unit
Stick water	Render Plant Effluent
Streaming/cascading	The concept of **streaming** materials to their highest and best use whenever it is practical or cost-effective to do so, but providing a '**cascading**' next best option when such an outcome is unachievable and so avoiding binary outcomes where materials are either processed for HNRV, or lost to disposal as the only available default option
Stumpage	Payment on a stem by stem basis
Sustainable Yield	See reference document RIRDC Publication#05/190 as available (www.ecowaste.com.au Sustainability Issues RIRDC/CSIRO)
Thermal Gradient	The option to apply a full range of temperature increases to the processing of waste streams as another 'sorting' or 'contaminant removal' technique
VATS	Value Adding Transfer Station

1. Background and Introduction

1.1 Previous Work to This Point

This NRBP Pre-Feasibility Study (PFS) is being undertaken as a natural progression from previous 'concept defining' reports:-

- NSW North Coast Bio energy Scoping Study April 2013 (which recommended more detailed research into a range of generic sources of biomass); and
- Northern Rivers BioHub Workshop February 2014.

In relation to Generic Project Development Process (Attachment A) this previous activity provides a valuable contribution to Stage 1 – Project Initiation and Conceptualisation.

The scope of this current NRBP-PFS is to review options and compile information to pre-feasibility stage. A Basic Project Definition (BPD) may be possible, or the PFS may highlight additional issues/tasks to be resolved.

1.2 Project Scope and Governance

Northern Rivers region is taken to include the combined areas of:-

- Tweed Shire Council
- Richmond Valley Council
- Lismore City Council
- Kyogle Shire Council
- Byron Shire Council
- Ballina Shire Council

The client for this project is the Nimbin Neighbourhood & Information Centre (NNIC) and a project specific Steering Committee has been established, consisting of representatives of:-

- NNIC
- RDA-NR
- NSW Trade & Investment – the Convenor
- NSW Office of Environment & Heritage
- Tweed Shire Council

The project manager for the Steering Committee is Natalie Meyer (NNIC)

The key components of this project include:-

1. Research potential biomass inputs: Mapping and assessing the potentially available sources of biomass in the region;
2. Identify bio-energy technologies and other bio-energy products including identifying the local, regional and national markets for potentially available bio-products including energy;
    a) Vendor enquiry to inform an initial project completion risk assessment
3. Developing first order logistics and general processing recommendations in the form of a detailed Project Block Flow Diagram, that will be at least capable of projecting material mass flows Detailed research of potential project opportunities in selected sites including substrate volumes and values, and testing of sample substrate for energy potential
4. Preliminary financial assumptions including revenue/capex/opex considerations

5. Present a first order proposed project completion risk assessment, that may well identify selected additional tasks that will need completing for BPF to be signed off
6. Preliminary project procurement options

From the outset, and based on the reference documents, there is an expectation that at least two Bio energy projects in the region, Casino and Murwillumbah, will present as present as viable in one form or another, such that the collection of potential waste stream samples is required for third parties to analyse.

1.3 Project Potential

Reference document: Northern Rivers Green Business Project 2012 – 'Doing green business: Barriers and Solutions for the Northern Rivers[1]*'*

In preparing for and facilitating the transition to a 'low carbon future' this 'BioHub' project has the potential to scope, design and implement tailored 'Systems & Infrastructure' responses that could:-

- Fully and sustainably support all regional agriculture, fisheries, energy supply, transport and waste management in the region by providing Highest Net Resource Value (HNRV) outcomes for all the wastes, residues and by-products of such existing businesses and **act as an attractor for new business to the region.**

- Provide an integrated 'framework' for the processing of urban waste streams such that the organic (biomass) fractions were processed and recovered/reused in the regional economy and the non-biomass materials presented for reuse as a major contribution to the incremental **reduction in resource intensity of the region**.

- Provide a structured framework to '…. **grow and welcome new, innovative and entrepreneurial industries…**' to the region.

With regard to the specific requirements of the brief, the Northern Rivers region is an area of high rainfall, high sunshine and rich soils that are ideal for the efficient production of 'biomass' in all its forms, including, agriculture and forestry (and the related processing/value adding businesses) and related land (and weed) management issues even specialty grown crops, as markets develop and mature.

The local community has expressed a strong appetite for low carbon energy supplies, with a concomitant reduction in GHG impacts and an equally strong appetite for market and/or community investment/ownership of facilities that can produce renewable energy and related bio products to replace/supplement products currently sourced from 'fossil' fuels.

There exists a number of bioenergy/bio products activities in the region that offer the possibility of being further optimised if more strategically linked into a more developed biomass management network and two particular opportunities have been identified for 'green field' 'biogas' developments at Casino and Murwillumbah, which will form the primary focus of this Pre-Feasibility Study.

At least two collateral benefits should result from the completion of this current initiative.

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[1] http://rdanorthernrivers.org.au/download/environmental_sustainability/green-industries/Green%20Business%20Report%20Final%20230212%20WEB.pdf

i) Since the majority of the potential biomass 'supply' sources are currently presenting as wastes, residues and/or by-products of existing 'primary' activities, **all such primary activities** should be rendered **more efficient and cost effective** as a result of being reapplied for a much more valuable end use. These outcomes will result in regional economic development benefits in addition to the GHG/low carbon objectives.

ii) The same 'systems and infrastructure' that emerges to value add the initial wastes, residues and by-products will also be available/suitable to support and service the nascent 'specially grown crops' sector which should facilitate the earliest establishment of such activities and attract such investment to the region.

1.4 Generic Biomass Issues

1.4.1 The (Emerging) Biomass Economy

Within a carbon constrained economy, fossil fuels (coal, gas, oil) will start to run out, become too expensive, be taxed to discourage use, or ultimate goods and services customers will start giving purchasing preference to 'non-fossil' based products. When this happens, the only truly practical alternative source of carbon based materials is biomass (usually considered as having been grown and harvested within the last 100 years).

Biomass was the original source of even the fossil fuels used today. The removal of CO_2 (and equivalent gases) from the atmosphere during the formation of these fuels, approximately 300 million years ago created the climatic conditions we enjoy today. However, when fossil fuels are combusted, they release the sequestered gases to atmosphere, which is the issue at the heart of the current climate change (GHG) debate.

When applied as the basis of manufacture/production of all products and services currently sourced from fossil fuels, biomass (<100 yrs) has some distinct characteristics:

i) It is ubiquitous and widespread, but this presents a disadvantage in terms of the relatively low bulk/energy density.

ii) The creation of current biomass materials is actually based on directly utilizing CO_2 from the atmosphere, in a potentially closed cycle. This means that no (effective or significant) increase in atmospheric CO_2 is created in the provision of the same or similar array of goods and services currently supplied form fossil fuels. However,

iii) There can never be enough (<100years yielded) biomass to entirely replace demand for all goods and services currently sourced from fossil fuels. If approximately 11.5 billion tonnes of global forestry and agriculture output for one year was converted to a crude oil equivalent, it would only satisfy approximately 50% of current global demand[2].

[2] https://www.irena.org/remap/IRENA_REmap_2030_Biomass_paper_2014.pdf
According to IRENA's global renewable energy roadmap – REmap 2030 – if the realisable potential of all renewable energy technologies beyond the business as usual are implemented, renewable energy could account for 36% of the global energy mix in 2030.This would be equal to a doubling of the global renewable energy share compared to 2010 levels.
By 2030, biomass could account for 60% of total final renewable energy use.
Global biomass supply in 2030 is estimated to range from 97 EJ (exajoules) to 147 EJ per year. Approximately 40% of this total would originate from agricultural residues and waste (37-66 EJ).The remaining supply potential is shared between energy crops (33-39 EJ) and forest products, including forest residues (24-43 EJ).

These characteristics determine the opportunities to optimise the use of sustainably yielded biomass[3] for the manufacture/production of 'bio' products to supplement and/or replace the existing fossil products and services:

i) Apply those biomass materials that can demonstrate a sustainable yield to achieve their Highest Net Resource Value (HNRV);

ii) Consider value adding the materials before transport (rather than transport to value add), to help address the (relatively) low bulk/energy density of these materials

iii) Establish systems and infrastructure that can accept all such materials, as and when they are available, close to source, and that can differentiate between:

- the wide range of different biomass properties and characteristics;
- the immediate processing/stabilization needs; and
- subsequent finished product potential.

Clearly there is not nearly enough sustainably harvested biomass to directly replace all current global applications of fossil resources (coal, oil and gas). Therefore it is crucial to apply those biomass resources that can be made sustainably available to their best and highest uses.

From this functional platform, the opportunity to optimise the development of the biomass economy was researched in detail for the Commonwealth Industry Department (Attachment C – *First Order Pre-Feasibility Study for DIISRTE* – Eco Waste, July 2013). This report provides the background and rationale that is now referred to as the 'BioHub Concept'.

1.4.2 First Point of Receival/Receiver of Last Resort

The 'first point of receival' function addresses the geographical issue. Biomass is a low bulk density material, and in its original form is also a low value material. Therefore it is crucial that the initial transport distance is as short as practical from the point of generation to the first point where the material will begin an iterative value adding process.

A <100km maximum radius catchment for the 'raw' or unprocessed materials is considered the right balance to ensure a critical mass of incoming material, with the least transport cost inherent in the transaction. This radius might be extended to say 300km for certain higher value materials or materials that have undergone some crucial level of pre-treatment/value adding so as to be able to 'afford' the additional transport costs.

The 'receiver of last resort characteristic' reflects the fact that of the five generic sources of potentially available biomass (Section 2 – 2.1.1-2.1.5), four are by-products or wastes, or generated as a result of some other primary activity.

In these circumstances, the generator will naturally look to put such materials to the most cost effective end use that they can achieve after ensuring that their primary activity receives the most immediate focus. In these situations, the surplus, waste or undervalued sources of biomass will usually only be supplied to a regional BioHub when all other potential applications have been exhausted.

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[3] RIRDC Publications No. 05/190 and No. 09/167 for sustainable yield principles and best practice

There may be occasions where the easy access and the widely communicated BioHub option will be a convenient and ready outlet for the available biomass, for fair value, when compared with other 'least cost' disposal options that may require disproportionate effort to achieve little, if any, greater net benefit.

As receiver of last resort, BioHubs would always accept surplus biomass materials, and this service offering will be reflected in the gate fee structures that will also reflect prevailing market circumstances.

The provision of the physical infrastructure to provide local first point of receival convenience, coupled with the receiver of last resort certainty, is anticipated to transform the potential biomass sector by providing convenient and logical options for materials that might not otherwise be put to a fully productive use.

Quality Control and Creator of Critical Mass

A comparison with the scrap metal sector is useful. Scrap metal yards exist in all significant population centres. At these facilities scrap metals are received, materials are logically assessed for quality and quantity before being accepted and subsequently stockpiled like-with-like to optimise end market returns on all materials accepted. The same process applies with biomass received at the proposed BioHub facilities.

Realising the highest end product value for all materials under management will require a detailed assessment of the actual qualities of all biomass being received as the basis for producing quality assured products at least cost.

The proposed BioHub will provide the capacity to accumulate like materials, as and when they are presented. This could act as a basis for supporting the highest value markets for such materials, rather than being inevitably down-cycled with lower quality materials in the absence of any other use or application.

Supporting a 'Streaming/Cascading' Strategy

Realising the highest net resource value (HNRV) from all materials received or gathered into a BioHub means generating maximum value and revenue. A foundation concept in achieving this is to provide the ability for materials presented to be streamed, like-with-like, towards the production of the most valuable end markets that their respective qualities, quantity and reliability of supply will support. However, given that most such markets are seasonal, cyclical, or occasional, ideally BioHubs would offer 'next best' or cascading opportunities for materials presented. Without this capacity, BioHubs would be obliged to accept only a binary option of disposal (including basic energy recovery) or rejection alone.

Pre-treating

Value will be created for the original biomass generator/supplier if materials can be assessed, screened, stabilized (if reactive as presented), size reduced, decontaminated or partially processed to the level of at least an intermediate quality product.

This could be especially true for:

- Municipal Solid Waste (MSW) sourced organic fraction (separation and sterilization);
- Surplus green/garden waste (screening and size reduction);
- Processing wastes and sludges (digestion and/or stabilization);

- Wood waste/forest residues (screening, streaming, size reduction, decontamination); and
- Manures and agricultural residues (blending, stabilization, streaming).

Pre-treated materials can then be transported as 'interim' products to other sites specialising in product manufacture based on these materials (such as a regional Bio-refinery), or traded/brokered to specialist third parties.

Product Manufacturing

Inevitably some regions can attract a surplus of biomass, while others may be able to supply markets with finished products that far exceed the ability of the local region to supply the volume or type of biomass required. The BioHub concept (Attachment C), when delivered as a network of cooperating regional facilities, will have the ability to address this imbalance.

This will require the pre-treatment function at all fixed BioHub sites, and even the production of some basic products such as bioenergy, in most locations. However certain locations will need to focus on larger scale product manufacture. This will utilise biomass that is available in the region, and intermediately processed products imported from other sites and sources where the resultant transport and logistics can be cost effectively absorbed.

For example, in the Dubbo region, the apparent demand for tailor-made, biochar-based, all-in-one fertilizer products appears to grossly exceed the capacity of locally sourced biomass to sustain. Such a situation may also arise in the provision of tailored fertilizers to service the regional sugar cane sector.

At other sites, such as South East NSW/North East Victoria or the peneplain area of NSW, the opportunity to specialise in the production of low ash, high density industrial reductants and/or coke/coal replacement products may be appropriate. In so doing, these sites will supply a market that is potentially far larger than any single site or region to fully satisfy on its own.

Such 'producer' BioHub sites are proposed to form part of an integrated network over time.

Within this proposed framework, the BioHub facilities may all be established with similar basic technological capabilities to receive, sort, screen, stockpile and pre-treat materials. Final product manufacturing capabilities may be selected to exactly suit the respective local conditions, such as torrefaction, pyrolysis, energy production, fermentation, digestion, fertilizer blending and pelletising etc.

Fixed regional BioHub facilities will also be able to offer contracted extension services, including for:

- Vegetation/weed management;
- Seasonal harvesting; and
- Campaign based land management/clearing or biomass aggregation/collection.

Additionally, certain temporary BioHub sites (with skid mounted and transportable plant and equipment) might be established on an occasional/seasonal/campaign basis and operated in any one particular location for only weeks or months each year. The equipment could then be rotated to other sites as required, or a system to aggregate regionally generated manures and effluent streams may prove to be a practical approach to address the issue of multiple small individual effluent generators.

Sustainable Yield Assessment and Certification

The drivers for optimising biomass as a sustainable source of carbon, to replace or supplement fossil resources, stem from the emergence of at least three generic global agendas:

i) Address climate change by avoiding the release of 'fossil' CO_2;
ii) Address natural resource depletion; and
iii) Observe sustainable economic practices.

The growth and production of biomass is essential for the provision of much more than just sustainable carbon molecules to support complex, integrated industrial economies. Such higher order benefits include, at least, the provision of:

- ecosystem services;
- sufficient food and fibre to sustain the global population;
- amenity and recreational services; and
- biodiversity and habitat maintenance.

There are a wide range of competing uses and values of certain biomass supplies. The provision of biomass to provide carbon based molecules to supplement or provide those core or 'drop in' functions currently provided by fossil resources is just one option. As such, the sustainability of biomass yield must be assessed in absolute terms in relation to the requirement that the earth's soils should be **maintained or improved in quality**, but never degraded (unless a satisfactory post use rehabilitation plan is agreed at the time)[4].

Many parties and countries are currently grappling with the establishment of bioenergy/biomass sustainable use and yield standards in the face of carbon being priced in the economy and carbon sequestration being valued and recognised. However the immediate driver is that the final value of any products and services generated from a BioHub will be greatly enhanced where the **sustainability status of the yield of all biomass presenting to a BioHub can be verified, confirmed and/or certified**.

For example, the value of biochar as a sequestration product is dependent on the source materials being sustainably yielded. For example: a metal product is offered to a manufacturer of a retail product as having a 'carbon lite' value (as compared to an identical product made from fossil supplies). Ultimately it is the certifiable sustainability of the yield of the source biomass that enables the manufacturer to market the final product as having a lower carbon profile, and to request acknowledgement of the lower carbon emissions liability in jurisdictions where a legislated price has been put on such CO_2 emissions.

As first point of receival, BioHubs will be ideally placed to assess the source and the sustainability of the yield of all materials presented as the basis for all subsequent downstream sustainability/carbon assessments. **The provision of this expert service will be of tangible value to all parties in a resultant supply/value chain.**

[4] Bioenergy – a Sustainable and Reliable Energy Source – Main Report, IEA Bioenergy: ExCo:2009:06, page 71. www.ieabioenergy.com.

Trading, Brokering – Establishing Fair Value in the Biomass Market

Biomass presents in a wide range of different forms, at different times and for different reasons (**Figure 1-1**). Each form is best suited to the manufacture of different materials, products or energy in response to varying market demand.

The wide range of biomass materials discussed and categorised in Sections 1.3, 2.1 and 3.1 are currently wasted, undervalued or simply lumped together into high level generic categories. They are considered only suitable for leaving on the ground in a passive attempt to return nutrients to the soil, for simple composting or for energy production as a primary activity.

If operated as described in this document, BioHubs will raise awareness of the different properties, characteristics and values of the various biomass types presenting, and establish benchmark pricing for each type. They will also be able to broker volumes of such materials between BioHub facilities and to specialist third parties, such as specialist end users looking for assured supplies.

The establishment of fair value for the various biomass materials and the establishment of a reliable platform to trade and broker supplies of biomass materials is a significant collateral benefit of BioHubs, but one which cannot yet be valued in this initial PFS.

1.4.3 Collateral Services and Benefits Provided by the BioHubs if Operated and Functioning as Proposed

This PFS assesses and evaluates the viability of the core functions of the proposed BioHubs – that is, to value add biomass and provide the essential systems, infrastructure and logistics to channel disparate biomass arisings towards specialised processors and end users. However, a wide range of strategic, commercial and social benefits will also be provided as a result. These benefits are of commercial and economic value but will not be estimated in this PFS other than to be noted for future reference.

i. Adds Value to Primary Activities

By providing the cost effective and sustainable realisation of lasting value from wastes, residues or surplus biomass sources (Section 2), the efficiency and sustainability of the respective primary activities will be enhanced and their viability improved.

Even biomass sourced from special purpose crops (Section 2.6) will benefit from accessing established systems, infrastructure, markets and trading values.

ii. Supply Assurance for Specialist End Users

Many of the potential end uses and markets for specialist biomass derived products (Section 3) are currently unviable to initiate because suitable supplies, by quality and quantity, are not available. Lack of availability may be in either absolute terms or for all practical purposes, due to geography and/or the lack of the supportive logistics systems.

BioHubs will create tangible value by being able to provide contracted supply assurance to end users or specialist processors.

iii. Platform for Continuous Technology Development

The emerging supply/value chains for the various sources of biomass, from generation, harvesting, processing and final product manufacture to ultimate use and application, are providing a rich framework of need and opportunity for a wide range of technology developers and vendors.

The proposed BioHub concept will provide at least two crucial benefits to such technology developers and vendors:

a) Better scoping and definition of the actual functional specifications at each stage of the value chain, for which new or improved technological solutions are required; and

b) Offer actual sites where pilot or demonstration technologies can be applied to fast track their logical development and commercialisation, without necessarily needing to secure their own supply and off take arrangements during the nascent stages of their development.

iv. Encourage and Facilitate the Highest Net Resource Value (HNRV) Realisation of all Biomass Materials under Management

Due to the disparate nature of existing biomass supplies there is a natural tendency for the emerging biomass processing sector to overlook or oversimplify the wide differences in biomass types or the wide range of end products needed and possible, and focus on products like simple bioenergy.

This situation arises because biomass supplies are not readily differentiated or reliably available, or the potential end markets are not yet commercially established.

The BioHubs are proposed to address this issue in detail and create tangible value in the process.

v. Supports Agroforestry, Vegetation Management & Sustainable Land Use Programs

The broad range of land management activities that involve invasive species management, reforestation, and revegetation of riparian zones, shelter belts, ridge lines and biodiversity/wildlife corridors etc., are all activities that have the potential to yield sustainable supplies of biomass as a supporting or collateral benefit to the primary objective (see Section 2.5.2).

Having a local BioHub would open up options for land owners and managers that can improve the viability of the primary activity by ensuring that surplus biomass can be delivered for fair value to a local BioHub. This capability could be a defining benefit for the proposed BioHub.

This provision of service by the BioHubs has a parallel in the cropping sector, where the railhead silo infrastructure capacity addresses the ready access to markets for cereal growers, who are then able to concentrate on the core business of growing the crop.

In the case of ‘woody weeds’ or Invasive Native Species (INS) management, progress is often limited by the availability of funds. Assuming regional BioHubs are economically viable and able to offer fair value for the biomass from woody weed management, then there may be more scope to ensure best practice regulatory, environmental and weed management outcomes can also be achieved.

vi. Direct Support for Urban Waste Minimisation Programs

Australia currently produces some 30 Mt/pa of urban waste, of which about 60% is ‘biomass’. In the Northern Rivers region the 6 Councils currently produce some 160kt/pa. If this material is separated from the balance (plastics, metals and inerts etc.), the considerable societal cost of disposal and treatment would be greatly reduced or eliminated, and significant resource recycling would occur in support of the sustainable circular economy.

The biomass fractions of urban waste streams fall into certain generic categories:

- Timber/wood waste;
- Garden/green waste;
- Organic fraction in residual waste streams; and
- Biosolids.

All of these can be accepted, treated and converted into value added products at a BioHub as a specialist service for respective local communities when delivered by expert and experienced BioHub operators.

Attachment B, is a Discussion Paper provided to outline, for future Regional Strategic Waste planning purposes, modern concepts and strategies and approaches to:-

a) Systematically optimising resource recovery from urban waste streams in the pursuit of the 'circular economy'; and
b) Provide a logistic pathway for 100% of biomass arisings to be systematically value added and achieve HNRV.

1.4.4 Defining Characteristics of Biomass as a Process Input

Consensus in the literature and as adopted by the International Energy Agency (IEA), lists five generic sources of biomass for the purposes of this PFS.

1. **Forestry and Agricultural <u>harvest</u> residues** – Characteristics: seasonal or campaign availability but homogeneous by-product of core activity.

2. **Forestry and Agricultural <u>processing</u> residues** – Characteristics: regularly available, homogenous and geographically concentrated but a supply pushed by-product.

3. **Urban waste streams** – Characteristics: end of (first) life arisings to be recovered as reliable, but heterogeneous flows via streaming/cascading systems.

4. **Land Management & Development Arisings** – Characteristics: one-off or irregular arisings of potentially high value homogeneous biomass.

5. **Specially grown or generated biomass** – Characteristics: highest quality, reliably available but most expensive as primary production costs to be recovered in sale of materials. Needs cost effective outlet for by-products.

Potential biomass supplies for this NRBP PFS project will adopt the same structure.

The main point of interest from these five generic sources of biomass is that #1–#4 all present as wastes, residues or by-products of some other primary activity, such that if the primary activity ceases, expands or alters in any way, the resultant wastes will alter as well.

This issue highlights the broad spectrum of conditions which will determine the variability that a regional BioHub must acknowledge and manage.

Biomass Supply Characteristics

- ➢ Ubiquitous – but disparate, low bulk/energy density (value add before transport);
- ➢ Presents in myriad of different forms – all with quite different HNRV applications;
- ➢ No uniform ‘sight unseen’ market – as a generic commodity;
- ➢ HNRV end markets awaiting assured supply – vice versa;
- ➢ Currently affordable supplies are by-products and residues – not the primary products; and
- ➢ Zero systems and infrastructure to address these issues (compare cereals or scrap metals).

Biomass Source	[1] Sustainability of biomass yield	[2] $ Value/gate fees likely to be realised at the gate of the initial processing centre (or BioHub)		[3] Reliability/predictability of supply or availability			[4] Relative quality of material	
		Input materials that pay a disposal fee to the facility operator	Input materials that need to be paid for					
		$200+	0 -$200	365 days/yr	Regular but seasonal	Sporadic, campaign based, unreliable	Homogeneous	Heterogeneous
1. Agricultural & forest residues	Essential prerequisite for all sources if the benefits over using fossil resources are to be fully achieved and monetized.		0-----------150			X	X	
2. Downstream processing of agricultural & forest materials		(30)-----------100		X	X		X	
3. Urban wastes								
a) MSW organics		(100)----------0		X				X
b) Green/garden wastes		(50)----0		X		X	X	
c) C&D/C&I wood wastes		(60)-----0		X				X
4. Land management residues								
a) Development/infrastructure maintenance operations		(20)-----50				X	X	
b) Woody weed/land management sources		(20)-----50				X	X	
5. Special purpose plantings								
a) Agroforestry			0------80		X		X	
b) Dedicated plantations			50-------150	X	X		X	
c) Algae and similar			50-------150	X	X		X	

Figure 1-1: Biomass ‘supply’ characteristics

- ➢ In addition to the characteristics in Figure 1-1 there is the issue of optimising the end uses of whatever biomass supplies are attracted to a BioHub.
- ➢ Figure 1-2 helps prioritise the end use applications given that biomass can never fully meet the market demand for all products and services currently met by fossil fuels (Section 1.1 (iii)). Channelling ‘bio’ products to applications that cannot be provided by the other purely energy generating technologies is therefore project defining.

Biomass – the Sustainable Competitive Advantage

Table 1: Comparison of benefits and properties of non fossil sources

Low carbon energy sources	Features/Properties								
	A	B	C	D	E	F	G	H	I
	Renewable	On demand supply	Heat	Power	Gas	Oil	Char	PetroChem industry manufacturing precursors	Potential to be Carbon negative
Fossil fuels with sequestration		✓	✓	✓					
Hydro	✓	✓		✓					
Wind	✓			✓					
Solar – thermal	✓		✓	✓					
Solar – PV	✓			✓					
Geothermal	✓	✓	✓	✓					
Wave/Tidal	✓			✓					
Nuclear		✓	✓	✓					
Biomass	✓	✓	✓	✓	✓	✓	✓	✓	✓

Whilst <100yrs biomass can be converted to fulfil all the roles currently provided by fossil resources – there is nowhere near enough – so should be applied to highest and best uses – bioenergy as a by-product.

Figure 1-2: Biomass – the sustainable competitive advantage

- Figure 1-2 suggests that focusing on the potential benefits of biomass (columns E-I) and leaving other low/no carbon energy sources to focus on pure power/energy, will better optimise the value and beneficial influence of whatever biomass sources can be sustainably secured.
  - Lastly, one defining characteristic of a supply/value chain in which surplus biomass supplements or replaces fossil fuelled production/manufacturing systems is its broad based, multi sources nature (Figure 1-3).

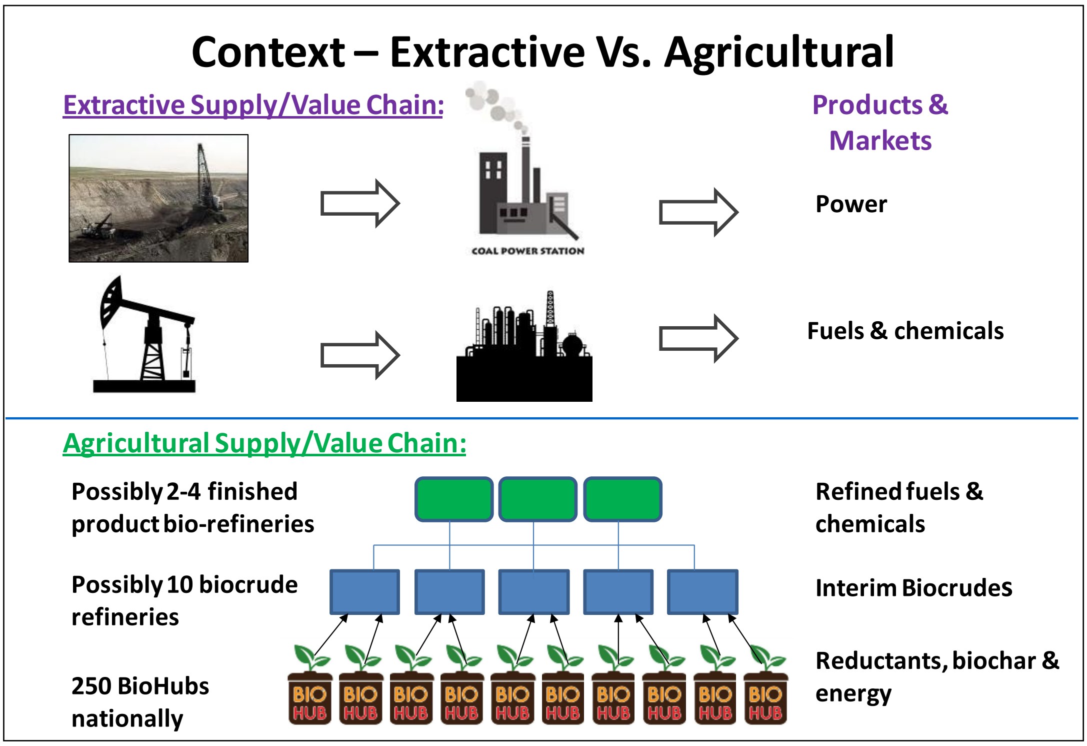

Figure 1-3: Context – extractive vs. agricultural supply/value chains

- For the manufacture of products and services from fossil fuels, the initial resource is energy concentrated and available from clearly identified mines, or wells, and the conversion facilities are well established to fully satisfy market demand (as shown above the line Figure 1-3).
- In contrast, to make similar products from biomass is effectively an agricultural (multi source) supply chain. This important difference helps define the form, function and value of the BioHub systems and infrastructure response, and highlights that the establishment of a viable and cost effective 'Bio Economy' will require optimal logistic efficiency to overcome the inherent emerging concentration of fossil resources.

2. Regional Assessment of Potential Sources of Biomass

2.1 Introduction to Generic Issues

The previous 'desktop' scoping study[5] has identified a wide range of potentially suitable/available sources of biomass that could be applied for higher net resource value (HNRV) applications including bioenergy (in all its forms) and resultant 'bio' products. Most of these identified materials are currently presenting as wastes, residues or by-products of some other 'primary' activity, such as:-

- Forestry residues;
- Sawmill wastes and residues;
- Arable agricultural harvesting and processing residues;
- Horticultural;
- Intensive animal husbandry manures, wash down wastes and residues;
- Abattoir effluents;
- Urban waste streams (organic fractions)
- Land/vegetation/weed management arisings.

Biomass of these types will currently be spray irrigated, spread to land (with varying degrees of pre-processing), left unrecovered on site, and/or lost to atmosphere, all usually representing as 'least cost disposal' outcomes for current owners/generators.

Whilst the 'scoping study' has identified most of these generic material flows, the work for this PFS has been to **interview the individual owners/generators of these materials to:**

- Specifically determine what it would take for them to make such materials available as regular inputs into a regional bio economy if it was established to extract the optimum value from such materials;

- Whether the biomass materials could present a 'sustainable yield' of materials to the proposed BioHub (see RIRDC document www.ecowaste.com.au Sustainability Issues).

- Identify the actual characteristics of the materials in terms of, qualities, quantities, reliability of supply, current pricing structures etc., so that, ultimately, the net benefits of the proposed BioHub network to the current bio-waste generator, can be adequately presented and quantified, as compared to Business as Usual (BaU).

The following information has been researched and collected:-

a) In direct interviews with current generators;
b) The listed reference material; and
c) Certain specific research tasks undertaken to support this PFS.

At the end of each sector section the 'carry forward' values are recorded for subsequent inclusion and/or synthesis in Section 4.

In each instant the quantified biomass materials are noted as **Contractual** or **Merchant**. This classification refers to the probability of an identified bio waste stream being able/likely to be **C**ontractable, as an assured input/supply for the purposes of financing any subsequent facilities, and **M**erchant, refers to identified waste streams where the current generator would be most likely to

[5] NSW North Coast Bio Energy Scoping Study (Ison et al, 2013)

supply their waste streams to any specialist new facility, once it was established and operational. These **M**erchant waste streams are unlikely to be available with a level of certainty necessary to support subsequent plant financing; except perhaps in aggregate, where many such waste streams might be discounted to support a minimum 'supply' quota.

2.2 Ag and Forestry Harvest Residues

2.2.1 Forestry Harvest Residues

NB: Forestry is a major activity in and surrounding the Northern Rivers region and is addressed at multiple points in this PFS:

2.2.1	*Harvest residues*
2.3.1	*Process residues – saw mills*
3.1	*Bioenergy markets*
3.2	*Biochar/fertilizer markets*
3.3	*Charcoal markets*
3.4	*Pretreated lignocellulosic supply opportunities*
4.2	*Proposed/possible sites*
4.3	*Proposed bio products range and mix*
4.4	*Proposed process and operational nodes*

The report 'The Private Native Forest and Plantation Resource of the NSW Northern Coast', 2002, prepared by Northern NSW Forestry Service (Casino) was updated 2008 and entitled 'Commercial Development of the Native Forest, Plantations and Processing Residues in Northern NSW'.

Currently NSW DPI (Forestry) is undertaking a detailed new assessment and report, but the information will only be available in 12-18 months. Given that the Casino catchment may not be individually identified so the data from the 2008 report is referenced herein, with additional information provided by Fabiano Ximenes , DPI (Research Scientist, Forest Science, Land & Water Resources) at a meeting 2/3/16 and subsequent correspondence.

Table 2-1: Estimated available residue resource from native forest and plantations in the Casino Catchment, 2008-2020

		Estimated Residue Availability per annum (tonnes)							
		Small Logs				Other Residues			
Radius around Casino (km)	Time Period	Native Forest	Hardwood Plantation	Softwood Plantation	Total	Native Forest	Hardwood Plantation	Softwood Plantation	Total
0-50	2008-2010	2,440	460		2,900	44,390	1,410		45,800
	2011-2015	2,660	2,490		5,150	44,890	12,230	3,270	60,390
	2016-2020	2,280	18,530		20,810	44,010	61,720		105,730
51-100	2008-2010	5,690	2,940		8,630	51,090	9,620		60,710
	2011-2015	6,200	17,190		23,390	52,260	45,060	3,820	101,140
	2016-2020	5,320	65,940		71,260	50,200	178,480		228,680
101-150	2008-2010		560		560	540	1,300		1,840
	2011-2015		13,570		13,570	540	23,340	2,110	25,990
	2016-2020		10,070		10,070	540	39,950		40,490
151-200	2008-2010								
	2011-2015								
	2016-2020								

Assuming that 'tops' are left on the forest floor for primary nutrient recycling and to contribute to erosion control outcomes (even though surface water usually runs under such surface material), only the 'small log' quantities will be considered. These materials used to sustain the now discontinued pulp wood/chip activity – as a benchmark for demonstrating net economic value.

And of these 'small log' quantities (2016-2020) from within a 100km radius, only 50% will be carried forward for further consideration to compensate for recovery and access difficulties for some of the material and to allow for a level of competition for the resource if it emerges.

Table 2-2: Forestry (small log) residues

Material	Potential kt/pa Available (as small logs)	Approx. Cost Delivered to Regional Facilities ±10%	Status – Contractable/ Merchant
Small log residues within 100km radius of Casino (Predominantly Spotted Gum 30% and Blackbutt 70% both quality hardwoods)	35 kt/pa	$50/tonne	Contractable

NB: Early feedback from the current reassessment indicates that at least 100 ktpa of residues will be available 2020 onwards. So this estimate represents a conservative initial commitment.

2.2.2 Sugar Cane Trash

NB: Sugar production in the Northern Rivers is a major regional industry and is addressed at multiple points in this PFS:

2.2.2	*Harvest residues – trash*
2.3.2	*Process residues – bagasse*
3.5	*Potential bio markets*
4.2	*Proposed sites*
4.3	*Proposed bio products range and mix*
4.4	*Proposed process and operational nodes*

The primary **harvest** residue from sugar cane production is referred to as cane trash, which is the leafy, non-cane material that is traditionally (and currently in Northern Rivers) burnt off prior to harvest, and/or left on the ground during harvest.

More recently 'green harvesting' techniques have been trialled whereby all the trash can be harvested with the cane and transported to the local mill, so as to consolidate the potential resource in one place, to facilitate subsequent uses for the material. This is most likely to be as a fuel source, at least initially, although due to the very reliable homogeneity of this material, the HNRV application of this material may turn out to be so much more than just a crude fuel applied to just raise steam.

In this consolidated form, at the mill, the material presents with a CV value of 9.1GJ/t (wet basis).

By not burning the trash in the field the negative resultant emissions are avoided, and the full energy and resource value subsequently presents at one convenient, centralised location which should encourage appropriate reuse options. However, this tangible benefit must be offset to a certain extent by the measurable lost efficiency in the harvesting and transport operations due to the handling cost of non-productive cane material.

Table 2-3: Sugar Cane Trash

Material	Potential kt/pa Available	Approx. Cost Delivered to Regional Facilities ±10%	Status – Contractable/ Merchant
Trash Available:- From Condong Hinterland	55 wet basis	$30 - $35/t	Contractable
From Broadwater Hinterland	90 wet basis	$30 - $35/t	Contractable
From Harwood Hinterland	75 wet basis	$30 - $35/t	Contractable

NB: Sunshine Sugar is actively reviewing the best options for the use and application of all trash currently being generated.

2.3 Ag & Forestry Process Residues

2.3.1 Forestry – Saw Mill Residues

Currently some 2,050 tpa of sawmill residues are shown to be allocated to existing markets (Table 2-4) but since this report was published (2008), local aggregators have entered into supply contracts to provide much of this material to Cape Byron Power (CBP) (Condong and Broadwater) to provide additional 'supply' to the two co-gen plants.

In a fully informed and freely traded local Bio Economy, such materials would be channelled to their Highest Net Resource Value market, and these homogeneous residue materials may find higher value applications other than being just applied to raise steam at a sugar mill. But until such options have been established, these materials are currently being applied for:

- Composting blends;
- Animal bedding; and
- Co-gen fuel.

Table 2-4: Estimated annual volume of processing residues 2008-2020, Casino Catchment

		Estimated Processing Residue Volumes (tonnes/annum)						
		Currently allocated to markets				No current markets		
Radius around Casino (km)	Time Period	Sawdust/ shavings	Woodchip	Other	Total	Sawdust/ shavings	Offcuts/ dockings/ boxed hearts	Total
0-50	2008-2010	45,850	48,570	3,770	98,190	280	21,360	21,640
	2011-2015	45,850	48,570	3,770	98,190	280	21,360	21,640
	2016-2020	45,850	48,570	3,770	98,190	280	21,360	21,640
51-100	2008-2010	2,050			2,050	240	3,000	3,240
	2011-2015	2,050			2,050	240	3,000	3,240
	2016-2020	2,050			2,050	240	3,000	3,240
101-150	2008-2010	8,510			8,510	2,840	16,830	19,670
	2011-2015	8,510			8,510	2,840	16,830	19,670
	2016-2020	8,510			8,510	2,840	16,830	19,670
151-200	2008-2010							
	2011-2015							
	2016-2020							

So in estimating a carry forward total for such materials, as might be available for 'BioHub' applications, the volumes identified in 2008 as 'no current markets' have been discounted by 50%.

NB: The current study will confirm the appropriate final values in 12-18 months.

Table 2-5: Saw mill residues

Material	Potential kt/pa Available	Approx. Cost Delivered to Regional Facilities ±10%	Status – Contractable/ Merchant
Saw mill residues	10 kt/pa	$50/tonne	Contractable

2.3.2 Sugar Cane Bagasse

After crushing the harvested cane and extracting the sugar content two primary processing residues present:-

a) Mill mud – the soil washed off the cane; and
b) Bagasse – the fibrous lignocellulosic residues of the crushed cane.

The Mill mud is traditionally returned to the growers to re-apply back onto the cane fields from which it originated.

Historically the bagasse material has presented as a bulky waste material and was originally burnt in boilers on site to raise process/steam and drying heat, whereby a process design feature was to simultaneously 'least cost' dispose of the bagasse such that after raising the necessary process heat there was little left except the ash, which, when combined with the Mill mud was reapplied to cane fields.

In more recent times boiler designs have been much more focussed on thermal efficiency and much of the bagasse generated has thus become surplus to this basic need and so could be put to other uses, including:-

- Dedicated power generation for offsite third party applications and grid connections;
- Packaged garden mulches for the garden centre market;
- As a homogenous substrate to manufacture liquid fuel products; and
- {CSR Pty. Ltd branched out into the building materials business based on their 'canite' wall and ceiling-board product range, made from bagasse all that time ago.}

Currently Sunshine Sugar provides all the bagasse it generates, under contract to CBP as a simple fuel for the two 30MW Co Gen plants, one at Condong and one at Broadwater. But as with cane trash, bagasse presents as a very reliable and homogenous raw material into the emerging Northern Rivers Bio economy, and as a material, it probably retains a HNRV much higher than can be achieved as a basic fuel for raising steam – if replacement, lower value materials could be reliably identified to perform the basic steam raising function.

Table 2-6: Bagasse

Material	Potential kt/pa Available	Approx. Cost Delivered to Regional Facilities (wet basis)	Status – Contractable/ Merchant
Bagasse from Condong	150 wet basis	$30 - $35/t	Contractable
Bagasse from Broadwater	250 wet basis	$30 - $35/t	Contractable
Bagasse from Harwood	225 wet basis	$30 - $35/t	Contractable

2.3.3 Tea tree Process Residues

Tea Tree is a native, grown as a permanent crop that is harvested annually for the extraction of the Tea Tree oil as the primary activity.

Harvesting involves removing all new growth each year, leaving just the root stock.

The harvested annual growth is then processed to extract the essential oil leaving a fibrous process residue.

Some 2,000ha are grown in the study area in three main areas, Rappville, Bora Creek and Tweed.

A further 700ha is grown in the Grafton region.

Residue is generated at approximately 60t/ha, which equates to:-

a) Study area – 2,000ha x 60t/ha/pa = 120,000t/pa
b) Around Grafton – 700ha x 60t/ha/pa = 42,000t/pa

This material is traditionally stockpiled after oil extraction at a smaller number of sites.

'Off the pile' sales for mulch products realises some $10 - $20 m^3 in the study area and some $23 - $28 m^3 for material destined for the Sydney market – sourced from Port Macquarie and Grafton regions.

However, current estimates are that with current stockpiles and annual production rates, some 100-120kt/pa could be available from the study area for processing into higher value products, if such facilities/capabilities were established in the region.

Table 2-7: Tea Tree Residues

Material	Potential kt/pa Available	Approx. Cost Delivered to Regional Facilities ±10%	Status – Contractable/ Merchant
Tea Tree fibre	100-120kt/pa or part thereof	$30 - $35 per tonne	Contractable

As support for the discussion of potential 'Bio' markets (3.2) the Tea Tree sector is currently formulating what the 'ideal' fertilizer or production input regime might be in the medium to long term.

Currently 'basic' chicken litter products are broadcast each year as the most usual practice (see 2.3.4) being a permanent crop and with lateral root structures near the surface, top dressing is preferred to drilling product into the ground.

SCU, DPI are currently developing a range of chicken litter/biochar products that could reduce loses to atmosphere and provide a more balanced and slow release product for the future (see 3.2).

2.3.4 Poultry Litter

The poultry sheds in the region are operated under two major brands – Inghams and Darwalla (approximately 40-45% market share each) with some minor independent operators. Tatham Poultry runs a specialised shed clearing service for the Ingham sheds.

This operation services approx. 40% of the sheds from Casino to the coast recovers some 16,000m^3 t/pa from the various shed types (meat, eggs, hatcheries, etc.)

The resultant material averages 50% manure 50% litter. The respective sheds receive \$3-\$5m^3 for the raw material and sells the resultant material to growers (nuts, tea tree etc.) for some \$25m^3 sometimes as blends, or raw, mature or composted (NB: approx. 2m^3 = 1t).

Dead birds are mostly sent to A.J. Bush (Beaudesert) for rendering.

Since Tatham Poultry represents some 40% of the total market, Table 2.3 represents an order of magnitude estimate of the chicken litter arisings from the study area.

Table 2-8: Poultry Litter Arisings

Material	Potential kt/pa Available	Approx. Cost to Central Facilities ±10%	Contractable/ Merchant
Poultry litter most meat, but some layers and limited hatcheries	32,000m^3/pa (or 16kt/pa)	\$25/m^3	Contractable

2.3.5 Piggeries

A theme of this PFS is to not only assess the potential to generate bio energy and related bio products, but to do so in the context of:-

a) Addressing specific issues and barriers for the respective waste generators and, if possible/practical
b) To provide solutions that could underpin the current and future growth of the respective industry sectors.

Since there are some 16-20 individual piggeries in the study area, all of which generate reliable quantities of effluent and manure slurries, suitable as inputs into a regional BioHub system, some effort has been made to research and understand the current issues from the piggery operators' perspective.

The core information summarised below is based on:-

a) Detailed discussions with individual piggery operators;
b) The Strategic Plan for the Development of the Pork Industry within the Northern Rivers Region of NSW, 2015;

c) A fact finding visit to the UQ piggery Gatton; and
d) APL – Strategic Plan 2015-2020.

All of which is synthesised and summarised as follows.

Context and Background

The pork sector in Northern Rivers represents only some 16-20 producers out of some 1,868 nationally and only some 36,000 pigs compared to some 2.5M nationally – in other words, only some 1-2% of the sector nationally.

However, the local pig meat sector is highly regarded and is not only an important regional industry, but, most importantly for the purposes of this PFS a project, significant generator of manure slurries and effluents that could greatly assist the region to establish a commercially significant Bio energy/ Bio products sector.

Current practice at most piggeries is for manure slurries and wash-down waters to be stabilized in onsite pondage (anaerobic and/or aerobic) with 'treated' water spray irrigated onto pasture, such that basic nutrients are recovered in the receiving soils and the settlement ponds are cleaned out every few years with the mature sludges also spread to pasture.

In simple terms, this approach represents 'least cost disposal' rather than an approach that proactively and systematically:-

- Minimises manure management costs for the growers
- Controls odour and amenity issues
- Optimises pasture productivity, or
- Captures the inherent bio energy/bio nutrient potential, and
- Releases CO_2 to atmosphere without capturing the full energy generation potential, or recognising the negative impacts.

Further, the 2015 'Strategic Plan' records growers listing:

- Challenging approvals processes for new piggeries
- Licencing and compliance issues
- Odour and effluent management concerns

All crucial issues to be addressed to advance the sector in the region.

In addition as these crucial issues negatively influencing the logical development of the sector (Some local producers indicated that summer fertility of sows is an emerging problem, due to heat stress – one producer advised that last summer 70% of mated sows failed to hold their piglets) and, as presented as an essential future necessity in pork production (UQ, Gatton, Jan 2016 Mark Bauer), increasing levels of climate control have been identified as a major emerging trend from now on, to address:-

- Livestock amenity and healthy herd objectives
- Livestock productivity
- Improved odour control
- Improved staff working conditions

But all this will come with increased energy demand.

In summary, the potential benefits to regional pork producers, of a systematically designed and implemented regional bio economy should include:-

i) A pathway to optimise bio energy production from their own, and other regional effluent streams.
ii) A system for optimising paddock productivity (precision farming objectives).
iii) Optimised control of odour and run off issues to facilitate new facility approvals and existing facility licencing requirements.
iv) Optimise livestock care and welfare issues to support niche product branding etc.

Table 2-9: Piggery Waste

Material	Potential kt/pa Available	Approx. Cost to Central Facilities ±10%	Contractable/ Merchant
Manure slurries and effluent	40,000SPU x 10L/ day = 146,000 t/yr or approx 14,000 t/ yr slurry	\$80 -\$100/t	Contractable

These objectives and data sets will be addressed in Section 4.

Figure 2-1 shows existing piggeries as distributed throughout the region with approx. pig numbers (SPUs) at each.

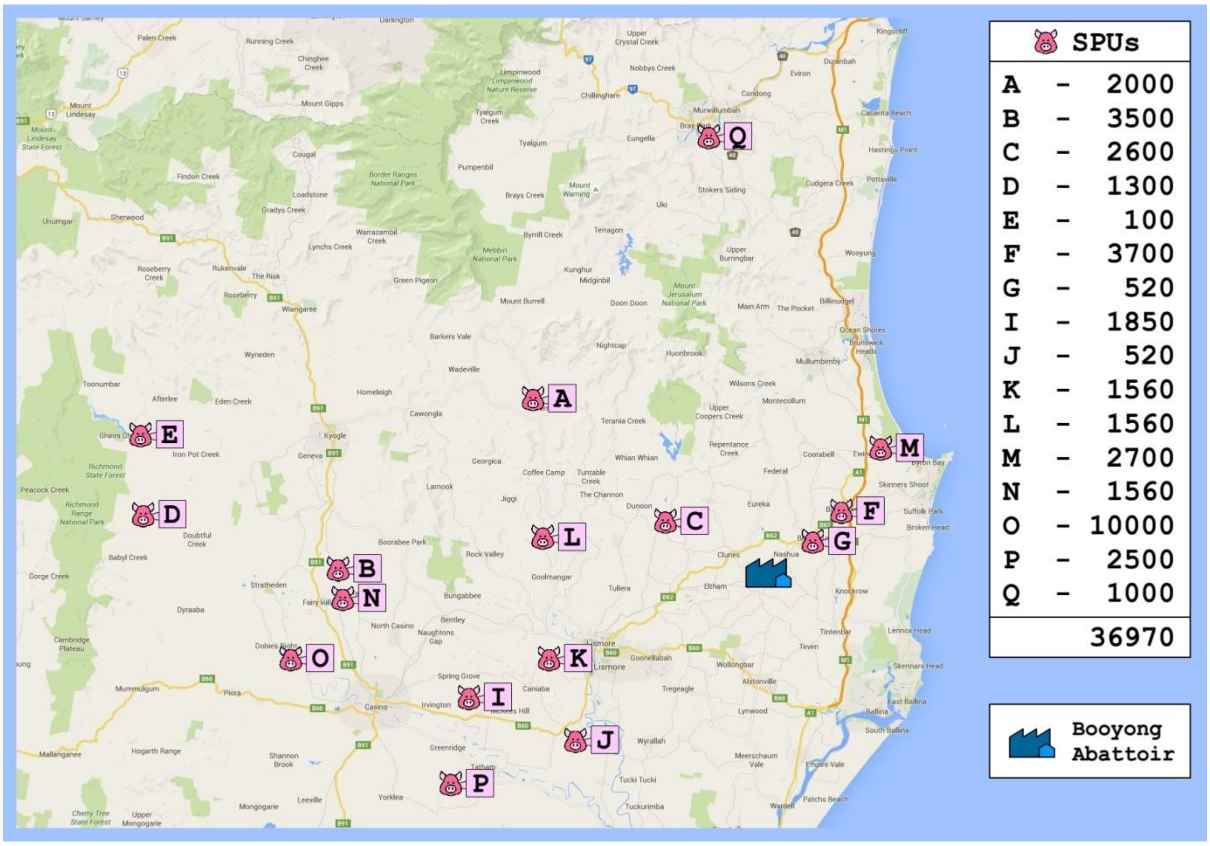

Figure 2-1: Regional piggery locations

As will be discussed and synthesised in Section 4, Figure 2-1 suggests four logical regional centres for the processing of pig manures and effluents, in combination with other suitable sources of Bio wastes, centred on:

Casino – E, D, B, N, O, I, P, = **20,810 SPUs**

Nimbin – A, L = **3,560 SPUs**

Booyong – K, J, C, G, f, M = **11,600 SPUs**

Murwillumbah – Q = **1,000 SPUs**

This information will be carried forward into Section 4.

Whilst all local piggeries currently use variations of the anaerobic/aerobic pond system, with final waste water and matured sludges sprayed/spread to local pasture, in aggregate some 40,000 pigs in the region have the potential to produce some $400,000 pa of electricity – as Table 2-10.

Table 2-10: Energy from piggery effluent

Parameter	Units	Average commercial operation
Scale of piggery	No sows	500
	SPU[1]	5,000
Volatile solids production[2]	Kg/day	1,233
Methane generation[3]	M^3/day	395
Energy[4]	MJ/day	14,123
Electricity (daily)[5]	kWh/day	1,034
Electrical output	kW	43

Assumptions	
Parameter	**Factor**
[1] Sow to pig ratio (SPU/per sow)	10
[2] VS production (kgVS/SPU/year)	90
[3] Methane conversion rate (m^3/kg VS added)	0.32
[4] Calorific value of methane (MJ/m^3)	35.8
[5] Electricity conversion rate for generator set (MJ/kWh)	13.65
[6] Total number of pigs in commercial production in NSW	940,000

Methane and energy generation per unit of production		
Methane/pig (SPU)	**Energy/pig (SPU)**	**Electricity/pig (SPU)**
28m^3/SPU/year	1,002 MJ/SPU/year	73 kWh/SPU/year

∴ 40,000 SPU x 73 kWh/SPU/year x (say) 10.5c/kWh = $306,600/pa potential value of power from Northern Rivers piggeries – all of which is currently lost to atmosphere under current management practices.

And finally, the digestate from these same effluent streams will contain all the minerals and nutrients that do not convert to the overheads 'Bio' gas phase, which for the 40,000 SPUs in the region will equate to some 90kg/SPU/year – or some 3,600 t/pa.

These values and quantities will now be carried forward to section 4 for synthesis and inclusion in a possible Bio Economy model for the Northern Rivers region.

2.3.6 Dairy Wastes

The dairy sector is a significant regional industry, representing some 6% of national milk production, which itself supports a major regional value adding sector in terms of ice cream and other processed products as well as fresh milk.

The local dairy herd is >11,000 cows located on some 84 farms throughout the region (Table 2-11).

Table 2-11: Northern Rivers dairy herd by LGA

LGA	**Litres of Milk**	**Farms**	**Cow/Farm**	Total Cows
RVC	18,582,276	25	135	3,399
Kyogle	17,000,583	24	129	3,091
Ballina	4,196,102	5	153	763
Lismore	15,544,432	19	149	2,826
Byron Bay	1,736,929	3	105	316
Tweed	4,766,667	8	108	867
Totals	**61,826,989**	**84**	**134 av**	**11,240**

Data as supplied by NSW DPI – Dairy and Intensive Livestock Development Division

From the perspective of addressing the potential for the regional dairy sector to contribute to an emerging bioenergy/bio products sector, Table 2-11 indicates:

i) That the multiple small (<300 cows) farms will most likely benefit from a regional or collective solution rather than each farm seeking to invest in best practice energy recovery and the manufacture of optimally balanced pasture improvement products;

ii) That most of these farms will be standard grazing operations such that most manures are left in the paddocks and only some 10-15% of the total potential manure volumes will be captured in the milking shed wash down waters and laneway maintenance;

iii) That few, if any, of these 84 separate farms are ideally suited to directly pipe effluent systems to a central processing unit;

iv) That the current effluent management practices at all/most of these operations is for anaerobic/aerobic pond systems, with or without a pre-solids trap, and the subsequent spray/spread of stabilized water and solids.

With a regional herd of >11,000 cows spending 10-15% of their time in the milking sheds, Table 2-12 indicates the methane/energy potential if it could be cost effectively harnessed.

Table 2-12: Table Methane/energy potential from regional herd

Manure				Effluent		
Manure as voided (kg/head/day)	TS (% raw manure)	VS (%TS)	Annual load kgVS/head/day	Volume (L/head/day)	Typical BOD concc. (mg/L)	Typical COD conc. (Mg/L)
55	8%	73%	3.2	50	1000-4500 (Av. 1500)	5000-10000 (Av. 6600)

Note: Figures are based on dairy cattle size of 400-500kg.

Table 2-13: Energy potential from dairy effluent

Material	Potential kt/pa Available	Approx. Cost to Central Facilities ±10%	Contractable/ Merchant
Collected small dairy slurries	11,240 cows x 50L/ day = 205,130t/yr = 16,400t/yr residual slurry	\$80 -\$100/t	Contractable

Parameter	Units	Average 'grazing' dairy operation
No. of cows	Head	144
VS production	Kg/day	46
CH_4 generation	m^3/day	18
Energy	MJ/day	652
Electricity (daily)	kWh/day	48
Electrical output	kW	2

Or, for a regional herd of 11,000 cows

Total potential CH_4 generation @ 467m^3/head/yr	Energy/dairy cow 16.7 GJ/head/year	Electricity/cow 1225 kWh/cow/year
5,137,000 m^3/year	183,700 GJ/year	13,475,000 kWh/year

@ 10.5c/kWh = \$1,413,462

Further, on a dry weight basis, 11,000 cows will generate 175,000 tonnes of digestate which could be a crucial input into any subsequent, specialty fertilizer manufacturing/blending plant.

These values and volumes will be carried to Section 4 for synthesis and evaluation.

2.3.7 Regional Abattoirs

The Northern Co-operative Meat Company (NCMC) operates two main abattoirs in the region. The main beef and veal abattoir at Casino (CSP) has the capacity to process some 12,500 cattle per week which equates to some 68,750t HSCW (Hot Standard Carcass Weight – for the purposes of subsequent estimated of waste and effluent stream).

The second plant, a specialised pig abattoir at Booyong, has the capacity to process up to 5,000 pigs per week.

NB: detailed data on the effluent streams from both facilities is readily available from www.ncmc-co.com.au/licences/environment

To better understand the potential to process the entire bio waste/effluent waste streams from CSP, samples were taken 7/3/16 and have been forwarded for detailed analysis and testing. Since the final results are not expected until after this PFS is concluded, the following assessments are based on standard formulas presented in the literature for a 70,000t HSCW abattoir including paunch waste, the 'stickwater' stream from the incorporated rendering plant. The effluent stream from the incorporated tannery (Casino Hide Tanners) CHT has been excluded where waste flows can be identified.

The following is provided as a guide until actual data is generated from the sample currently being tested and analysed:-

- CSP – say 70,000t HSCW facility with a rendering plant and with paunch waste included

Table 2-14: Quantity and quality of effluent from abattoirs

Material	Potential kt/pa Available	Approx. Cost to Central Facilities ±10%	Contractable/ Merchant
Full effluent stream including paunch	980ML/year	TBN	Contractable

	Volume		Chemical oxygen demand (COD)	
	Daily volume (kL/day)	Per unit production (kL/t HSCW)	Concentration (mg/L)	Load per unit production (kg/t HSCW)
Range	130 - 2,150	3.5-12.5	3,000-6,000	11.8-66.52

- Say 60kg COD/t HSCW (including paunch)
- Say 0.352 conversion rate of COD to methane.
  ∴ 70,000t HSCW @11.9m^3 methane/t
  And 31.3kwh/t HSCW = 2,191,000kwh @ say 10.5cents kWh = $230,055

NB: all subject to receipt of actual effluent test results in due course.

In this section, we allocate extra space to exploring the advantages of incorporating, the two local abattoirs respective bio-waste and effluent streams into a framework for the proposed Northern Rivers BioHub network and overarching Bio Economy, since the establishment of some of the 'foundation' infrastructure facilities, such as the proposed AD facility in Casino, will benefit from the direct involvement of certain 'anchor' participants, and NCMC facilities currently generate such sustaining flows of bio-wastes and high BOD/COD effluents.

The task therefore is to:-

a) Understand the current practices, commercial drivers and strategy outcomes; and then
b) Scope an alternative strategy based on achieving HNRV outcomes for the materials under management; and
c) Then demonstrate the full suite of benefits in the event that (b) represents, on balance, a more cost effective outcome than BaU.

A subsequent task would then be to develop a detailed Implementation Plan to actually achieve the identified benefits.

A similar approach has been adopted for other major regional sectors including urban waste streams, the sugar sector and the forestry sector and the combined piggery/dairy sectors.

To put the potential benefits of proposed changes to current bio-waste and effluent management systems into perspective the **current practices** must be compared with the proposed **fully integrated Bio Economy approach**.

2.3.7.1 Current bio-wastes and effluent management systems and practices

The current bio-waste and effluent management systems and practices at NCMC could be described as Best Practice when compared to industry peers, in relation to stabilization of the very reactive primary effluent streams (TS/VS, BOD/COD values) and control of odour/impacts to public amenity.

However, in terms of optimising the resource value of these 'secondary product' streams the current practices could be referred to as 'least cost disposal' systems, in that whilst the high net cost of managing these materials is significantly offset by the realisation of collateral benefits, in terms of irrigation and (stabilized) nutrient recovery, all of the potential 'bio' energy values are dissipated to atmosphere, and even the nutrient recovery by the receiving soils at San Marla farm represents a closely managed balance between the maximum nutrient load allowable vs the ideal application of nutrients, trace elements and micro nutrients necessary for optimised paddock productively.

Figure 2-2 is a generic representation of such medium to large abattoir 'best practice' effluent management.

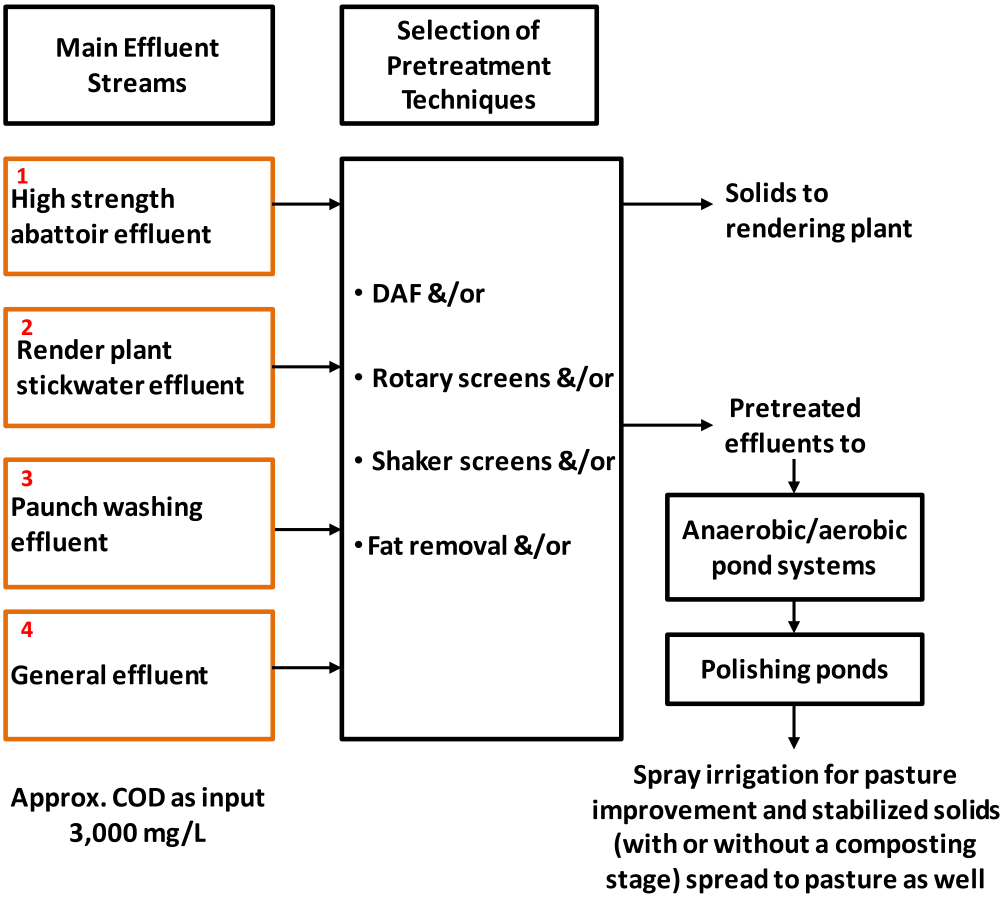

Figure 2-2: Typical medium/large abattoir effluent treatment systems

Result: Sprayed COD approx 100mg/L or 3,000 - 100mg/L = 2,900 mg/L of dissipated energy production potential reverted back to atmosphere without delivering any net benefit to the proposed regional Bio Economy

A goal of developing sustainable and cost effective strategies to embrace the advent of a fully functioning Bio Economy in the region must be to identify and scope the full range of integrated systems and infrastructure (public and private) that will enable all regional primary biomass processing activities to focus on core business, whilst achieving the full benefits from realising the HNRV from all their wastes, residues, effluents and by-products.

The HNRVs inherent in abattoir bio-wastes and effluents include:-

i. Large volumes of water for reuse in agriculture, industry or in any other logical application where potable water quality is not necessary or required;
ii. Bio energy potential, which could be recovered and reapplied in many different ways;
iii. Biogenic carbon sources for reuse to supplement and/or replace 'fossil' alternatives; and
iv. Nutrients, trace elements and micro nutrients all essential to optimised soil productively if applied in measured proportion to defined need.

Figure 2-3 provides a first order schematic of the possible material flows, enabling processing capabilities and generic final product markets to achieve (i) – (iv) above.

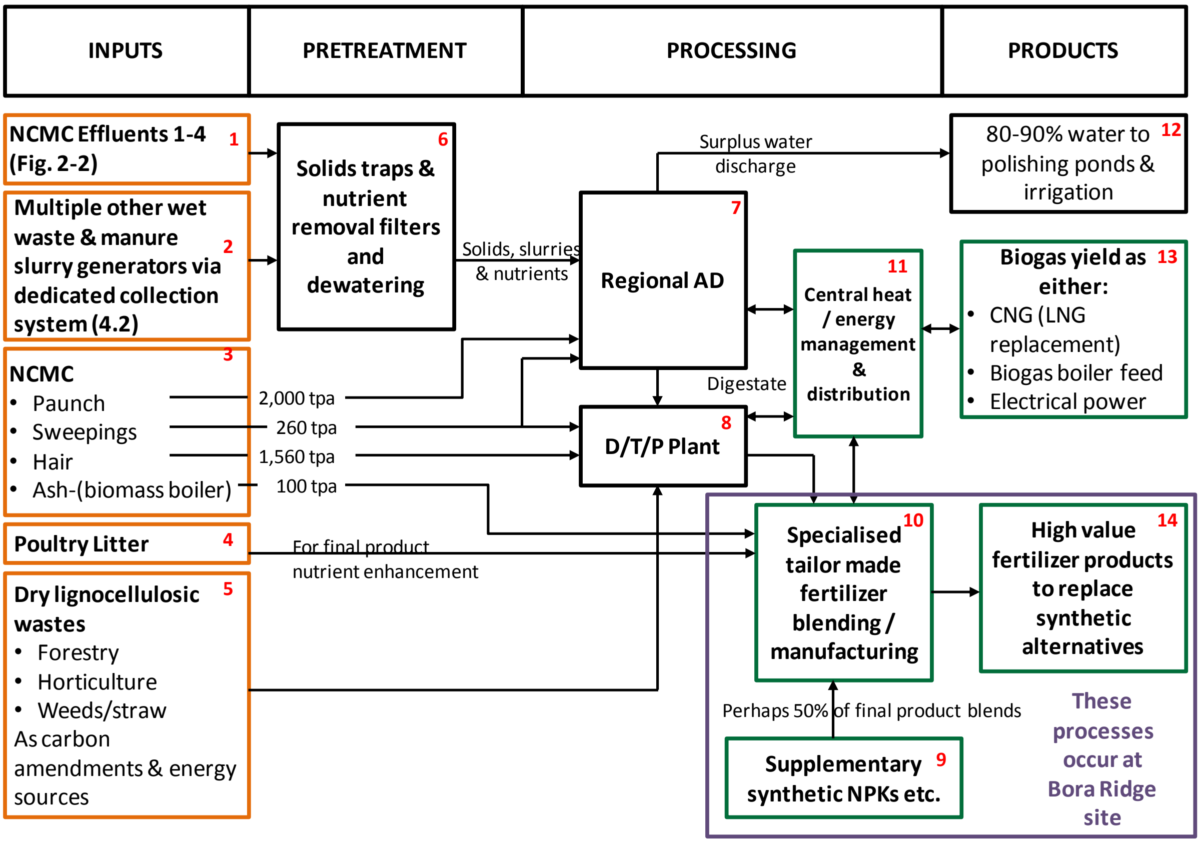

Figure 2-3: A proposed generic approach to effluent treatment to contribute to and benefit from full engagement with an emerging regional Bio Economy

NB: See Figures 4-1, 4-2, 4-3 and 4-4 for site specific Block Flow Diagrams.

The following 'key' provides a basic function or rationale for each of the numbered nodes of activity.

Node 1 *The existing NCMC effluent streams Nodes 1-4 Fig. 2-2.*

Node 2 *To capital justify the proposed suite of specifically commissioned processing capabilities, they should be optimally sized and accept a fully range of input waste streams to ensure that the primary products of Bio energy and biochar based fertilizers are of the highest quality possible – a quality that is most* ***unlikely*** *to be achieved by accepting only one particular bio-waste stream. Multiple (compatible) bio-waste/effluent inputs will also provide 'supply' security for what will be a significant capital investment.*

Node 3 *Such a facility could also beneficially process most other site generated peripheral waste streams, to realise both any bio energy potential with residual solids being converted by Node 8 – the D/T/P capability.*

Node 4 *Regional sourced poultry litter is at once a material currently applied within a 'least cost disposal' paradigm, but also a potentially vital source of Biogenic nutrients for final product blending and manufacture (Node 10).*

Node 5 *Dry lignocellulosic materials are essential for generating bio energy (parasitic load and export sale) and carbon for Node 10 blending and manufacturing.*

Node 6 *AD processing of wet wastes only derives value from the entrained VS/TS, BOD/COD and residual nutrients in the effluents, rather than from the majority H_2O molecules themselves. So to process excess pure water represents a significant capital expense (hydraulic load) for no product benefit. So Node 6 reflects a process to remove solids and dissolved nutrients to the greatest extent practical to achieve the most productive input stream to the subsequent AD processing unit, with the smallest* *tankage possible. Since existing pondage and irrigation systems currently exist, under this scenario, they would continue to be used in a much reduced (biological) duty.*

Node 7 *This AD unit would be sized, scoped and specified for the full range of inputs identified in this PFS, to produce the product range identified in Section 3 and be directly linked to:_*

a) The Biogas clean up and conversion at Node 13; and

b) The D/T/P plant (Node 8) for the HNRV value adding of the resultant digestates.

Node 8 *D/T/P (Drying/Torrefying/Pyrolysis) – such integrated processing capabilities can be applied to drying materials (completely endothermic – <105°C) when required, Torrefying materials (mostly endothermic – <300°C) and Pyrolysing materials (completely exothermic/syngas – <600°C). Such processes can occur in a single, multi stage reactor, or in specialised reactors, and run in isolation or in multi stream configurations (see Fig. 2-4 below) but the two main products will be:-*

a) Individually processed input bio-wastes into solid/charred 'ingredients' each with its own unique properties, to be transferred to individual input silos at Node 10 – for subsequent blending and incorporating into full range of tightly specified fertilizer products for individual customers and agricultural sectors.

b) Syngas as a quality Hydrogen based energy product, for use and application:-

i) To provide the parasitic energy demand for the entire D/T/P process train;

ii) To provide an energy source to Node 11 for redistribution to other of the integrated BioHub processing functions that require heat/power; and

iii) For export.

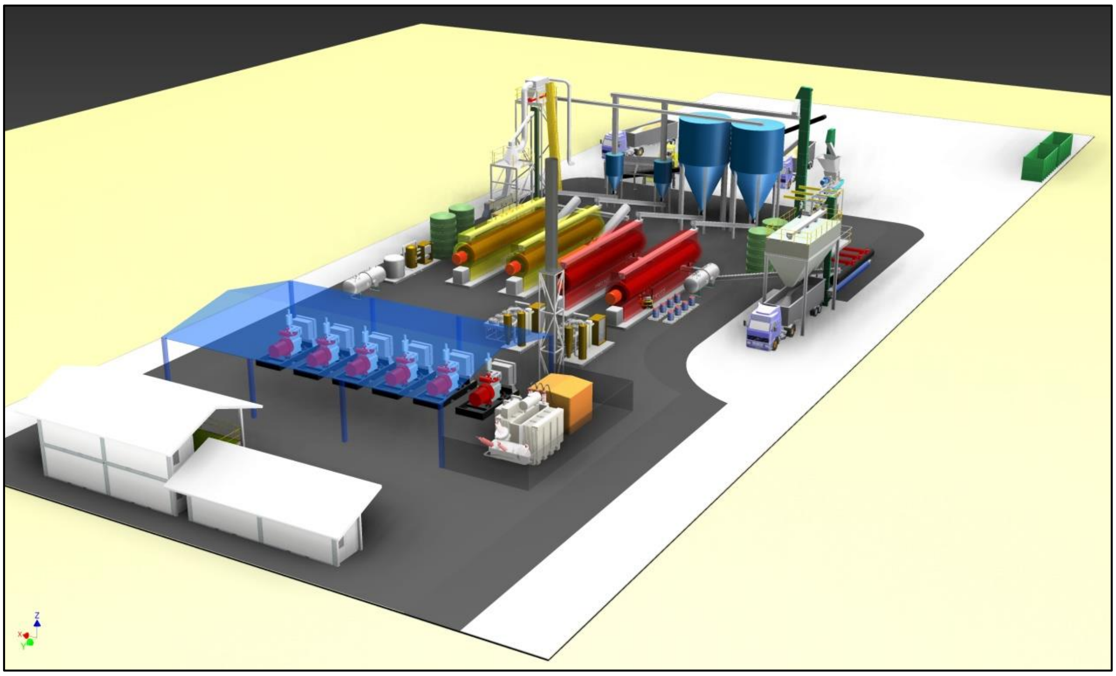

Figure 2-4: Multi train biochar/bioenergy processing facility

Node 9 *Node 10 will feature the product of specifically purpose made/customer specified fertilizer products, to* ***exactly*** *meet their fertilizer requirements for the year. Whilst perhaps 30-50% of the nutrient value for such products will be generated at Node 8, to ensure total compliance with customer requests in every instance, a full range of standard synthetic fertilizer products will be available for inclusion as required to give totally assured product performance.*

Node 10 *As above. This facility is the crucial direct interface with the fertilizer buying market. This facility will receive detailed requests from growers (and their respective agronomists) for high analysis blends* *that they have determined are exactly the optimum blend of primary nutrients, trace elements and micro nutrients for their planned cropping activity for that season.*

The intended value proposition for the grower includes:-

*i) **All the fertilization** and soil amendment needs for the respective crops to be applied with the least number of individual spreading events, to economise on spreading costs;*

ii) Since some 20-50% of the mass and utility and effectiveness of such products, will be provided by carefully prepared biochar products and other non-synthetic minerals, the costs will be reduced per unit of yield when compared with the straight synthetic alternatives;

iii) Wastage through run off or volitation losses will be reduce or even eliminated;

iv) Slow release products can be prepared for specific crops and needs;

v) Sequestered carbon will increase organic carbon levels in the receiving soils;

vi) Products can be prilled and/or pelletized to exactly suit existing spreading/drilling equipment;

vii) pH buffering properties and water holding capabilities can be incorporated into the products as required.

Node 11 Such an integrated BioHub facility will need heat/energy/power harvested from certain operational nodes and redistributed to others from time to time, and surpluses exported in one of a number of different forms. This Node would also host the final single emission point for the site, ensuring complete compliance with operating licence conditions.

Node 12 Existing waste water polishing and spray irrigation operations to be maintained and/or expanded to receive not only the majority of the existing abattoir water stream, but also the final treated water discharge from the new AD unit.

Node 13 The primary BioGas product could be applied for one or all of the following energy product types after gas clean up –

i) BioGas for local boilers;

ii) Compressed as CNG, to be offered to the manure slurry/wet waste providers as a direct LNG supplement/replacement for use on their respective farms for heat/power generation as they see fit;

iii) Converted directly into power for delivering (behind the meter) to local customers, or just supplied via the grid;

iv) As hot water or steam to any local customers with a base load heat demand. This might be existing businesses, or offered as an inducement for new customer(s) to set up adjacent to the BioHub.

Node 14 As 10 above.

Summary

This possible scenario will be considered within the broader regional Bio Economy context in Section 4.

To progress this concept a directly targeted Feasibility Study will be required, after the tasks identified to achieve BPD (Attachment A) in Section 7 have been completed. However, the objective and purpose of proposing the schematic in Fig. 2-3 is to demonstrate that making the transition from 'least cost disposal' strategies, for all the waste, residue or by-product biomass materials acquired in the area will, by necessity, be a complex multi stakeholder undertaking.

A feature of Fig. 2-3 is that considerable investment will be required to produce the HNRV quality assured products for which secure market demand can be demonstrated.

Fig. 2-3 attempts to establish that the capital justification for the expensive new facilities is fully supported by the **revenues generated from the high value products**, and not by **increasing 'disposal' or waste management costs/charges for the original bio-waste and effluent generators** (see Figs. 3.1&3.2). In fact, the enthusiastic engagement and participation of the respective bio-waste and effluent generators will be very problematic if such product driven approach cannot demonstrate a commensurate reduction, or at least capping, of the net costs currently incurred by their current 'least cost disposal' practices.

Such a net benefit to existing bio-waste/effluent generators is fundamentally based on:-

i. Improving the efficiency of use and reuse of the primary water streams involved;
ii. Capturing the full energy potential from these materials, a potential that is currently dissipated to atmosphere as an inevitable consequence of current treatment stabilization techniques; and
iii. Transitioning the nexus between manure/effluent spreading to pasture, as both a waste disposal technique and a pasture productivity improver, into a process much more closely aligned with the prevailing 'precision farming' agenda.

Not only should these three value adding approaches capital justify the integrated BioHub concept and demonstrate recurring operating cost control for the waste generators, but a range of collateral benefits and advantages should also accrue to the host community, such as:-

i. By value adding the bio-wastes of local business, the primary activities should achieve a productivity dividend and improve competitiveness in the local, national and international market place.
ii. Such sustainable Bio Economy outcomes can strongly support participating brands and sector reputations; and
iii. Serve as a driver of economic development to attract similar agro businesses, wood products and food processing activities to the region, as a direct result of achieving an efficient and sustainable Bio Economy reputation.

2.3.8 Food processing and specialised horticulture

During the series of 'waste generator' interviews that were conducted as the platform research activity for this PFS, a great deal of company and/or sector specific information was provided and collected.

This information has provided the necessary information relating to the individual waste flows and how an integrated BioHub network in the region would benefit both the existing 'bio' waste generator and the viability of the proposed BioHub facility.

However in most instances where an installed BioHub capacity was established and operational, that:-

i) Includes conveniently accessible wet waste processing/value adding facilities – linked to real markets;

ii) Includes conveniently accessible dry lignocellulosic processing/value adding capability – linked to real markets; and

iii) Is designed to service the main 'choke points' in the existing bio-waste material flows, such as STPs, landfills and major 'anchor' biomass generating businesses, sectors and industries.

Then the respective food processing operations would be in a position to optimise their respective needs and opportunities to participate beneficially.

All the wet waste food producers currently operate trade waste contracts with their respective councils such that the receiving STPs are adequately providing 'least cost disposal' services and in some instances rely on these major effluent flows to balance their operations.

On the other hand the permanent horticulture growers present both potential sources of biomass inputs into the proposed Regional BioHub Network and simultaneously offer specialist fertilizer and mulch product markets.

2.4 Urban Waste Streams

2.4.1 Introduction and Vision

As discussed 1.4.3(v) urban waste streams contain <50% biomass. Within the traditional/historical approach (Attachment B page 2) these materials have generally been managed for 'least cost' treatment and disposal. Often this management approach results in the production of composts or spray irrigation products that can demonstrate some residual value, but within the context of the emerging 'bio economy' the opportunity now exists to plan in the short to medium term for medium to long term outcomes that will see these same materials achieving a significant portion of their inherent highest net resource value.

To this end, attachment B is provided:-

a) To canvas the concepts, principles and strategies that will ultimately inform a systematic transition from 'least cost treatment and disposal' outcomes, to systematic HNRV application for these same materials as inputs into the 'bio economy; and

b) Provide a guide to the development of future Regional Waste Management Strategies for not only the <50% of biomass in such urban wastes, but also for all the other non-biomass material streams that would be liberated and aggregated in the process.

The biomass fractions of urban waste streams include:-

i) Domestic garden/green wastes;
ii) Domestic food and small garden wastes;
iii) Residual biomass materials presenting in the residual waste bins;
iv) STP sludges and biosolids;
v) Sale yard wastes;
vi) C&I wood wastes;
vii) C&D wood wastes; and
viii) C&I trade wastes/grease trap and Gross Pollutant Traps (GPT) wastes.

The current fate for these materials includes:-

- Landfill disposal (with or without LFG recovery)
- Composting for (usually semi-restricted) application to land as soil amendments
- Treatment/stabilization/spray irrigation etc.

All such uses and applications are achieved as a cost to the waste generators or ratepayers even after application of any marginal income achieved for certain compost products.

The transition to systematically realising the HNRV for all these materials must follow the 'shandy principle' (Attachment B 4.4 pages 9-11) because, however much effort is applied to source separation, these materials will still present in 'process engineering' terms as 'indeterminate' in both quality and quantity and for the purposes of singly or solely supporting the manufacture of genuinely highest value products.

Attachment B describes the processes and strategies to:-

a) Collect and process MSW materials into a full range of broadly specified secondary resources, such that

b) Genuine consumer facing finished goods and services manufacturers/providers can fully utilize these materials by 'shandying' them in with virgin resources to produce HNRV outcomes for the supplier of these reclaimed materials.

This approach, focused on transitioning secondary resources, reclaimed from urban waste streams, back into the productive economy at HNRV, will require significant expenditure on systems, infrastructure and beneficiation plants. The objective of the approach adopted in Attachment B, is to be able to capital justify most such expenditure **from the increased receipts from the high value product outcomes, rather than putting up the domestic waste charge**.

In fact, this approach, when fully detailed should aim to initially stabilize domestic waste charges (DWCs) to CPI increased only, and subsequently, demonstrate downward pressure on DWC's as the full value of all the reclaimed resources are shandied back into the productive economy for full value. For a current case study see http://ecowaste.com.au/issues.html (WSROC Options Review) which establishes the concepts advanced in Attachment B into a deliverable framework for the WSROC Councils. The same concepts could be adapted to exactly suit the prevailing circumstances in Northern Rivers region.

2.4.2 Strategic Potential and Opportunities

In considering the medium to long term strategies and options for the management of the >50% organic/biomass content of the regional urban waste streams, the existing and planned strategies (as detailed in the NE Waste Strategy 2014) provides the essential starting point from which to assess and evaluate future options.

The emergence of a readily available regional system of networked BioHubs and related infrastructure, that is proposed and capital justified to address all the other identified non-urban wastes biomass sources can then present as a tangible, proven and costed option for individual councils or NE waste as a whole to consider in due course.

Adoption of the concepts and principles outlined in Attachment B will facilitate a structured transition from the current 'least cost disposal' (with or without token product sales) to one where the same materials are presented, with 'shandying' pathways to HNRV outcomes as discrete ingredients, rather than trying to present as finished products in their own right.

Further, whilst the 'key drivers and policy context' for current strategies are expressed in terms of legislative compliance (NE Waste Strategy Section 1.2), by focusing on presenting reclaimed materials being 'shandied' into the production of full value, consumer facing products and services, the actual achievement of all the 'key result areas and objectives' will be achieved or facilitated as collateral outcomes.

In brief, the following refers to the **'Areas'** in the current NEW strategy -

AREA 1 – Regional Co-operation and Communication – where individual councils (and their selected collection and sorting contractors) focus on presenting all streams of reclaimed materials to standards recognised by the full range of 'actual consumer facing finished goods and services manufacturers' the outcome will require regional collaboration, at the very least. (Attachment B Fig.4.1)

AREA 2 – Waste Generation – one key strategy to '… limit the need for additional landfills…' is to engage in a process of systematic resource reuse for HNRV outcomes especially where the improved and increased level of systematic resource recovery is capital justified by the much increased revenues from the resultant products and services, rather than by increases in the domestic waste charge.

AREA 3 – Resource Recovery – all as Attachment B with special attention to the recommendation for 1 or 2 residual waste management centres, to, as a minimum, reduce any residual materials by >90% whilst producing the balance of the input materials as available to be 'shandied' into specialist product manufacture.

AREA 4 – Landfill Diversion – all as Attachment B

AREA 5 – Problem Wastes – referred to as 'too toxic/too valuable' Attachment B Fig.1.1. Solutions in this area require national approaches, and NE Waste can play an active and useful role in prosecuting the emerging, if nascent, national agenda in this area.

Fully developing these concepts and strategies is beyond the brief for this 'Northern Rivers BioHub Project' PFS, but the need and opportunity is listed in Section 7 as a specific 'further work' task that could be undertaken in parallel with any subsequent review of the NE Waste Strategy, or by individual councils with a specific interest in this area of 'next generation' urban waste management.

However, the proposed concept provides a framework to project potential biomass inputs into an emerging Northern Rivers BioHub network. Such potential biomass arising can be considered by type:-

i) The >50% mixed biomass content in kerbside collected residual waste;

ii) FOGO collections;

iii) Parks, gardens and garden wastes;

iv) STP solids and nutrients; and

v) C&I trade wastes and (supermarket) food wastes etc.

Such potential arisings can also be considered within the short/immediate, medium and longer term project implementation time lines as anticipated by this PFS. Table 2-1 and subsequent key makes some initial, but practical projections to provide some basic data to be included in Section 4.

Table 2-15: PFS projections of urban waste biomass fractions to fully value added outcomes over time

PFS Projections of Urban Waste Biomass Fractions to Fully Value Added Outcomes Over Time	Short 0-5 years		Medium 5-10 years		Long 10-15+ years	
		% of Available Materials		% of Available Materials		% of Available Materials
i) Residual from red bin [1]	Landfill	100% [2]	Landfill	50% [3]	Landfill	20% [4]
			VATS D/T/P	50%	VATS	80%
ii) FOGO [5]	Composting	100% [6]	Composting	80% [7]	Composting	50% [8]
			D/T/P	20%	D/T/P	50%
iii) Clean green/garden [9]	Composting	100% [10]	Composting	50% [11]	Composting	40% [12]
			D/T/P	50%	D/T/P	60%
iv) STP solids and nutrients [13]	Existing STP operations	[14]	AD	10% [15]	AD	50% [16]
			Existing operations	90%	Existing operations	50%
v) C&I trade/wet waste and supermarkets etc. [17]	Existing operations	[18]	Existing operations	60% [19]	Existing operations	40% [20]
			AD	40%	AD	60%

KEY to Table 2-1

1. *The NE Waste Strategy 2014 identifies (Fig 6) that food and garden organics represent a basic 49% of the contents of the residual bin contents and that of the 31% of 'other', some 14% is also biomass or 5% of the total (54% in total).*

   Of these proportions, current strategies may redirect:

   - *Some recyclable paper and cardboard to direct recycling;*
   - *Some clean food/garden material to other uses; and*
   - *Some reduction in volume due to waste minimisation/avoidance consultation strategies.*

   So, a balance of say 45% of the 75,000t/yr (see Table 2.16) will be taken forward to Section 4 as a potential input tonnage. (see Table 2.16)

2. *Currently 100% of this material is disposed of to landfill at an average cost of $100/t.*

3. *If a version of the Attachment B strategy is adopted, all these biomass materials can be separated from the other 'non biomass' materials and exposed to a 'thermal gradient' (Attachment B, 4.15) which in this application would mean torrefaction temperatures to produce an interim 'ingredient' into tailor made fertilizer production with all NPK and trace elements retained for inclusion (shandying) in accordance with any finished product specification.*

4. *As 3, but with increased VATS capability in the region and therefore much higher levels of value adding (and hence diversion).*

5. *FOGO collections are operated in Lismore and Ballina Council areas and the collected material composted to produce a compliant product for general application around the municipality or for further value adding/blending by local landscape products manufacturers.*

   These operations are conducted at a net cost to the councils but qualify as legitimate 'diversion' and in the two councils where the system operates, investment in bins, contracted collection services, processing/composting and ongoing support for 'product' reuse arrangements means that no change to current practices is contemplated for at least the next 5 - 10 years.

   However, for other regional councils, if and when actual BioHub facilities have been established to service regionally generated forestry and agricultural residues, a D/T/P capability will have been established and *so will provide councils with an option to avail themselves of the opportunity, without needing to actually procure such an option in isolation.*

6. *Assumes composting of 100% of current FOGO collections.*
7. *Assumes that at least Lismore and Ballina Councils will continue with existing composting operations and that other councils will avail themselves of D/T/P service at newly established regional BioHubs.*
8. *Assumes that in the long term all regional councils (except perhaps Kyogle) will be availing themselves of either the regional composting or D/T/P opportunities.*
9. *Ditto 5 – estimated as a further 4kg/hh/wk.*
10. *Ditto 6.*
11. *Ditto 7.*
12. *Ditto 8.*
13. *In the emerging 'bio economy', where bioenergy presents as a much sought after product, and, the release of CO_2 to atmosphere is actively disincentivised, the standard operators of STPs will require a strategic reassessment. The current practice at all regional STPs is to stabilize the TS/VS and BOD/COD by (ultimately) aerobically treating all incoming effluents such that when stability/treatment standards have been achieved:*

    a) *All/most of the bioenergy generating potential has been lost; and*

    b) *This potential has been converted simply to a negative atmospheric carbon footprint.*

    Thus a major emphasis in this PFS is to canvass the opportunity to establish a systematic AD capability in the region such that all regional STPs will have the option to simultaneously capture the full energy and nutrient potential of the wet wastes and effluents under management whilst reducing the negative CO_2 impacts of current operations.

    The process options are captured in Section 4.
14. *These options will only be in consideration for the short term.*
15. *These options will become available for detailed consideration in the medium term.*
16. *These options will be systematically available to all councils in the long term, but extended asset life of some facilities may delay immediate adoption.*

    NB: In most cases, the existing STPs could be refigured as treated water polishing facilities once the primary biological load has been transferred to a regional AD based BioHub.
17. *As has now been demonstrated in WA (WMR – Feb-March 2016) once appropriate AD capacity is available in any particular region, locally generated C&I food, food processing, supermarket rejects etc. can be processed to recover their inherent bioenergy and residual nutrient values – but usually on a Merchant basis – and in the case of supermarket packaged goods, an appropriate de-packaging unit would need to be included.*
18. *In the short term, this option may not be available, but detailed negotiations may well be initiated with regional waste generators with a view to transitioning at least some input resources from Merchant to Contractable, eg. Supermarket chains or major regional food processors.*
19. *Such materials being projected for receival in the medium term; and*
20. *Even more in the long term.*

Table 2-16: Potential biomass arisings from regional councils

Material	Potential kt/pa Available	Approx. Cost to Central Facilities ±10%	Contractable/ Merchant
Residual biomass in red bin	45% of 75,000 t/yr currently to landfill SAY 35,000t/yr	Gate fee $50 -$80/t	Contractable
FOGO – Lismore composts	N/A	N/A	N/A
STP slurries (excluding RVC)	180,000EP @12,628ML/yr Slurry=635,000t/yr	SAY 50% 310,000t/yr	Contractable

2.4.3 Regional Biomass as Potential inputs into the emerging Bio Economy

If a fully functioning Bio Economy was operational in the study area the various biomass arisings from each participating Council would have the practical opportunity to be processed as an ingredient into the manufacture of a wide range of HNRV consumer facing end products or services. These outcomes are difficult to capital justify on a council by council basis, because they are dependent on manufacturing finished products, (which is not core business for local government) rather than just 'least cost disposal' objectives.

These outcomes will require universal regional co-operation and collaboration, not only between individual councils, but with the expert service providers and specialist end product manufacturers that such integrated Bio Economy will introduce.

Table 2-16 indicates the volume, end product and net benefit that could be achieved if such an approach was adopted and incrementally implemented.

Table 2-17: Potential gross benefits if major urban waste biomass/organics were processed to HNRV via a regional BioHub network

Bio Waste Stream	Current Fate	Total Regional t/pa (50% of total landfill volume)	Current Income to Council	Potential Market Value if processed by Regional BioHub Network
Biomass content of residual/red bin	Landfill (some LFG recovery)	Say 25 kt/pa	Say $100/t landfill **cost** ($2,500,000)	Products- Approx. 1.5MW bio power Approx. 5000t/pa biochar
Green/garden/ parks	Composted for reuse or low value sale	Say 35 kt/pa	Final value net of composting costs say $NIL	Products- Approx. 2MW bio power Approx. 10,000t/pa biochar
STP Product potential	Released to atmosphere and/or spread to land	240,000 EP	1,763,000m^3 CH_4 to atmosphere NO income only processing costs	Enough power to supply 937 local households or $500,000/pa in total

2.5 Land Management Arisings

2.5.1 Introduction to Generic Issues

This category of waste, residue or by-product biomass arisings differs from the previous three classifications due to its sporadic or 'once only' availability as a potential feedstock into a proposed regional BioHub. However, as individual sources of biomass, these usually present as very homogeneous when the do occur. For the sporadic or 'once only' characteristic of individual sources, over time, different sources tend to arise so that a BioHub may well benefit from considering not only individual biomass sources, but the generic opportunity on a 'regular merchant' basis.

2.5.2 Camphor Laurel

Camphor Laurel was first introduced as school yard 'shade trees' (1822) but has since infested the region from Taree NSW in the south to Bundaberg QLD in the north.

This is a 'prickly pear' or 'cane toad' issue, where the Camphor Laurel has relished local conditions and now 'crowds' out all native species wherever it has proliferated.

Camphor Laurel is now a registered 'noxious weed' but is so established and endemic, and so costly to eradicate as a single outcome, that many communities have 'given up' on ever attempting to eradicate or even control Camphor Laurel – unless a new approach, technology or source of funding can be identified.

Current Forestry NSW estimates are that some 4.2M/t of Camphor Laurel currently exists above ground, and that during any systematic eradication program (probably 50-60 years) an additional 2M/t would grow – presenting a potential 'biomass' resource of some 6M/t over 50/60 years if some systematic management and eradication strategy could be developed.

The current 'infestation' status has developed since 1822 from just a few original shade trees so any program of controlled eradication would need to be **absolute**, as with the Ebola virus or rats on Macquarie Island or foxes in Tasmania. Since any residual trees would continue to provide fruit for birds and therefore continue to be dispersed and reseeded along fence lines, power lines, creek beds and all manner of other inaccessible and inappropriate locations, but the direct costs for such an eradication will naturally influence the community to resolve that, they are perhaps not such a problem after all. However, when approached from the perspective of 'opportunity' and the systematic development of a regional Bio Economy, perhaps eradication over 50 years, generating some $1B locally in Gross Regional Product (GRP), could demonstrate that a much more detailed feasibility study is warranted.

It is well beyond the scope of this Northern Rivers BioHub PFS to undertake such a study, but to present some concept of the possibility, the following very 'first order' estimates are provided to provoke further consideration.

First order estimate of total eradication costs scope:-

- 6,000,000 tonnes available from Bundaberg to Taree;
- Eradication program to be systematically planned over a 50 year period;

- For every tree removed, the appropriate native species to be replanted to a plan that provided shade, habitat and, after 50 years, perhaps a portion of these replantings would be available to support an ongoing and sustainable timber products sector;
- In sensitive areas, trees to be removed gradually so that local amenity and shade was never unduly affected at any one time (a similar program to the ACT street trees program); and
- In very inaccessible areas, trees might just be destroyed rather than harvested to minimise logistics expenses.
- Along creek beds and other similarly erosion prone locations root and stumps would be left to maintain bank stability until the replacement natives matured.

Cost estimate

- 6,000,000t over 50 years = 120,000t/yr or 533t/day
- 10 work teams (4 workers each) = 53t/day each
- 1 FTE year – say $100,000/yr

Table 2-18: Total labour cost

Total Labour Cost	
10 teams x 4 workers = 40 men x 50yrs @$100k/pa	$200M
Admin. and overheads, say 10%	$20M
Harvesting plant and equipment $500,000 per team; service cost say 15% = $75,000 x 10 teams x 50 years	$37.5M
Nursery costs for replacement natives, say $250,000/yr	$12.5M
Transport and logistics - $1,000/day x 10 teams x 11,250 days	$112.5M
Follow up maintenance crew to eliminate regrowth (or payment to landholders to achieve the same job, or combination of both) 10 inspectors x $100,000yr x 50 years	$50M
TOTAL Contingency say 15% First order eradication cost, say	**$432.5M** $65M $500M

Table 2-19: The potential HNRV products available from this harvested material

Primary product value created from 6M/t over 50/60 years	
Essential oil extract (2% yield) say 120k/t @$50/t	$6M
Saw mill products (10% yield) say 600k/t @$50/t	$30M
Fuel pellets, or pyrolysed charcoal products etc. (40% yield) say 2,400k/t @$200/t	$480M
Biochar/lignocellulosic feedstock for bio refineries etc. (30% yield) say 1,800k/t @$150/t	$270M
By-product bio energy (20% yield) say 1,200k/t @10cents/kwh	$150M
Direct products – Budget – Total	**$936M**

Even if these 'first order' estimates are only accurate ±30% this potential outcome would leave some $300M to put towards marginal capacity upgrades to the regional BioHub processing network that is proposed and scoped in Section 4.

However, since the actual Camphor Laurel supply would be some 100-120kt/pa the operational nodes proposed in Section 4 would only need expanding, rather than initiating since they have all been capital justified from other more assured supply and off take arrangement, so, probably $50-$100M would be required to provide the installed capacity to achieve these 'first order' outcomes.

The collateral and uncosted benefits that would accrue to the region if this level of activity was progressed include:-

- Some direct investment in the region in the order of $150M;
- Full time expert jobs – 50-60 FTEs over 50 years;
- The integrated activity could 'anchor' the regional 'systems and infrastructure' as the foundation for a self-sufficient Bio Economy;
- Provide the groundwork for the establishment of a planned and sustainable timber products sector to supplement native forestry and without resorting to 'mono culture' plantations;
- Demonstrate sustainable and responsible land management practices as the basis for establishing a carbon neutral regional community by integrating multiple needs, opportunities and agendas into regional planning.

Next steps

At the very least, we suggest that a systematic approach to managing Camphor Laurel for long term benefit and sustainable economic development is worth of a much more detailed study.

A first step might be to establish the 'dis-benefit' cost of the 'do nothing' option, in terms of native vegetation suppression and habitat modification and biodiversity outcomes etc.

Then a much more detailed review of the systematic eradication plan including a more accurate assessment of the potential product values, especially where a regional BioHub network is emerging to address all the other biomass processing opportunities as outlined in Section 4.

2.5.3 Infrastructure Development

The current construction of the upgraded Pacific Highway right through the heart of the study area provides an example of **what has happened without** a fully operational BioHub capability in the region and what **could have happened** if such a BioHub network had been fully operational.

2.5.3.1 A summary of what is actually happening – A review of the contractual objectives for the contractors can be summarised as:

- An important infrastructure project is being routed through heavily forested areas for much of its length and all the vegetation in the path will need to be completely cleared to make way for the subsequent soft soil/hard rock earthmoving and civil construction of the new Highway.

- Contractors engaged to undertake the mass vegetation removal were engaged as an outcome of a competitive tender process – promoting 'least cost' to achieve the project's primary objectives – to make way for the subsequent construction process.

- Much effort was documented to manage and control the **primary impacts** of the vegetation removal and processing, including soil erosion, weed management, 'pasteurisation' of the processed biomass, fauna protection and general attention to avoid damage and intrusion into areas and vegetation beyond the immediate boundaries of the construction sites. However, despite documented adoption of the 'waste hierarchy' very little attention was directed to the HNRV application of the vast biomass resource under management.

- A summary of the actual resource utilization included:-

  i) RMS removed timber suitable for bridge maintenance, then

  ii) Forestry NSW was engaged for the initial removal of readily accessible, saw log quality material (approx 8% or some 20,000m^3 @$170m3 from Nambucca Heads to Glenugie); **= $3.4M**

  iii) The removal and mulching of all the remaining vegetation (some 300,000m^3 from Nambucca Heads to Glenugie);

  iv) The 'composting' or 'pasteurization' of the stockpiles of mulch, to render it 'safe' for subsequent uses, both on and off site;

  v) The application of the resultant mulch for all landscaping applications as required by the finished project needs and requirements, 280m^3 @$50m^3 **= $14M**

  vi) The availability for surplus mulch to be 'sold' into the regional 'mulch' market wherever such an outcome could return any associated costs for such a reuse option.

Even with significant demand for biomass fuel for the two local Co-Gen plants little or none of the cleared vegetation found even this most basic of productive end uses, mostly because the 'mulching' approach rendered the material too contaminated with soil and debris, and not chipped to the required specification for even such a basic application. Potential value recovered **$17.4M**.

This management approach directly reflects the 'least cost disposal' approach of so many of the potential biomass sources identified and discussed in 2.2, 2.3 and 2.4 above.

The biomass of this type generated from even the highway stretch from Grafton to Byron Bay has been estimated at some 300,000m^3 [6] but when managed as above returned no net benefit or revenue to any single party and certainly made no positive contribution to the potential Bio Economy of the Northern Rivers.

So, if the integrated BioHub, systems and Infrastructure proposed in Section 4 was fully operational what difference might this have made to the current scenario and what revised decision making processes could have been adopted.

2.5.3.2 The anticipated outcome if the Regional BioHub network was fully functioning at the time

Step 1 – as soon as the highway route was determined, an independent local expert representative of the Northern Rivers Bio Economy would have been invited to specifically assess the resource and be fully briefed by RMS on all essential operational and logistical requirements derived from the necessity to complete the primary highway construction project as efficiently and cost effectively as practical. With the availability of a fully operational BioHub network in the region, such an approach could be included as a step in any formal project approval process. The cost structures for managing the task (as 2.5.3.1 above) could have been tabled as a comparative benchmark against which to evaluate any alternative proposals.

Step 2 – an alternative harvesting approach would have been developed that, whilst more expensive than simple clearing and mulching, would have:-

i) Sought to truly optimise quality saw log recovery, accessing material iteratively as new areas were opened up. Say 10% or 30,000m^3 @$170m^3 **= $5.1M.**

ii) Of the balance of the material, a logical hierarchy might have included – applying tops, stumps and scrub for mulching, 'pasteurization' to a standard and a quantity exactly as required by the project for remediation and final landscaping. Say 50% or 150,000m^3 @$50m^3 **= $7.5M.**

iii) All non-saw log stems and branch material removed for processing by the regional BioHub network to sustain the ongoing of the full range of HNRV 'bio' products, including:-

- Quality hardwoods for the manufacture of export grade metallurgical reductants;
- Lesser grade material for essential oil extraction and biochar manufacture (for subsequent fertilizer blending);
- Bio energy product – waste heat/steam
  – syngas
  – secure supply to local Co-Gen plants
- Pre-treating standard lignocellulosic feedstock material to offer to emerging higher order bio refineries operators;
- Stockpile non sensitive stem wood to support expanding fuel pellet production. Say 40% or 120,000m^3 @$400m^3 **= $48M.**

In summary, the 300,000m^3 of cleared vegetation could have sustained the production of some **$61M** (compared to some $17.4M without BioHubs) of net revenue, over say a 10 year period if:-

[6] RMS Pers Com 31/3/16

a) The initial decision making process was fully informed by HNRV considerations, and striving to support a highest value product range in a 'streaming/cascading' framework (see 1.4.2) and all made possible because –

b) An existing regional BioHub network was established and fully operational.

The expectation is that the marginally increased direct harvesting and removal cost would have been greater than the 'least cost disposal' strategy (at 2.5.3.1 above), but the net result would have been to generate considerable net revenue for all stakeholders in the regional supply/value chain simply because the BioHub network existed and was available, and the decision making processes were transferred to expert parties, with specific expertise in achieving HNRV outcomes from materials currently presenting as secondary wastes, residues and by-products of some other core primary activity (in this case the building of a new highway).

Such one-off sources of biomass can occur as a result of projects, such as the Pacific Highway project above, which can be 10–20 years in the planning, in which case higher order outcomes should be easy to plan and implement. Alternatively, cyclones or natural disasters will occur without any notice at all.

Other regular one off arisings will occur as a result of normal Green and Brown field developments and engineering/infrastructure projects, which will arise with relatively short panning horizons.

And, storm or natural disaster arisings will occur with regularity (if totally unplanned), enough to build capacity into the integrated BioHub network to accommodate the inevitable, if sporadic, arisings of such potentially valuable biomass sources.

In aggregate these sources of biomass will present with a strategically reliable flow of biomass and surplus capacity will be accommodated in the proposed modelling in Section 4 in the form of processing capacity as scoping of Surplus Material Management Centres, such as refunctioned or closed landfills, or other such suitable facilities.

2.6 Special Purpose Crops

This category refers to the concept of planting crops that are specifically suited and grown to produce industrial 'bio' inputs as their primary purpose. This differs from by-products of some other primary food, fibre, building materials activity.

There is some nascent activity being considered to grow a specific energy crop in the region but, generally the actual plant species being considered for such applications are all the subject of genetic development to render them better suited and fully productive for this role as industrial inputs, which may well render them suitable **only** as industrial inputs and no longer suitable for food, fibre or building material inputs.

In developing the BioHub concept further in Section 4, the main consideration to carry forward into this synthesis phase is that the integrated BioHub network, essential systems and infrastructure response to the needs of the wastes, residues and by-products sectors may well be ideally suited to manage and process either the special purpose crops themselves, or, at least the wastes, residues and by-products of such special purpose crops.

2.7 Summary and Analysis of Biomass Resources Identified

The following tables aggregate the carry forward data from this Section for analysis in Section 4.

Table 2-20: Summary of 'Dry'/Contractable Sources

Table No.	Material	Potentially available kt/pa (MC)	Carry forward to Section 4	Comments
2-2	Forestry harvest residues	50 kt/pa (25%)	50 kt/pa	This material could beneficially be applied to the production of high value products including high value metallurgical reductants from the hardwood residues and biochar products from the softwood or more indeterminate material, with bio energy being a significant by-product of such activities.
2-3	Sugar cane trash	220 kt/pa (35%)	100 kt/pa	Sugar cane trash is mostly burnt prior to harvest and/or left as mulch in the cane fields. Recently, green cane harvesting techniques have been trialed so that this material could present as aggregated at the participating mills so as to facilitate subsequent uses in the future. The immediate opportunity is to apply this material as a fuel to the existing Co-Gen plants; but the low returns available from this application constrains the viability of the current aggregation trails. Cane trash makes very high quality biochar materials that could feature as a primary ingredient in future fertilizer manufacturing/ blending initiatives. Such an outcome could prove very viable from a grower's perspective but will require alternative fuel sources to be identified and secured for the two existing Co-Gen plants, which have the commercial advantage of existing, and being able to bid for this material immediately. The higher value alternatives are still to be established. NB: A similar strategic scenario could also apply to the 625kt/pa (wet) of bagasse, especially if alternative fuels could be secured for the two regional Co-Gen units.
2-5	Saw mill residues	10 kt/pa (20%)	10 kt/pa	Saw mill residues currently enjoy reliable, if low value reuse opportunities and markets. However as homogenous and reliable sources of biomass they could achieve much higher value outcomes, to the benefit of the current generators, if and when a regional BioHub network is established. This will again present a dilemma for the current lower value end users in that they will need to pay more for the same material or secure alternative supplies of material.
2.7	Tea Tree mulch	100=120 kt/pa (30%)	80 kt/pa	The current markets and end uses for this material are basically low value and distant, such that significant stockpiles remain. This material is homogenous and relatively secure as a source of supply and should achieve much improved returns to growers when a regional BioHub network is developed, even in stages.
	Totals	**380 kt/pa (<30%)**	**240 kt/pa**	Whilst all these materials retain current end uses or markets and their availability is always dependent on the ongoing primary activities respectively. Subject to mutually agreed 'terms of supply' all these materials could be available to the regional BioHub network developer (or any of the individual operational nodes) on a bankable contractual basis.

Table 2-21: Summary of 'Wet'/Contractable Sources

Table No.	Material	Potentially available kt/pa (MC)	Carry forward to Section 4	Comments
2-9	Piggeries 'dewatered slurries'	(40,000 SPU) 14.6 ML/pa (85%)	10 ML/pa (85%) (10,000t/pa)	Currently all these materials are anaerobically and/or aerobically stabilized in ponding systems, whereby their entire bio energy potential is dissipated to atmosphere. The major gas released is methane which has a GHG effect some 21 times greater than CO_2, but which, conversely offers the considerable bio energy production potential. Current 'least cost disposal' practices for all these materials do usually produce a residual, digestate, bio solids, stabilized solids fraction which contains a very high proportion of organic carbon, macro and micro nutrients and trace elements which are currently sprayed or spread (or both) to land. This practice returns whatever beneficial nutrients (and/or residual contaminates) to the land to impart benefits to soil/crop productivity. However, this practice is usually managed and controlled from a 'capacity to absorb' and/or 'nutrient run off minimization' perspective, rather than an optimized pasture productivity perspective – which would seem more appropriate and sustainable in an era of 'precision farming' and the quest for optimum efficiency from our agricultural sectors. A preferred outcome would appear to be to establish systems and infrastructure that fully valued and monetized these materials in the interests of returning the greatest benefit to current generators.
2-10	Dairy 'dewatered slurries'	(11,240 Head) 20.5 ML/pa (85%)	16.4 ML/pa (85%) (16,400t/pa)	
2-14	Casino Abattoir including 'stickwater'	70,000 (HSCW) 128 ML/pa (90%) subject to current sample tests & analysis	980 ML/pa	
	Booyong Abattoir (slurry)	6,300t/yr	6,300t/yr	
	ST	1,025 ML/pa	1,013 ML/pa (1,013,000t/pa)	
	Regional STPs 180,000 EP (producing 1.5Mm³/CH_4/pa currently going direct to atmosphere	12,600 ML/pa residual slurry 635,000t/yr	Say 50% 310,000t/yr	
	Grand Total	**13,635 ML/pa full effluent load**	**1,323 ML/pa (82%) or 1,323,000t/pa**	

Table 2-22: Poultry litter – Contractable

Material	Potential kt/pa Available	Approx. Cost to Central Facilities ±10%	Contractable / Merchant	Comments
Poultry litter most meat, but some layers and limited hatcheries	32,000m³/pa (or 16kt/pa)	\$25/m³	Contractable	This poultry litter material is a special waste since its primary value is its very high mineral/ nutrient content and the ability to process the material to achieve HNRV either by AD and/or torrefaction (or even composting in certain circumstances). In Section 4, this material can be applied for greatest benefit in a number of processes.

Table 2-23: Urban Waste Biomass - Contractable

Bio Waste Stream	Current Fate	Total Regional t/pa (50% of total landfill volume)	Current Income to Council	Potential Market Value if processed by Regional BioHub Network	Comments
Biomass content of residual/red bin	Landfill (some LFG recovery)	Say 25 kt/pa	Say $100/t landfill **cost** ($2,500,000)	Products- Approx 1.5MW bio power Approx 5000t/pa biochar	The opportunity to completely reassess how these urban waste streams are managed should be fully explored in the context of the development and implementation of the proposed regional BioHub network. Currently all such biomass (or organic) waste streams are stabilized by dissipating the energy and resource value to atmosphere (with some limited re-application of the organic carbon and inherent nutrient values via composting and spraying irrigation). An analysis of this considerable opportunity is beyond the scope of this Northern Rivers BioHub project PFS but some initial background information is provided in Attachment B and further reading regarding the generic possibilities is available at www.ecowaste.com.au (Sustainable Issues -WSROC). An adaptation of this work to address the specific circumstances and opportunities in the study area is proposed in Section 7.
Green/garden/ parks	Composted for reuse or low value sale	Say 35 kt/pa	Final value net of composting costs say $NIL	Products- Approx 2MW bio power Approx 10,000 t/ pa biochar	
STP Product potential	Released to atmosphere and/or spread to land	240,000 EP	$>5,000m^3/day$[7] of CH_4 to atmosphere NO income only processing costs	Enough power to supply 937 local households or $500,000/pa in total	

These types, sources, volumes and qualities of waste residue and by-product biomass sources will be synthesised into the generic regional BioHub model – Section 4.

[7] SEDA – Wet Waste to Energy Manual, 1999 – pro-rata calculation

3. Bio Product Markets

3.1 Opportunities and Guiding Philosophy

In adopting all the essential objectives, drivers and strategy defining concepts and principles identified in sections 1.3 and 1.4, the resulting commercial rubric results.

- Currently all the available sustainably yielded biomass materials presenting in the study area are managed for 'least cost disposal', which invariably involves leaving or spreading materials on (sometimes in) the ground for the inherent carbon to oxidise to atmosphere and/or be eventually incorporated back into surface soils with the other minerals and nutrients.

- In a fully functioning Bio Economy, these same materials present as a potential industrial input; as the prime raw material from which to manufacture any product or service currently supplied from 'fossil' resources. Thus the potential markets for 'bio' products, as full replacement, or just supplementary products and services, is well established and deep, clearly specified as to quantity, quality and performance, but also clearly benchmarked for all/any negative GHG or resource depletion impacts which:

  a) May not yet be internalised into existing cost structures; and

  b) Currently serve to support future pricing for non-fossil alternatives.

- Whereas all such materials present as an operational cost or a lost opportunity to the current owner/manager, then, naturally, they seek to spend as little as possible on disposal compliance issues; and any final benefits may only be token, as conceptually depicted in Fig. 3-1.

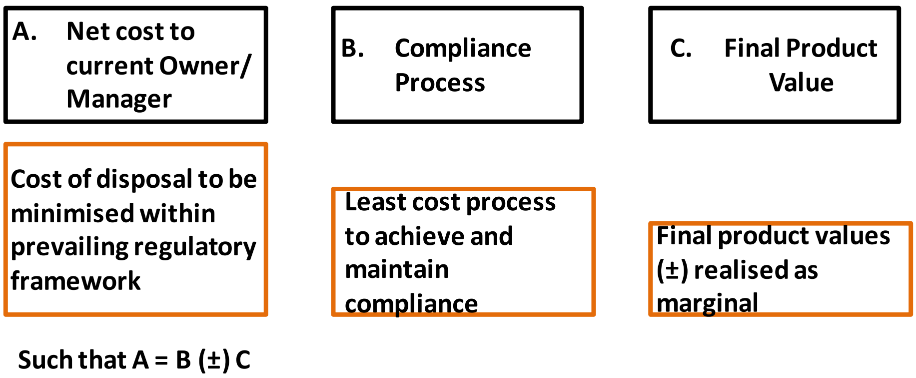

Figure 3-1: Conceptual representation of 'least cost disposal' approach

The alternative Highest Net Resource Value (HNRV) approach however is structured to achieve a quite different net result for the original owner/manager of the materials and the local community.

A. Net cost to current Owner/ Manager	B. Value Adding Process	C. Final Product
Secondary materials presented as defined inputs to recognised value adding process	Optimally designed & operated full value realisation process(es)	Manufactured to enter productive economy as fully valued product and/or ingredient

Such that A = C – B

Figure 3-2: Conceptual representation of HNRV approach

NB: Even if the value for A remains similar in Fig 3-1 and 3-2 but is no longer a lost opportunity and/or a potentially escalating liability going forward, net benefits will accrue to the current owner/manager as long as B) is demonstrated as the most efficient process to achieve C). The likelihood is that the processing capability (B) will be much more capital intensive than for the 'least cost' option but that the capital justification for this additional expense should be supported by the increase in product value (C) rather than by increasing the 'disposal costs' at (A).

All the following 'Bio' product categories have been assessed against this rubric.

3.2 Bioenergy

All of the following bioenergy opportunities have been assessed against the concepts defined in Fig. 1-2.

3.2.1 Biogas

As described and quantified in Section 4, this energy stream is projected to present:

a) From the proposed 'Casino' AD facility
b) From the proposed 'Nimbin' AD facility
c) From the proposed 'Murwillumbah' AD facility.

Biogas is the gaseous product of anaerobic digestion and is predominantly CH_4 (methane) with CO_2 (Carbon monoxide) and may have small amounts of (H_2S) (Hydrogen Sulphide) and will contain moisture as this gas is released from the aqueous conditions in the reaction vessel.

This gas is similar in composition to natural gas (NG) (which isn't reticulated in the Northern Rivers region) and LNG (Liquefied Natural Gas) which is the 'fossil' equivalent most often supplied in the Northern Rivers area, usually where heat is required.

The original biogas can readily be dried, decontaminated and compressed so as to present to the market as a direct LNG replacement. In this form the upgraded biogas is termed CNG (Compressed Natural Gas) or RNG (Renewable Natural Gas).

As CNG/RNG, this energy product can be applied in an application where LNG can be used, including:

1. Direct power generation, usually via a specially designed reciprocating engine;

2. As a direct boiler fuel or source of process heat; and

3. As a transport fuel, most likely to be of most use in the Northern Rivers as a supplementary or co-fuel to modified diesel engines, such as might be most suitable for direct network and/or regional stakeholder users – such as council fleets etc.

As a stationary engine fuel it could be used at the respective sites of all the parties proposing to supply their manure slurries to the central plants. This could be most attractive at the individual sites of the participating piggeries, dairies, STPs, abattoirs and even the food processing contributors. These parties would then have the option to use the CNG they contributed to the manufacture of, for 'on demand' 'behind the meter 'power generation or heat/steam generation as was advantageous to each respectively.

3.2.2 Syngas

As described and quantified in Section 4, this energy stream is projected to present:

a) From the proposed 'Casino' facility dry lignocellulosic processing (Biochar) reactor;
b) Form the proposed 'Murwillumbah' dry lignocellulosic processing (Biochar) reactor; and
c) From the proposed 'Bora Creek' dry lignocellulosic processing (Biochar) reactor.

Syngas, or synthesis gas is a product of gasification/pyrolysis processes, and is produced at elevated temperatures (approx. 400-600°C but about 400-480°C in these proposed applications) and is a Hydrogen rich gas (with CO and some CO_2) and can be applied as a petrochemical input material (significant potential if/when a 'bio-methanol' market emerges) but most likely, as a 'bio' power generating energy product, especially at the proposed Bora Creek site.

At the proposed 'Casino' and 'Murwillumbah' sites this syngas may be best employed to provide process heating and drying the inputs to optimise CNG outputs rather than look to combine the CNG and syngas products, which would add an unnecessary complication to what otherwise would be a very straight forward, 'off the shelf' technical solution.

3.2.3 Solid Bio-Fuels

The only logical need/opportunity in the region to direct dry lignocellulosic materials for direct thermal oxidation (combustion) as a heat/steam generating source is in relation to the two 30MW co-generating facilities, at Condong and Broadwater sugar mills respectively. This currently installed power generating capacity has the potential to feature as the primary source of 'bio' power in the region, available to consumers/end users simply via the grid.

Currently some 60-70% of the fuel source for these facilities is supplied as bagasse, the primary waste/by-product from the respective mills.

One of the objectives of this PFS is to identify alternative fuels sources that could ensure that both these facilities can run at 100% capacity (say 8,000 hrs/pa). Currently, the plant owners/operators are looking to secure additional, supplementary fuel sources, such as:

i) Saw mill residues
i) Forestry residues
ii) Camphor Laurel arisings
iii) Energy crop plantings
iv) Cane trash
v) Cane trash and bagasse from increased planting should the growers feel so inclined;

vi) 'Green field' development arisings, where suitable vegetation is available after site preparations activities.

All of these materials could be suitable and provided to the facilities at a price acceptable to the Co-gen plant operators; and, in the short to medium term, they could help meet an important objective of this project; to help facilitate the 100% availability of these important local capabilities.

However, in accordance with 1.4.3 iv) and Figs. 3-1 and 3-2 above, all the above materials i) – vi) could be processed for a much higher net resource value than to be only applied for the basic task of providing heat to raise steam.

In the medium term we would recommend that a detailed and sensitively focused program be initiated to (re)consider the use of commercial and industrial wood waste as an important additional/supplementary fuel source.

Since the original application by Sunshine Sugar at the time the facilities were proposed, installed and commissioned an opportunity to use these materials could now prove more fruitful in light of:

a) These C&I wood waste materials could strongly sustain the classification that they had no higher resource value than to be applied simply to generate heat/steam;

b) If enough were secured, some/all of the materials i)-vi) could be freed up in the regional biofuels 'market place' to be applied for much HNRV applications and support the development of new industry sector uses.

c) Conversion technologies and failsafe emissions cleanup systems have now advanced considerably in performance and cost effectiveness to the point where, subject to trials and demonstration, no unacceptable environmental outcomes need occur.

d) It is unlikely that a more sustainable and cost effective use of these materials will eventuate in even the long term due to the contamination issues, thus helping the provision of long term and sustainable supply from a catchment arc stretching from South East Qld to Sydney Metropolitan Area (potentially > 100 ktpa subject to negotiation).

3.3 Compost

The application of clean source separated biomass materials to manufacture quality, consumer demanded composts can certainly represent the HNRV application for such materials.

The strategic difference between a 'least cost disposal' compost product and a HNRV product relates to the degree with which the finished material is demanded by the market, rather than 'supply pushed' and usually evidenced by the price end users are prepared to pay for the finished product.

An ideal situation presents in the study region, in that successful facilities currently exist, and sell/utilize their final products.

However, with the development of a fully integrated regional BioHub network, all such materials will be free to move to their HNRV. Surplus, off spec, or unsold composts will have an alternative outlet as ingredients into regional D/T/P facilities to maintain the most productive balance between supply and demand.

3.4 Biochar/land applications and fertilizer ingredients

As depicted Fig. 1.2, the unique properties of biomass are as the primary raw material into processes that can manufacturer the 'bio' version of fossil gas, oil and coal (Columns E-I) and thus provides a sustainable alternative source material for the production and manufacture of every product and service that we currently rely on fossil resources to support.

In the current nascent emergence of a Bio Economy, certain end product categories represent readily achievable high value markets for 'bio' products and ingredients, the production of tailor-made biochars for land application, to sequester carbon whilst providing valuable soil productivity improvements (and replacing/supplementing the use of synthetic fossil based or non-renewable or resource depleting fertilizer products) is one such market segment.

Attachment E provides a very small sample of the >2000 published pages on the subject of biochar in soils, but in summary, the tangible properties of each finished biochar is the result of the properties and characteristics **of the original biomass materials** and the **process conditions that they are exposed to**.

From this base, finished, balanced fertilizer products can be manufactured from different finished biochars that will reliably exhibit properties that can be applied to the production of finished, blended, all-in-one tailor-made fertilizers, that are produced to exactly satisfy a particular grower's requirements for any one crop or application.

The biochar blended finished fertilizer market is now scientifically established and ready for full scale commercialisation by the appropriate and fully experienced parties, and for the purpose of this Northern Rivers BioHub Project, production of specialty biochar based fertilizer products is adopted as a foundation element of the broader PFS assessment.

In the proposed biomass processing facilities as described in Section 4 ('Casino' Fig.4.1/'Nimbin' Fig.4.2/'Murwillumbah' Fig.4.3/'Bora Ridge' 4.4) the digestate residuals, that contain all the residual solids (carbon, macro and micro nutrients essential trace elements and minerals) are proposed to be dried and incorporated into a range of finished biochar materials that would then be processed, as ingredients, into the production of tailor-made, customer demanded finished fertilizer products.

The sustainability, environmental and ecological advantages of this approach is that:-

i) The inherent energy values in the original biomass materials is fully captured for monetizing as 3.2 above; and

ii) The residual carbon content in these materials is conserved in the finished biochars as:-

- The physical/catalytic matrix of the biochar structures;
- A long term carbon sequestration product; and
- A 'carrier' of entrained and affixed nutrients and minerals for inclusion in the final fertilizer products.

The commercial advantages of this approach centres on the ability of the biochar components in finished fertilizer blends to effectively 'extend' traditional synthetic fertilizer products (N.P.K. etc.) for an outcome whereby crop yields for growers in **maintained or improved** when compared to synthetic only applicators, and so the biochar components in such finished products can sustain a market value closer to the value of the synthetic materials that can then be avoided, or some $500-$700/t. This pricing framework represents HNRV in relation to the original manure slurries and compares most favourably with the alternative 'least cost disposal' practices currently applied. Further, this optimisation of the final value of the end products, and not by raising the effluent disposal charges to the respective primary products.

Immediate market opportunities that could be explored for such blended fertilizer products include:-

1. **Cane Growers**
   Current situation
   - Some 37,000ha are planted to sugar cane in the study area
   - Current fertilizer application averages some 280kg/ha at a cost of some $500-$600/t or $5,700,000pa as a total expenditure.

   Future needs

   - To develop a slow release, blended product that would still provide N in the second year, and
   - Reduce, eliminate NO_x wastage to atmosphere especially in the second year.

   PFS objective

   - To blend and provide biochar extended (20-30%) fertilizer products that are blended locally (Bora Creek or similar) to exactly meet the currently expressed grower needs.

   Value proposition to biochar manufacture in this scenario

   - Say final product was a 30/70% blend of biochar ingredients and traditional synthetic NPK inputs.
   - Say ramp up to 50% market penetration over the medium term based on improved performance and controlled/reduced costs

Total fertilizer requirements	10,360t/pa
50% market uptake as initial 5-10yr goal	5,000t/pa
Of which 30% is biochar materials	1,500t/pa

     ∴ 1,500t/pa @say $400/t = $600,000 annual sales

2. **Other broad acre customers**
   Because of the Northern Rivers unique access to a wide range of suitable biomass sources and adjacent synthetic fertilizer sources (SEQ) the proposed fertilizer blend plant would be ideally located to be a reliable and cost effective supplier of similar blended products to the broad acre growers in New England, the Orana and SEQ regions, logically ranging up to 50kt – 150kt/pa of finished products in the medium term based on performance, proven crop yields and controlled/reduced costs.
   Say 50kt medium term – 50kt/pa @$400/t = $20M/pa
   And 100kt in the long term – 100kt/pa @$400/t = $40M/pa
   All representing a direct regional economic benefit for the Northern Rivers region.

3. **Local manure slurry providers**
   Currently the generators (mostly piggeries and dairies) that it is proposed would have their manure slurries collected regularly for application as essential inputs into the 2(3) proposed regional AD plants, spread these same manures to pasture, which, whilst it may only currently present a 'least cost disposal' outcome from a regional Bio Economy point of view, it does provide very reliable and measurable improved pasture productivity benefits.

To encourage the approximate 100 regional piggeries/dairies to participate in the proposed collecting and systematic value adding arrangement provided, the current manure slurry generators need to realise a tangible net benefit to business as usual (BaU). On the one hand, the proposed arrangements could deliver CNG back to each property as a tangible realisation of the energy potential in their manures which is currently lost to atmosphere. But they (mostly) have paddocks that need fertilizing.

The proposed prilled/pelletiser fertilizer products that would be available have at least the following advantages:-

i) They could be tailor-made to exactly meet the agronomically determined needs for any particular pasture in any particular year;

ii) This removes the currently experienced reality, whereby pastures are often over or under fertilized;

iii) The potential for run off in wet periods would be reduced/eliminated; and

iv) Fertilizer application programs need only occur once or twice each year and thus reduce operational spreading costs.

The actual commercial arrangements with each manure slurry generator will need to be subject of specific discussion/negotiations with a future project developer, but a net benefit for the AD operator, the manure slurry generator and the general regional economy seems achievable centred on the following:-

i) Currently the energy value of manures is dissipated to atmosphere;

ii) The energy needs for such small piggeries and dairies is likely to grow with the introduction of more climate control and greater process sophistication; and

iii) Currently manure solids applications and the related spray irrigation activities are often a compromise between the needs for effluent disposal and optimal pasture productivity. This proposed, blended, tailor-made fertilizer approach seeks to minimise effluent management costs, whilst optimising pasture productivity and minimising negative environmental impacts at each stage.

3.4.1 Summary

The proposed biochar manufacturing facility (Fig.4.4) processing some 340,000t/pa of finished blended fertilizer product would:-

i) Provide a platform for the production of some 20MW of Bio energy for local use and application;

ii) Provide a regional facility to make value added, tailor-made fertilizer products for the local cane growers, as well as the local horticultural, fruit, nuts and pastoral sectors.

iii) Provide an opportunity to export fertilizer products to attract additional income into the regional economy. The gross revenue from such a plant would be approximately 340kt/pa @$500/t or some $170M/pa. (Compared with the $230M/pa regional economic benefit from the entire sugar sector.)

This project is worthy of a much more detailed study as the basis of attracting expert project developers to fund the detailed feasibility studies and pre-engineering estimates.

Such a new facility will need to be developed in stages, to a pace related to the market take up for the proposed list of Bio Products, and such scheduling should be a specific task and outcome of any future studies or more detailed feasibility assessments.

Of course, if a capability of this sort is never developed, then:-

a) None of the potential benefits will accrue; and
b) The available biomass inputs will either be abandoned to "least cost disposal" outcomes.

What does emerge from such a potential green field project of this sort is the need to identify and engage a party(s) with the vision, capability and enthusiasm to bring such a conceptual project to completion.

3.5 Metallurgical grade charcoals and reductants

The predominant species harvested by Forests NSW and even private forests and plantations include quality hardwood species, such as Blackbutt and Spotted Gum

After ensuring reliable supply of quality sawlogs to the local saw mill industries, strong international markets exist for specialist metallurgical charcoals and industrial reductants that could present in the market as direct replacements for products currently supplied from 'fossil' resources – mostly a globally traded product – Calcined Anthracite.

Global demand for these specialty products is approximately 4.5Mt/pa and traded at $500-$900/t in its 'fossil' form. A significant premium can be negotiated for high quality direct 'bio' replacements because of the valuable marketing advantages that 'bio' inputs can impart to the finished steel products. Direct 'bio' replacements can be readily manufactured from quality, low ash hardwood residues, exactly as present from forestry operations to the west and south of the study area, and a significant by-product from the manufacture of such products is syngas as a Bio energy product.

The co-location of such a facility at Bora Creek, could generate some 10-20kt/pa of such products for export to SE Asian mills and result in some 5MW of surplus (syngas) Bio energy for local or regional use and application.

The contribution to the regional Bio economy could be in the order of –

- Reductants $7M/pa
- Bio energy 5MW @say 10.5c/kWh (a value negotiated with a local customer)

Again, a detailed feasibility study should be undertaken with an expert project developer with existing market access for these products.

3.6 Pre-treated lignocellulosic supply opportunities

As an integrated Bio Economy emerges, a typical broad based 'triangular' supply/value chain will emerge (Fig.1.3) whereby, as in most agricultural based sectors, multiple individual surplus biomass generators will be able to access convenient 'first point of receival' facilities, or BioHubs at which materials are sorted like-with-like to support the homogenous supply to higher order processors 'bio' refinery, whilst a selection of finished products are produced for local/regional consumption.

A strategic role for a regional BioHub network will be to process materials received that are surplus to local demand for secure 'supply' to more capital intensive and specialised facilities, such as 'bio' fuels refineries or special purpose 'bio' chemical manufacturers to support the generic petrochemical sector. (See recent announcement of the proposed BioFuels plant to be built at Gladstone.)

Individual BioHubs will be ideally placed to manage inventory and seasonal risks by presenting surplus materials in a form exactly suited to such higher value processors. Such facilities will greatly appreciate being able to contract all, or even a portion of the feedstock supplies to reliable suppliers, since the absence of such 'supply' certainty has to be the major impediment to the development of this higher order process/refinery sector.

When detailed feasibility work is undertaken on this regional BioHub network concept, we expect that the development of such pre-treated 'supply' arrangements with existing or prospective higher order facilities will comprehensively manage the inevitable seasonal and network inventory management risks that will arise at that time.

It is to be expected that not only will this approach prove valuable to such higher order 'bio' products manufacturers/refiners, but it will also convert inventory and seasonal risks for BioHub operators from a operational problem to a significant profit centre in its own right.

4. Conceptual and Staged 'Block Flow Diagram' Description for each Proposed Processing Node of an Integrated Regional BioHub Network

Whilst the core focus of this PFS is to scope and validate a potential plant in Casino to service the NCMC, RVC STP and local piggeries respective effluent streams, this study does so in the medium to long term context of the viability of establishing a fully integrated Bio Economy within the Northern Rivers region.

Having identified the extraordinary volume of potentially available waste, residue and/or by-product biomass materials currently arising in the region the following generic discussion on possible operational sites does not attempt to spread certain functions over a number of suitable and adjacent sites; neither does the project brief allow for more detailed and/or integrated staged implementation and scale up of certain sites or their functionality. Rather, a view of the 'global' potential is described and quantified to provide the platform and rationale for further and much more detailed research subsequently.

One feature of the following Section is the need for a specialist project development entity or group to be established since the potential can now be seen as being well beyond the logical purview of any one single stakeholder.

4.1 Potential siting and function of operational nodes for possible regional Bio Economy network

The following proposes certain processing sites. These selections are derived from:-

i) Proximity to certain 'anchor' waste materials;

ii) The logistics principal of 'value adding before transport' rather than 'transporting to value add', all due to the low energy and bulk density of all the materials scheduled on Tables 2.19, 2.20, 2.21, 2.22;

iii) Proximity to certain 'anchor' markets; and

iv) Existing expertise and compatible activities (e.g. Lismore composting facilities or the location of the existing Co-Gen plants etc.)

The following sites that have been identified to host an operational node for the proposed regional BioHub network include –

4.1.1 Casino

Probably the vacant block behind Riverina Stockfeeds, with the positive advantages including:-

- Convenient distance from NCMC effluent ponds, RVC STP wastes (piped across from Spring Gove Road, around the north of town to Reynolds Road) and Mondoro piggery (piped access from Dobies Bight).

- Conveniently located to receive forest residue material originating to the west of Casino.

- Compatible zoning values with adjacent landfill and saleyards.

➢ Adjacent to potential (behind the meter) or CNG industrial energy customers.

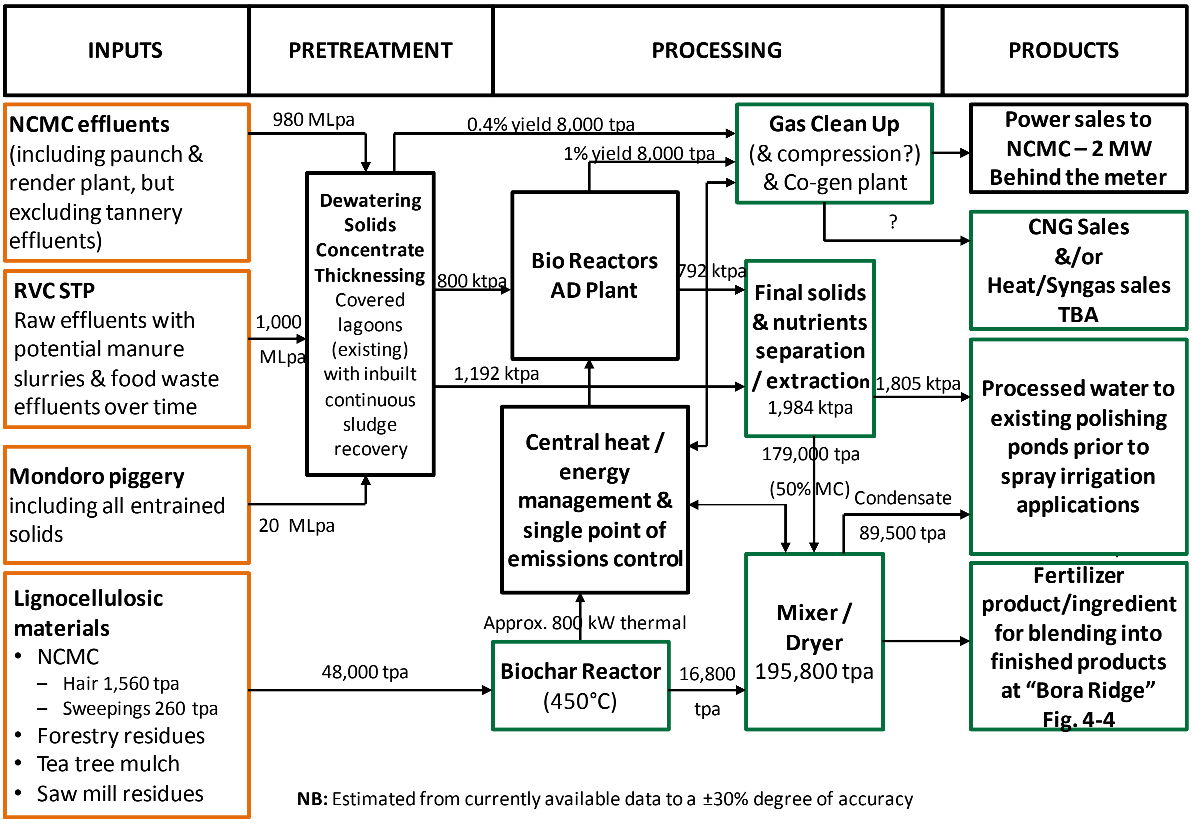

Figure 4-1: Casino – Proposed on site activities and basic Block Flow Diagram (adapted from Fig. 2-3)

4.1.2 Nimbin

➢ Strong local community support to an AD facility that accepted and processed the combined effluent waste streams from the local dairy and local piggery.

➢ These proposed manure slurry inputs could be supplemented from other trucked in effluents to ensure the minimum critical volumes to achieve viability.

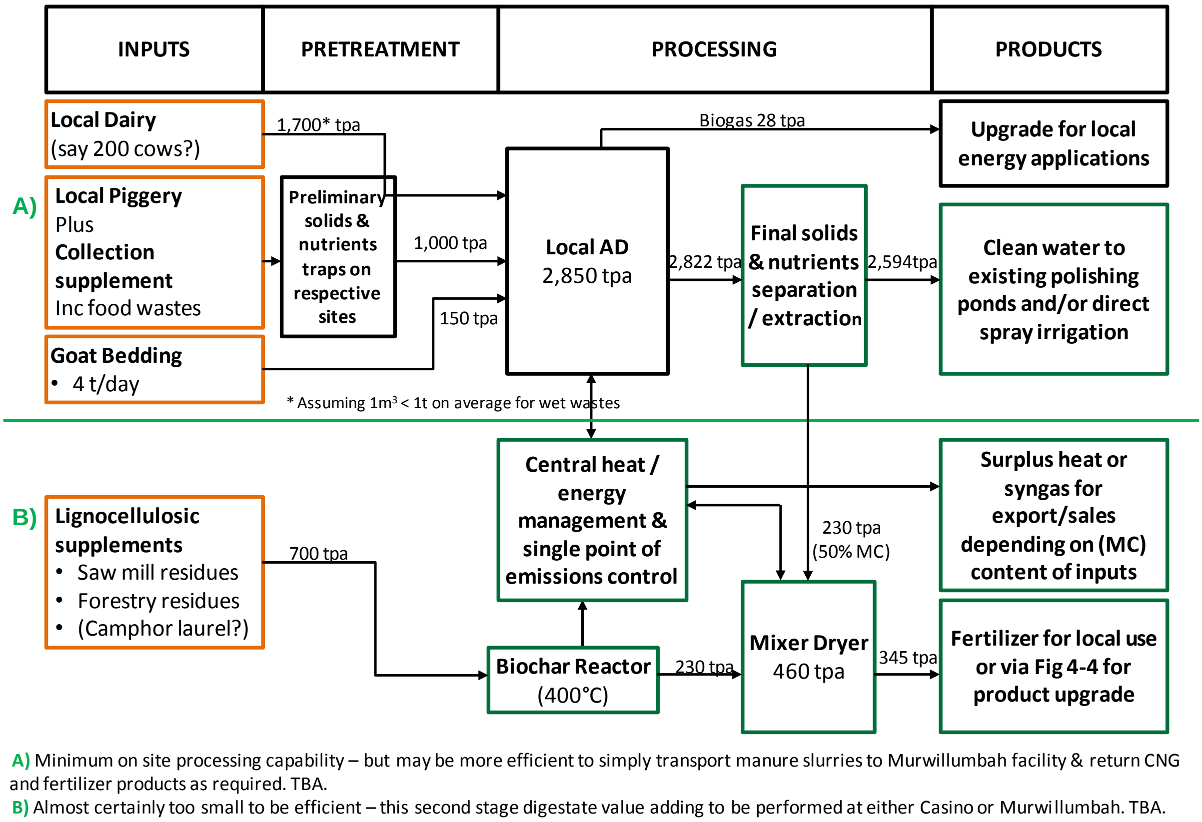

Figure 4-2: Nimbin – Proposed on site activities and basic Block Flow Diagram

4.1.3 Murwillumbah

Three possible sites have been suggested during the stakeholder interview process:

a) Adjacent to the existing industrial zone to the east of the town.
b) Existing Council landfill/quarry site (Stotts Creek Resource Recovery Centre) north east of town (this site could be ideal if a regional MSW processing program was advanced, see 2.4)
c) Condong Mill – fuel preparation facility (for energy/fuels preparation) and/or higher order processing of bagasse and trash in the event that replacement fuels can be secured for the two Co-Gen plants.

But, a site adjacent to the existing STP might also have logistics advantages since so much of the potential facility inputs are **wet wastes**.

In this ‘surplus biomass’ catchment are numerous dairies, some piggeries, industrial food processors, a brewery and numerous ‘behind the meter’ potential energy customers for either power, CNG or a mixture of both for what would be a local capability anchored by wet waste supplies and therefore an AD facility.

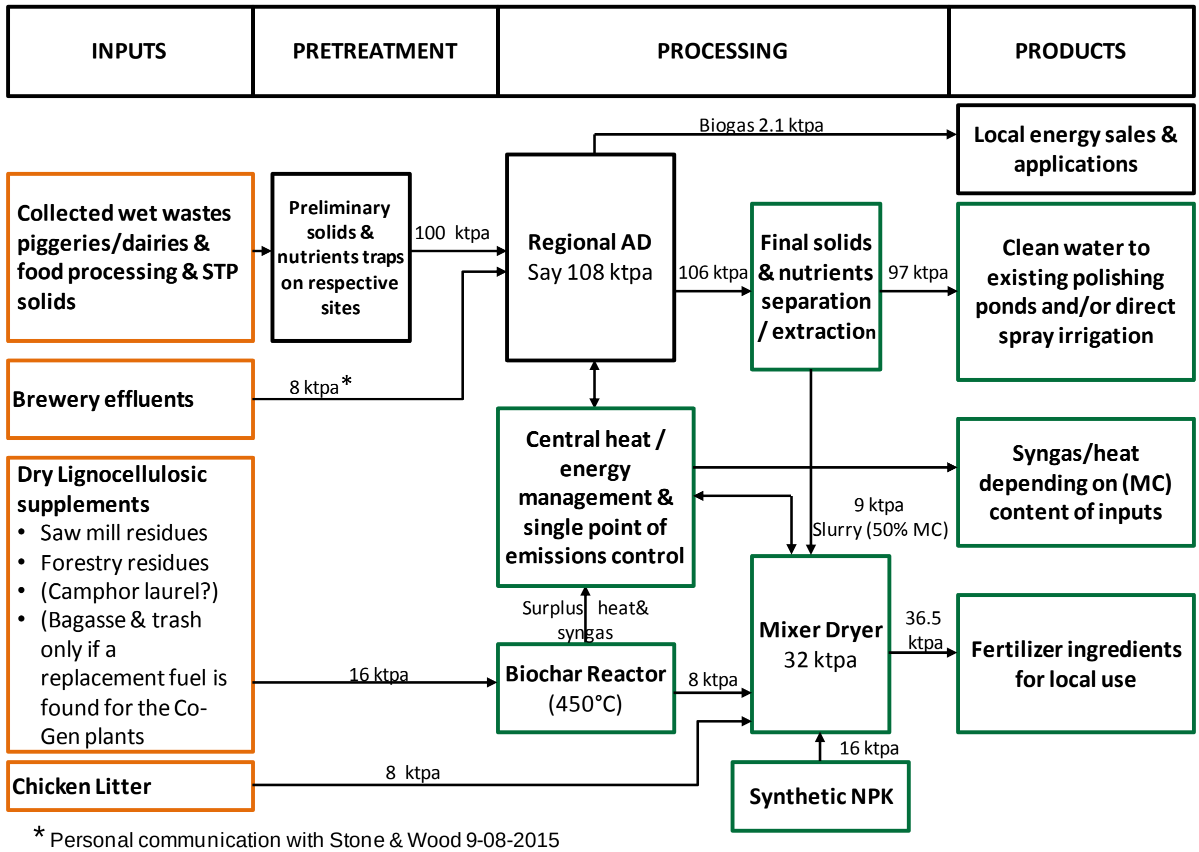

Figure 4-3: Murwillumbah – Proposed on site(s) activity and basic block flow diagram

4.1.4 Bora Ridge

This currently undeveloped site has been secured by RVC with a view that it could be ideal for a regional landfill and/or urban waste processing facility.

As with Stotts Creek (4.1.3) this could indeed be an ideal site for MSW processing (see 2.4) but this site is also:-

- Central for tea tree mulch processing
- Central for poultry litter receival
- Ideal to receive forest residues from the west and south.
- Ideal as a site for a specialist regional blended fertilizer plant, especially to service the cane growing sector, and the permanent horticulture sector.
- To receive and process bagasse and cane trash for highest order products, in the event that alternative fuel sources can be cost effectively secured for the existing Co-Gen plants and Broadwater mills general operating energy needs.

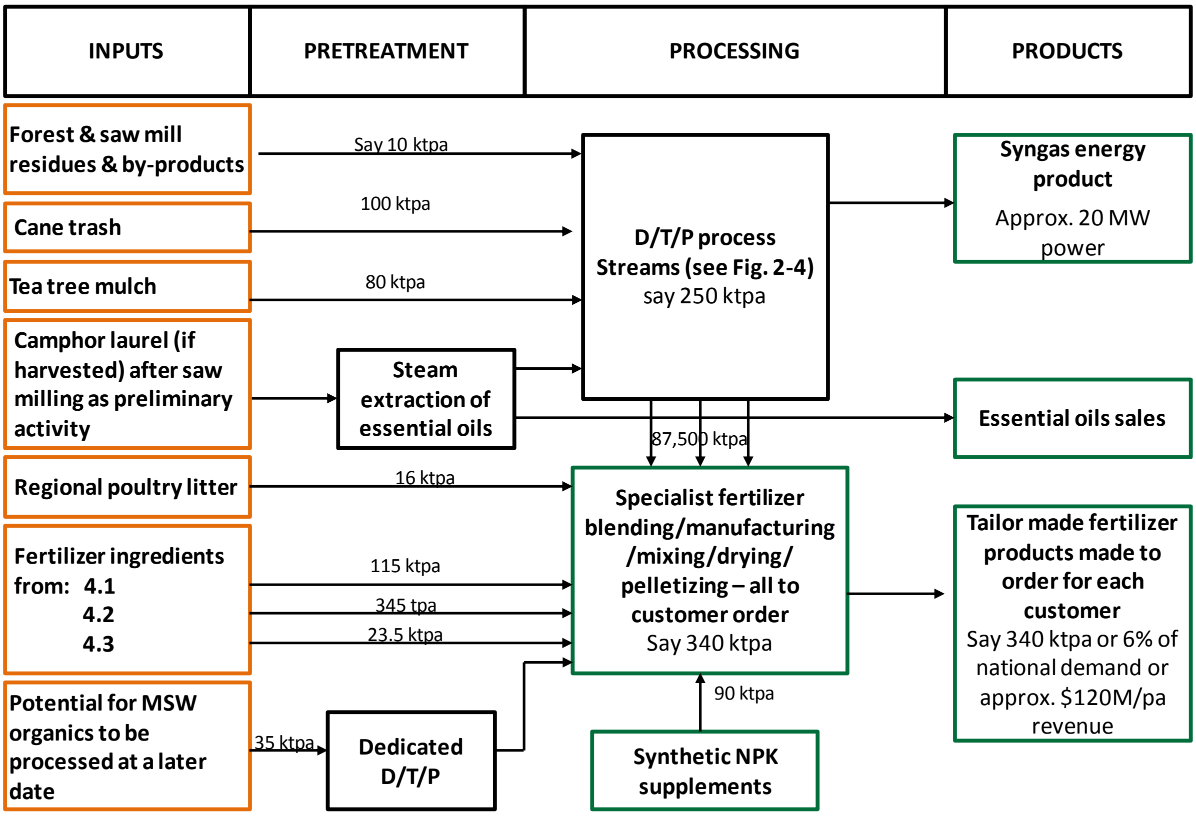

Figure 4-4: Bora Ridge – Proposed on site activity and basic block flow diagram

4.1.5 Lismore City Council Resource Recovery and Composting Operation

This site is well established and well patronised and processes the FOGO collections from Lismore residents and from a similar scheme operated by Ballina City Council.

Within the context of this PFS, where composting presents as the most cost effective and suitable end use for biomass collected in the region, then this existing site seems ideal to fulfil this role.

4.2 Proposed wet waste collection service

As summarised Table 2-20, the regional piggery, dairy, food processing STPs, abattoir and produce some 13,625ML/pa of wet wastes and manure slurries, all of which are currently treated/stabilized, ultimately, by aeration/oxidation and spreading to land.

This amount of wet, reactive (high TS/VS/BOD/COD) material currently presents as:

a) A considerable net discharge of CO_2 to atmosphere, but also
b) A considerable opportunity to harness the energy potential from these materials that is currently dissipated during the aerobic stabilization process, and
c) Fully optimise the nutrient values as a precise, manufacturing activity rather than as a ‘least cost disposal’ practice.

There are at least 150 point sources of these materials in the study region and all except 5-10 are too small individually as to be most cost effectively processed individually.

The proposed solution is to identify and select a limited number of processing sites (4.1.1, 4.1.2, 4.1.3 above) where such wet wastes and manure slurries can be processed as cost effectively as possible and optimise both the energy recovery available from anaerobic processing/stabilization, and aggregating the residual (digestate) mineralised/nutrient value for higher value application to land as an ingredient into a tailor made, HNRV, fertilizer manufacturing facility.

For this approach to be viable:-

i) The source wet wastes and slurries will need to be collected from the generators on a regular basis, whilst as ‘unstabilised’ as practical so as to retain their inherent energy production potential;

ii) Many of these materials may need to be concentrated on site to maximise recovery of energy potential and nutrients, whilst leaving the majority of the water for on-site applications as currently practiced;

iii) These materials will be best collected once or twice per week and brought to the 2 or 3 specialist AD processing facilities.

Cost estimates have been received from such specialist wet waste collection contractors and an average collection cost value of $80/t has been included in the cost estimates Section 5.

5. First Order Economic Viability Analysis of Each Proposed Operation Node and a Summary of Steps to Bring Each to BFD

5.1 Approach & Methodology

In reaching a position on the economic viability of the NRBP in general, or any of the individual operational nodes in isolation it is valuable to revisit and record the various issues principles, issues and opportunities that have been identified in the previous sections that alone or in aggregate will help define or generate viability.

i) All the potentially available waste, residual or by product biomass resources in the region are currently being managed for "least cost disposal". This implies that even where some net benefit or even product sale is achieved the approach is to apply as little capital as possible to the task of managing these secondary materials and aiming for outcomes that are only preferable to the direct cost of disposal. Such approaches tend to be shaped as "minimum cost to ensure compliance".

   The costs, impacts and outcomes, of these approaches where agreed and recorded, provide a valuable minimum performance benchmark for the HNRV realisation strategies proposed and adopted in this PFS.

   However, to truly achieve the proposed HNRV outcomes, the extra capex/opex required must be justified by the realisation of additional revenue from the production of highest value "bio" products (and energy) (see 3.1). This criteria establishes the obligation to not revert to "least cost disposal" strategies when scoping and implementing the individual projects. The ultimate viability is dependent on embracing the complexity and multiple issues and stakeholder management requirements.

ii) Why are so few such "bio" projects occurring at present? One reason identified above is that, whilst each biomass/waste generator is managing their materials for "least cost disposal" and within the "silo" of their own business or sector, the crucial and tangible opportunities to actually achieve HNRV outcomes arise form shared systems and infrastructure and the ability to manufacture highest value, finished consumer facing "bio" products by complementing the inherent properties of one particular waste stream with the inherent properties of other compatible inputs.

iii) When multiple stakeholders contribute bio-waste inputs to a collaborative BioHub project they will each have minimum expectations of net benefit {(i) above} that must be achieved to ensure their wholehearted collaboration.

iv) Avoidance of "stranded" investment where a project's viability is based on the availability of low priced, or negatively priced inputs, to achieve an acceptable rate of return. It is crucial that the project can demonstrate that the project really is achieving HNRV, to avoid some subsequent new technology/promoter/"bio" product market emerging to "attract" the original wastes away from the initial project.

All these issues have been directly addressed in the following "first order economic viability analysis" of each operational node.

5.2 Casino – Proposed Regional AD Facility and Related Activities

This operational node is the most viable and immediately actionable, and has the potential to present as an ”anchor” project for the subsequent implementation of the Northern Rivers BioHub Network.

Crucially, as generalised (i) to (iii) above, the strength of this potential project is the practical involvement of NCMC, as the “anchor” participant, with the anticipated participation of RVC and Mondoro adding scale and value that would not be achieved by anyone party acting alone.

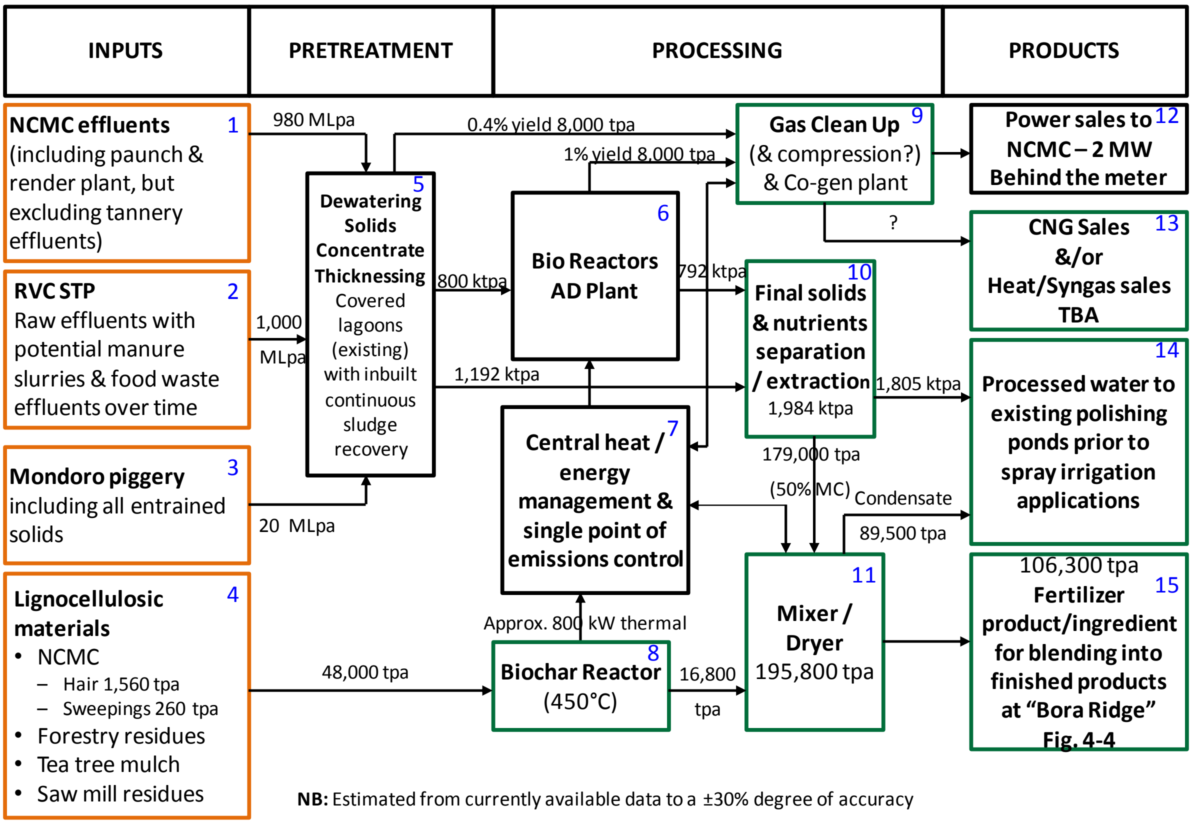

Figure 5-1: Casino – Proposed on site activities and basic Block Flow Diagram

KEY to Fig. 5.1

Node 1. *NCMC – incentive to be involved:*

- *Considerable current operational cost of compliance with licence conditions with no direct ROI for continual waste system upgrades;*
- *Future Capex on waste/effluent system compliance upgrades likely to be some $20M over the next 5-10 years;*
- *NCMC acknowledge that to realise the HNRV from their waste streams is –*
  a) A specialist activity, and
  b) Best scoped and developed as a collaborative effort, and
  c) That for a specialist effluent reprocessor to realise the optimum “bio” energy and “bio” product value from their waste streams they should avoid pre-treating and bio stabilizing these materials before presently them to the specialist regional facility.

- *NCMC is currently "upgrading" the tannery effluent stream, which would be unsuitable for the proposed AD facility until the heavy metal contaminants have been reliably removed.*

- *The NCMC general abattoir effluents and render plant "stick water" with paunch and yard manures are all ideal as inputs to the proposed AD facility (approximately 980ML/pa 6-8% solids).*

In summary, a specialist reginal facility that could accept these waste streams untreated, to extract maximum energy value and that could negate the need for major Capex expenditure on future "compliance" measures would be strongly supported.

In addition, NCMC has a recurring annual power demand for some 5.5MW of which some 2MW is base demand for the chillers. Further, with all effluents processed by a specialist regional AD facility the San Marla farm could convert from applying treated water and solids as a compliance management approach, to accepting irrigation waters and tailor made pasture fertilization products as required for optimal pasture productivity. All of which would greatly reduce management time allocated to compliance issues and allow for more focus on primary/core business.

Node 2 *RVC – incentive to be involved:*

- *The processing of the raw STP inflows via the proposed regional AD facility will realise "bio" energy and nutrient recovery outcomes that are unlikely to prove viable for RVC to implement in isolation.*

- *With all raw effluent flows directed to such a facility, the Council would be in a position to revisit local trade waste agreements with major food processors or any other suitable bio waste generator to supply their effluents as "unstabilised" as practical – so that:*
    - *a) The full energy and nutrient values can be recovered at an "expert" regional facility, rather than being inefficiently dissipated by each respective generator;*
    - *b) Additional "bio" manufacturing could be attracted to the region, because bio waste issues are managed at the proposed facility and not presented as "compliance cost" issues for new business.*

- *RVC could also consider supplying FOGO or shredded (small) green/garden waste to the facility for an outcome that would be more cost effective than tunnel or open windrow composting.*

- *By directly connecting the existing sewage network to the new facility, this installed infrastructure would be productively employed to transport and aggregate bio solids at a dedicated value adding facility, and could be employed in the slurry food waste collection proposal (see. 4.2) by providing truck discharge points without needing to visit the actual facility with every load.*

Node 3 *Incentive for Mondoro to participate:*

- *Current "least cost disposal" practices could be replaced with:*
    - *a) Tailor made pasture productivity improvers rather than just stabilized manures;*
    - *b) Irrigation water available as required, but not a compliance issue in periods of adequate rainfall;*

c) *Access to CNG (or behind the meter power) as a cost effective energy dividend from manures whose energy potential is currently dissipate to atmosphere.*

The next step is to quantify and qualify these benefits and compare with actual "business as usual" practices.

Node 4 *Lignocellulosic amendment materials*

- *These materials to be acquired to provide:-*
  a) *The primary energy source to the entire facility*
  b) *Supply the "biochar" material to blend with the recovered digestate materials to create well defined finished product for use at the proposed "bio" fertilizer blend plant (Bora Ridge?).*

Node 5 *Raw effluent dewatering stage*

- *The active portion of all these waste streams is only some 2% – 15% of the total fluid flows. The rest is water.*

- *Building expensive reactor vessels/tankage just to hold all that water will greatly increase the capital cost for the project*
- *The "efficiency" issue is that these "raw" input flows have a significant biogas generation potential, even after the readily recoverable solids have been removed, so if bioenergy is an objective, managing these large fluid flows, needs sensitive attention.*

- *A range of options have been suggested to address this issue:-*
  i) *Adapt the existing lagoons and install covers to collect all/any biogas available. Such an adaptation would ideally include continuous settled sludge removal from the bottom and a "processed water" discharge weir to transport the substantial de-sludged water to Node 10 for final solids and nutrients removal prior to discharge*

  ii) *Other options include dedicated "thicknesser" tanks, which may be inappropriately expensive. If the existing lagoons do not prove suitable for such a change of function, them the alternative would be to build a dedicated lagoon to specifically achieve these functions.*

Node 6 *AD Bio-reactor vessel(s)*

- *This tailored AD reactor capability will be supplied with "dewatered" slurries from the bottom of the proposed covered lagoon (Node 5) with the intent of optimising biogas generator/unit of tankage to control capital costs.*

- *Reactor vessel temperature would be maintained at the vendors preferred temperature with a feed from Node 7.*

Node 7 *Facility service centre*

- *With a facility of this complexity, there are numerous sources of heat/steam/off gases and numerous points of heat/energy need and demand (with any excess to be presented for off-site sale).*

- *Node 7 represents the central plant capacity to match and manage this demand.*

- *This Node would also collect and process all/any off gases/emissions to ensure all discharges meet licence conditions.*

Node 8 *Biochar reactor*

- *This Node pyrolysises "dry" lignocellulosic feedstocks to produce:-*
  - *a) Biochar for Node 11*
  - *b) The primary energy input into the entire system via Node 7.*

- *In this scenario, all mineral/nutrient content in the "dry" input materials will be retained in the biochar, to improve the final fertilizer ingredients (Node 15).*

- *There is no ash from this Node.*

Node 9 *Gas clean up*

- *The two sources of biogas (from Nodes 5&6) will arrive "wet" and as a basic mix of CH_4 and CO_2 (and other minor constituents). In this Node the gas will be dried and the CH_4 proportion (CO_2 removed) upgraded as required by the end user.*
- *For power generation (2MW) for behind the meter supply to offset the 2MW base demand from the NCMC chillers either the gas could be cleaned up to supply direct coupled engines, or supplied as a gas directly to the plant for them to use as they like within the complex processes of the abattoir.*

- *Once "dried" and cleaned up, the biogas could be compressed to present as a direct LPG replacement in the regional market.*

- *If a fixed, base load 2MW power is agreed with NCMC, any additional biogas generation could be dried and compressed for regional use as an adaptable inventory control measure.*

- *Compressed Natural Gas (CNG) can also be used as a duel/supplementary fuel into diesel engines and either NCMC or RVC or other, might see benefit in providing dual fuelled vehicles as an option in the final project plan.*

Node 10 *Final solids and nutrient removal*

- *Once the project scope is focused on optimizing nutrient recovery for the fertilizer operation, then the final AD discharge water and digestate slurries should be captured for inclusion into Node 11.*

- *Such a process includes mechanical separation and a propriety activated carbon (biochar) filter, all of which can then be directly dried and processed at Node 11.*

Node 11 *Final biochar and nutrient processing*

- *Much of the drying energy in this process comes from passing the "wet" slurries from Node 10 over the hot (450^{o}C) biochar as it emerges from Node 8 and requires quenching in the absence of oxygen. Any additional drying heat would be supplied from Node 7 and the nutrient rich material would be "baked" onto the biochar in the process.*

Node 12 *Power sales to NCMC*

- *The eventual total of electrical power available from the proposed process configuration is yet to be determined, but will certainly be in excess of 2MW (net of parasitic load).*

- *Factors that will determine the outcome include, at least:-*
  - *a) Finally designed plant configuration*
  - *b) Final test values for the respective input effluents*
  - *c) Finally agreed parasitic loads for the plant*
  - *d) Finally negotiated product mix*

- *Experienced AD plant designers/vendors have been approached in the development of this report and gas production estimates have been received averaging some 8,280,000m^3/pa biogas (approx. 2.5MW). These estimates have been derived from past experience with similar effluent streams and their reading of the literature.*

- *This 2.5MW value will be used to demonstrate "first order" economic viability for the project.*

Node 13 *CNG sales*

- *As Node 12 above.*

Node 14 *Polished water*

- *This volume of polished water is proposed to be returned to the three primary effluent providers for irrigation purposes as they have demonstrable demand, rather than as they had to take it before as the end use of the previous "compliance" management practices.*
- *In this proposed scenario, it would be possible to return the water as a tailored fertigation product, to optimize pasture productivity.*

Node 15 *Bio fertilizer ingredient (see 3.4)*

- *The proposed facility at Bora Ridge would be manufacturing synthetic fertilizer replacements/supplements for regional and export markets.*

- *The product from Node 15 may find some commercial applications as it presents from this facility, but the HNRV outcome may be to provide the material to the proposed Bora Ridge plant to be blended with other ingredients to exactly meet some well-defined customer demand.*

- *Or, alternatively, chicken litter and other ingredients could be added at Node 11 to ensure that the materials from this facility are presented entirely fit for some clearly articulated end use (sugar cane?)*

To "bookend" the range of options and staged development scenarios that could be adopted in the implementation of this NRBP the following Project Viability Summary has been prepared to canvas:-

A. The full scenario, as Figure 5.1; and
B. A minimalist "power only" scenario.

	Scenario A	Scenario B
First Order Capex		
Nodes 5, 6, 9, 10 including AD	$12,000,000	$12,500,000
Nodes 7, 8, 11 including Fertilizer	18,000,000	Nil
Sub Total	**30,000,000**	**12,500,000**
Revenue –		
2MW @$105 MW/hr	1,785,000	1,785,000
Bio Based Fertilizer A 108,000tpa @$550	59,400,000	
B Slurry to land $5		Say 500,000
Sub Total	**61,185,000**	**2,285,000**
Gate fee cost/income/save NCMC $20M over 5-10 yrs	Nil	Nil
Lignocellulosic 48,000 tpa @$50	(2,400,000)	
Synthetic NPK 60,000 tpa @$650	(39,000,000)	
Less Opex A 8% Capex	(2,400,000)	(624,000)
B 5% Capex		
Total	**$17,385,000**	**1,661,000**
Profit contribution or ROI	**57.96%**	**13.29%**

Summary

Scenario A & B present as "bookends" to the wide range of possible project implementation scenarios.

Certainly Scenario B could be implemented quite simply since NCMC would be the majority supplier of bio effluent and the anchor customer for the power generated.

Scenario A on the other hand is more complex and will be dependent on establishing the market for the not inconsiderable volume of biochar product that would be produced once the project was fully developed.

The resolution of these outcomes may well rest on:-

a) More detailed research to confirm all the related preliminary and capex costs for both scenarios;

b) The expertise and risk appetites of the potential project developers; and

c) The result of the subsequent negotiations with NCMC in relation to the final values agreed for:-
   i. Providing the integrated waste services and reducing/eliminating future "compliance" budget allocations (for example, if NCMC paid $500,000/pa for waste processing services from the proposed plant the ROI could be lifted to 17.29%); and
   ii. Setting a price for the resultant power (or CNG) buyback.

5.3 Nimbin – Proposed On-site Activities and BFD

This project is being progressed and managed by others.

5.4 Murwillumbah – Proposed On-site Activities and BFD

Unlike Casino, this proposed operational facility has no specific "anchor" waste generator other than:

a) The reliability of the proposed regional slurry collection system. However, since this collection service is budgeted to cost some $80/t delivered (or some $8M/pa) the cost of net inputs to the plant may well equal or exceed the potential value of the bio-products and bio-energy that could be generated; and

b) The potential waste materials from the Stone & Wood Brewery, however, this is only some 8,000t/pa of material and since it currently costs some $160,000pa in disposal costs, the change to the proposed facility would need to demonstrate a commercial benefit – say 50% of current costs ($80,000pa).

The following viability assessment has been prepared as two scenarios:-

A. As described in Figure 4.3 (No Bora Ridge option); and
B. As a much reduced power only configuration.

	Scenario A	Scenario B
Capex estimates		
A – As Figure 4.3	$19,000,000	
B – Figure 4.3 less BioFertilizer		5,500,000
Revenue Forecasts:		
➢ 1MW power @$105	892,500	892,500
A – finished BioFertilizer (No Bora Ridge)	20,075,000	
B – Slurries to spread to pasture $5		42,500
Sub Total	**20,968,000**	**935,000**
Gate fee cost/income		
➢ Slurry collections 100ktpa @$50	(5,000,000)	(5,000,000)
➢ Brewing waste	80,000	80,000
➢ Chicken litter	(240,000)	
➢ Synthetic NPK 16ktpa $600	(9,600,000	
➢ Dry Ligno 16ktpa $50	(800,000)	
Sub Total	**(15,560,000)**	**(4,920,000)**
Profit contribution	**$5,408,000**	**($3,985,000)**
ROI	**28.46%**	

The comparison between scenarios A & B demonstrates the crucial need to recover the HNRV (and as the principles 3.1 above) to capital justify the significant extra expense required to only just recover the inherent energy in these regional waste streams.

Further, since the identified (wet) waste streams will require collecting/aggregating instead of direct piping, there is an even further need to realise the HNRV from these materials.

This piping issue highlights to considerable potential to fully utilize the installed capacity in the local sewer/waste water system. If the AD plant was located adjacent to the existing STP, the existing piping could be used to completely overcome the collection/aggregation costs, and provide a strong incentive to attract similar food processing industries to the region.

In these circumstances, the costs imposed by Council via Trade Waste Agreement could be negated (or even reversed) where the full commercial value of these effluents could be efficiently converted revenue and "bio" energy and products rather than as a treatment cost.

5.5 Bora Ridge – Proposed On-site Activities and BFD

The following "first order" project viability analysis is based on Fig. 4.4 but with variations to reflect:-

i. No semi processed biochar material from 4.2 and 4.3 since they may not turn out to be independently viable projects;
ii. The MSW organics have been omitted until subsequent discussions with all or any of the 6 Councils indicates an inclination to fully explore this option; and
iii. Camphor Laurel is included but overall viability is not substantially impacted if it was excluded.

First Order Viability Assessment	**$**
Capex	100,000,000
Forecast revenues – 20MW power @$120	19,200,000
– essential oil sales	120,000
– bio fertilizer sales	110,600,000
Sub Total	129,920,000
Plus gate fees/input costs	(87,865,000)
Less operating costs	(5,500,000)
Profit contribution	36,555,000
ROI	36.56%

Of course this ultimate scenario is most unlikely to ever play out as assessed. At the very least the installed capacities would be developed in incremental stages, and in the case of the finished bio fertilizer production capability it may take some time to establish local, regional, national and even international markets for the projected volume of finished product since the entire local cane growing sector only uses 10,360t/pa of such products (only 3.3% of the projected production volume possible from regional/Northern Rivers "biomass" sources). However, this does establish the inherent viability of what could be achieved by pursuing the HNRV approach to regional biomass processing in place of the current "least cost disposal" approaches currently employed.

And at a higher "Regional Bio Economy" level the networking of the inherently profitable Casino and Bora Ridge facilities could allow the viability of Murwillumbah and even Nimbin, to be reconsidered in the context of a regionally viable "network" rather than as a series of completely independent operations.

Such a consideration now seems very topical as a possible structure to further develop the concepts canvassed in this PFS are considered at the highest levels.

6. First Order Review of the Project Completion Risks for the Various Operational Nodes and/or Strategic Opportunities and Discussion of Primary Mitigation Measures

In this section we explore a range of the most significant project completion risk areas, and suggest some risk mitigation measures for each whilst balancing such possible solutions to the actual benefits that will accrue if the Northern Rivers BioHub Project (NRBP) proceeds, at least generally in accordance with the proposals in this PFS.

6.1 Project complexity/novelty

The inherent complexity of this (NRBP), as proposed and detailed herein is a project completion risk, in that there are a lot of 'moving parts' to be co-ordinated, managed and harmonised for the project to reach its full potential. However, the complexity is also a project strength and benefit, in that the overall outcomes are not dependent on any single waste stream, operational node or product/market opportunity for it to progress in well planned stages.

Such a project has never been attempted in exactly the form as proposed in this PFS, and for that reason, garnering full support and participation from the wide range of stakeholders that could/should potentially be involved is perhaps the largest single project completion risk issue.

However, the potential benefits from the project proceeding are regional benefits for multiple parties and interests. The project therefore offers economic, social and environmental outcomes that have the potential to place the region in general, in the vanguard of the emerging 'bio' economy. This seems to be a very appropriate and desirable outcome for a region that is already a major generator of surplus biomass.

If a decision to advance this NRBP was left to any single stakeholder, the overall complexity might seem disproportionate to that single stakeholder's specific interests, as waste producers, new product customers, actual facility developers or respective technology vendors. However, a party with a specific brief to advance the interests of the **region generally**, (such as RDA?), might be ideal (if adequately resourced) to manage and harmonise the complexities whilst always accommodating the particular interests of individual participants.

This concept is further supported in that RDA has State and Federal Government mandates, all of which could prove to be decisive benefits in delivering a project of this type; since, once established (even in stages) and proven, the model could be replicated on a state-wide and national scale.

The next stage is to complete the vital tasks (Section 7) to actually achieve Basic Project Definition (BPD – Attachment A).

Once BPD is signed off for the immediate short term objective(s) within the medium to long term context and framework, attracting the funding for the Stages 3 and 4, activities will be greatly facilitated and focussed since a platform and framework will be available to coordinate the full range of integrated activities, including:-

i. The development of the primary AD unit(s);
ii. The optimal value adding of the digestate materials into finished fertilizer products;
iii. Exploring the manure slurry collection systems;
iv. Exploring the CNG upgrading use and redistribution systems; and

v. Any other of the operational initiatives canvassed in this PFS

6.1.1 Siting issues

As outlined in Section 4, in relation to each proposed operational node, siting selection analysis has not been included in this PFS other than to propose the general locations. In each case there appear to be multiple options, especially in relation to the location of the various activities outlined Fig.4.3 and Fig. 4.4. These particular operational activities could well be spread over more than one simple site where appropriate and cost effective to do so.

6.2 Supply (Biomass Feedstocks) certainty

All the biomass feedstocks proposed as the essential raw materials to be converted into the proposed slate of high value 'bio' products are currently presenting, in the hands of their current owners, generators, managers as wastes, residues and/or by-products. Whilst each owner, generator or manager aspires to reduce current 'least cost' management techniques or recover greater levels of value from such materials, in isolation no obvious or practical solution is cost effective or capital justifiable. In effect, the integrated NRBP provides the common systems and infrastructure that facilitates the optimum outcomes for **all such primary stakeholders**.

At this level, the NRBP is a common service or infrastructure offering, such as reticulated water, trade waste, or scrap metal facilities in each community. In such situations, the optimum outcome is not practical at an individual level, but carefully designed and operated facilities can provide specialist benefits and so allow participating stakeholders to focus attention on their respective primary activities.

Following assessment of the immediate and future opportunities detailed in this PFS, for this Northern Rivers BioHub Project to proceed in a timely manner, detailed discussions/negotiations will need to be undertaken with all the (wet and dry 'contractable) biomass generators, including Forestry, the 6 local Councils, ATTIA, all local piggeries and dairies, NCMC/Booyong as a minimum.

To demonstrate momentum, such primary stakeholders discussion should perhaps conclude with the execution of a provisional MOU with each party, so that future project development activity can proceed from the basis that the essential biomass inputs will be at least conditionally available as the basis for securing funding for Stages 3 & 4.

From a supply risk perspective, the mitigation measure relates to the broad range of potential 'supply' sources, for at least the attainment of all short to medium term objectives, subject to the established commercial viability of each implementable stage.

6.3 Technology/process risks

The technologies and processes proposed in this NRBP PFS are all established and proven, but not always at the scale proposed or in the exact duty proposed (other than for the basic AD capability which are proven in every duty proposed). This means that each processing node should be developed and implemented by parties specifically expert, and with track record in progressing such technology development and implementation projects through to timely and successful commissioning.

The processes and technologies proposed are not new or experimental but will need incremental adaptation and/or scale ups to fulfil the task allocated to them in this PFS. In particular:-

- **Casino Node** – the basic AD capability is 'off the shelf' as related to the absolute duty and function proposed, and even staged capacity implementation is practical. The short term issue will be the establishment of the digestate processing into HNRV end products. However, in the next Stage 3 & 4 tasks, options are readily available to establish modular D/T/P capabilities, so that these materials are stabilized and available for a range of interim end uses until a regional facility is established (Bora Ridge?).

- **Nimbin Node** – the viability of this facility will depend upon appropriate scaling and technology applications, but the mitigation measure could be that once the slurry collection system is initiated, the Nimbin slurries and bedding could be processed at Casino and CNG returned for local use and application.

- **Murwillumbah Node** – the range of activities proposed Fig. 4.3 may well be most efficiently co-located on a single site or separate functions located on other of the potentially available sites in the region. Only a site specific and stakeholder discussions can resolve these possibilities.

- **Bora Creek Node** – again portions of the integrated activities proposed Fig. 4.4 may well benefit from being co-located on one site, or the primary energy generating activity may be beneficially located adjacent to Broadwater Mill, if alternative/additional fuel sources are still required for the existing Co Gen plant.

  Fertilizer blending – the manufacturing and prilling function is 'off the shelf' technology – the only 'start-up' risk is related to market development (see Section 6.4)

The only significant completion risk issue relates to the complexity of the overall 'network' concept and the mitigation measure to address this can only be to establish a truly representative NRBP project development entity to oversee and coordinate the timely, inter-related and scheduled delivery of all separable nodes and activities.

Whilst all the processes and technologies will require scale up (or down) or adaptation to meet the requirements proposed in this PFS, these are issues that the relevant vendors, or the process engineering fraternity in general, address in the normal course of doing business.

It can be argued that it is not possible to go and have a look at exactly what is proposed herein operating in exactly the same duty as is proposed, as this is an entirely new project of considerable benefit to the stakeholders involved and the region in general. As such, the primary mitigation measure is to carefully engage the most appropriate and experienced implementation team. That is a 'smart' capability that the Australian engineering fraternity excel at, if accurately engaged and adequately resourced, and made sufficiently accountable for the eventual project outcomes.

6.4 Market/off take risks and issues

All of the primary markets proposed in this PFS – energy, fertilizers and reductants - are very mature and highly specified; in their 'fossil' manifestation they are competitively and transparently priced and readily available. The only difference in this NRBP PFS is that 'bio' equivalents are being proposed that will meet or exceed the performance requirements of their 'fossil' alternatives and for a similar or lower price.

All the markets and proposed end uses of the potential power and/or CNG have the demonstrated need and demand for the bio energy products proposed to be available. Once the project reaches a BPD stage and a commitment to proceed can be demonstrated, detailed discussions with all the biomass supply stakeholders will confirm he most cost effective power/CNG sales and distribution systems.

The shortcomings of the current ‘fossil’ or synthetic fertilizer offerings have been researched and used as the basis for the very detailed alternative ‘bio’ offering proposed.

Subject to expert and timely oversight of this ‘bio’ fertilizer development project, no significant completion risk has been identified

The other major product market proposed is tailor-made, blended fertilizer products.

Assured product off take will require the production of demonstration products and broad acre trials with potential growers and end users.

Similar market confirmation projects are occurring elsewhere in NSW and at the appropriate time, the NRBP should look to engage and collaborate with these initiatives to fast track this market defining task.

‘Black’ or fossil energy/power is in decline due to reducing market demand and the increasingly viable adoption of alternative sources of supply (see Fig. 1.1).

The ‘bio’ energy that will arise from this integrated PFS is first and foremost presenting as a valuable ‘by-product’ of the primary activity, to manufacture ‘bio’ products. This sort of energy/power is the only form that can demonstrate sustainable market ‘pull

6.5 Social licence to operate

Generally put, this relates to ensuring that the community thoroughly supports and endorses this project.

Since everything about this project is socially, economically and environmentally beneficial and positive, and provided that every effort is made to inform and consult with the community at each stage of the project development, acquiring and retaining a social licence is not seen as a completion risk for the project.

The community has already participated in an initial consultation process (Reference *http://sustainnorthernrivers.org/wp-content/uploads/2015/10/Social-licence-for-bioenergy-Prospects-in-the-NSW-Northern-Rivers_final-revised2.pdf)* and the sensitivities around the issues of managing the proposed biomass resources can continue to be addressed to coincide with the communities fully informed views.

Of particular relevance to the local community would be issues such as the use of selected Forestry residues, or the proposal to eradicate Camphor Laurel over a 50 year program, or any facility that generate noise, odour, undue traffic impacts, and everything proposed herein has been sensitively scoped and proposed to avoid any of these potential disbenefits, so the primary risk mitigation measure must be to fully engage, explain and include the community so that even the potential of such disbenefits occurring is avoided and then comprehensive project development principles and guidelines (Section 1.3, 1.4) are adhered to and the sustainable benefits of generating a fully integrated bio economy in the region are appreciated and realised in full.

6.6 Licencing approvals issues

The thermal processing of the proposed wastes, residues and by-products is an issue of considerable attention by NSW EPA and since little of what is proposed has ever been implemented exactly as proposed, detailed and time consuming negotiations will be required.

NSW EPA is particularly concerned to ensure that air, land and water will not receive pollutants that are specified as unacceptable.

Nothing that is proposed in this PFS is anticipated to deliver such unacceptable outcomes. However, there is a rigorous approval process that will need to be followed and resourced. Other than for the time and effort involved, there need be no completion risk for the project as a whole if the process is undertaken with due diligence.

Preliminary discussions have been held with EPA in relation to BioHub development throughout NSW.

From this platform we are of the view that even the proposals for processing MSW (6.7) and C&I wood waste (6.9) in much the manner proposed herein is a concept that can be advanced through negotiation, discussion, demonstration and protocol development, and certainly need not be immediately dismissed just because such concepts are not currently scheduled or approved or accepted.

6.7 MSW issues

Some 50-60% of MSW materials under management by the 6 regional Councils are biomass/ organics. Without a regional BioHub network available to process these materials to realise their HNRV, existing practice is predominately 'least cost disposal'.

With a fully functioning Regional BioHub network these materials can be processed to:-

a) Fully value the carbon, macro/micro nutrients and trace elements and minerals; and
b) Completely control/remove any chemical/physical contamination.

The technology now exists to achieve these outcomes, and in separating all such biomass materials from the residual metals, plastics/synthetics/inerts net domestic waste charges can be controlled and reduced as the value of these recovered materials is appreciated.

However, such project is well outside the scope of this NRBP PFS, but if pursed by all or any of the 6 participating Councils, a detailed and fully costed strategy could be developed and, if/when adopted, incrementally included into regional strategic waste plans for the region over the next 3-5 years or as contracts rollover, or new landfill strategies/facilities present for review and the development of >90% landfill diversion without needing to adopted completely unsustainable traditional style Energy-from-Waste options.

6.8 Camphor Laurel – from invasive weed to crucial resource

The very preliminary proposal (2.5.2) at least serves to highlight that:-

i. The management of Camphor Laurel need not be a net cost to the community, but rather that it could be managed, systematically for the realisation of HNRV contributing some $1B to the local economy over 50 years;

ii. That if sensitively and incrementally eradicated, the 6Mt of biomass generated would justify the establishment of the installed capacity to process CL in the short term, but then leave the region with a permanent timber products processing sector based on selectively replanted natives; and
iii. Some 50-60 FTE and permanent jobs would be created.

The initiating action is simply for the relevant authorities and community representatives to meet and reach a position on whether to pursue the possibility to a next exploratory step.

Everything else would then grow from this simple first step.

6.9 C&I wood waste as an energy product

An objective of this PFS was to explore additional/alternative fuel sources that could be beneficially applied to ensure that the two sugar mill Co-Gen plants could run at full capacity (8,000hrs/pw).

The principles established 1.3 and 1.4 have informed this investigation.

Of the materials (i) – (v) listed 3.2.3 all have the potential to be applied for much HNRV outcomes than simple combustion in the event that the proposed regional BioHub network is fully operational.

However, the opportunity to systematically revisit the opportunity to process C&I wood waste now seems a distinct possibility in light of (a)-(d) 3.2.3.

It is difficult to rationalise that these materials have any other higher resource value than to be applied for their inherent 'bio' energy content and the systematic management and recovery of all the paint and treatment chemicals of concern in the process.

This possibility will require patient and detailed negotiations with EPA and the demonstration and certification of the selected technologies and QA/QC systems, but it is our informed opinion that this is all possible at this time and appears to be the most sustainable and cost effective solution to this problem.

7. Tasks to Complete PFS to Achieve BPD

This section reviews the research and data collected to this point, within the conceptual and strategic context outlined in both the project brief and also Sections 1.3 and 1.4. This establishes a base line for each of the proposed operational nodes and the regional network as a whole from which to list and schedule the task that now needs to be completed to achieve BPD.

7.1 General issues and context

This PFS has made the case for crafting the future development of a fully functioning Bio Economy in the Northern Rivers region around some key concepts:-

i. Managing all the surplus, waste and by-product biomass arisings in the region to recover the HNRV from all such materials under management;

ii. Developing regional systems and infrastructure that can recognise all such materials for their respective highest and best use, as a collective, collaborative, regional outcome, rather than leaving each bio waste generator to continue operating in isolation. This recognises that processing solutions and 'bio' product market penetration requires scale; and

iii. Demonstrating to each individual bio waste generator, that the proposed regional solutions scoped and canvassed herein represent a beneficial, sustainable and cost effective improvement on BAU (see 3.1 incl. Fig.3-1 and Fig.3-2)

And, it is in relation to this crucial final point that the steps necessary to progress from the conclusions of this PFS to a signed off BPD arise.

Without the enthusiastic and proactive support of the current bio waste generators, as interviewed and engaged to date, no structured or 'likely' operational node can be usefully scoped and modelled for the purpose of achieving BPD.

What is proposed: is that following the completion of certain minor tasks, as listed separately against each node summary below, the concepts and possibilities identified in this PFS be agreed to, as a first order regional framework to progress the initiative. Then, following the confirmation of a representative 'steering' group (or entity) to progress the project, individual stakeholder forums be established for each proposed operational node.

At such events all the primary proposed bio waste generators:-

a) Would be thanked for their participation and collaboration to date;
b) Be fully briefed on the potential that has been identified in each instance;
c) Asked for feedback and suggestions;
d) Encouraged to collaborate further by sharing certain operational cost data to establish (A) as referred to in Fig.3-1 and Fig.3-2;
e) Perhaps establish 'criteria for success' that would act as a benchmark that would signal their ongoing and active engagement in the proposed project; and perhaps
f) Obtain agreement to enter into a conditional MOU with an as yet to be identified project development entity, so that all subsequent time, effort and resources employed, to at least BPD, would not be unduly at risk whilst the project was advanced.

(NB – for the ORANA BioHub Project, RDA (Orana) has very successfully undertaken this interim project facilitation role, as that project progresses from initial PFS though to BPD. In this instance, the Federal and State Government representation of RDA has proved very appropriate and effective and might be worth consideration if no other appropriate party is identified. But the existing Sustain Northern Rivers Energy Group may also be ideally constituted to undertake this coordinating and facilitating role.)

7.2 Proposed 'Casino' operational node

Progress to date –

- NCMC, RVC and Mondoro piggeries has so far been interviewed and once the projects conceptual objectives had been explained and discussed all have enthusiastically participated to date, providing preliminary waste stream data, explaining current practices (but no costings) and actively participating by providing 'all of waste stream' effluent samples.

- Those samples have been delivered to the relevant laboratories, as directed by Utilitas Pty Ltd and initial results are expected by mid-April 2016.

- From all the information available and provided to date Fig.4.1 has been prepared to provide an initial conceptual BFD of a proposed process/operational configuration that would achieve or exceed all the preliminary and secondary objectives of the project.

- The next step is to derive:-

    i) Confirmation of proposed effluent quantities and qualities (the awaited test results may require a second round of testing to add in or eliminate certain effluent materials from any of the three current participants, to derive the optimum proposed input materials for such a project – and additional sources may even be required).

    ii) Once the proposed input/feedstock materials have been agreed the propose AD facility can be sized and Capex/Opex budgets prepared.

- With this essential Capex/Opex data to hand, and the 'criteria for success' negotiated with each potential effluent provider, the individual viability assessments can be completed (Section 5). So far, realistic assessments can be prepared to address potential sales revenue and the Capex/Opex for the D/T/P and fertilizer blending can all be estimated but without the 'gate fee' estimates and the AD Capex/Opex values this work cannot proceed at this time.

- In addition to the information being prepared by Utilitas to complete this task, generic AD plant Capex/Opex/yield data is being aggregated from 'open source' sources to contrast and compare with other information that comes to hand in due course.

7.3 Proposed 'Nimbin' operational node

This project is being progressed by NNIC and no input has been requested to this point, other than to make a token consideration for the supply of 'top up' piggery and dairy slurries in the event that the proposed collection scheme is advanced (7.8 below).

7.4 Proposed 'Murwillumbah' operational nodes

As with 'Casino' this PFS has served to outline the scope, function and benefits for an operational/ processing node in the Murwillumbah area.

A selection of wet wastes has been identified (Fig.4-3) and a selection of possible sites canvassed.

To progress this project further we propose a staged approach similar to 'Casino', starting with a primary stakeholder forum with an agenda similar to 7.1 (a) – (f).

Again, from such a forum, the scope of the proposed project (Fig.4-3) would be confirmed and/or amended and the process would provide the essential data that would enable the completion of the basic viability assessment in Section 5.

7.5 Proposed 'Bora Ridge' operational node(s)

Unlike the proposed 'Casino' and 'Murwillumbah' nodes, this proposed Bora Ridge project is much easier to estimate in terms of Capex/Opex input/gate fee values and market revenues.

However, a major proposed input is the pre-treated materials from the three proposed facilities Figs. 4-1, 4-2 and 4-3 and so the Section 5 viability estimates will need to await the outcomes of 7.2, 7.3 and 7.4 above.

The full functionality of this site could also be greatly influenced by the outcomes of 7.6, 7.7 and 7.9 below.

7.6 Proposal to develop HNRV MSW strategies for the medium to long term, with any of the six participating councils that wish to fully explore this option

Outside of the scope of this NRBP PFS, any councils that wished to explore these proposed >90% diversion options, whereby all reclaimed materials were directed for HNRV outcomes by being 'shandied' back into the productive economy (as briefly described Attachment B), the first step would be to convene an initial exploratory workshop (perhaps hosted by NEW) and all/any subsequent steps would or would not emerge from that event.

7.7 Commercial and Industrial (C&I) wood waste proposal

A dedicated and specific program to fully and logically explore this issue is important, not just for the optimisation of the bio energy generating capacity of these two prime regional assets, but also for the profound and project defining outcomes for the emerging Northern Rivers Bio Economy in the medium to long term.

The current commercial and regional economic situation is that these two prime assets supply power to the grid (after satisfying the operational needs of the two mills) and the price for that power is only sufficient for the businesses to offer some $30/t for this raw biomass source (adjusted for quality, moisture content or net CV etc.)

With projects such as the Gladstone bio fuels project, the bagasse/hydrolysis/ethanol project coming to fruition at Harwood mill and even the proposed fertilizer blending/manufacturing plant at Bora Ridge (and any other such initiative that will emerge in the short to medium term as the regional Bio Economy logically develops) the value to higher order bio-product processes of these homogenous feedstocks, such as cane trash, bagasse, will quickly exceed the price the Co Gen plants can afford to pay whilst ever the only product they are making is (relatively) low priced power.

In the short to medium term, the Co Gen plants will have a range of 'existing user' rights and strategies available to them to 'disincentivize' alternative users of these materials from establishing in the first place, but eventually market forces must prevail and the proposal herein is to acknowledge the underlying commercial tension that must occur and work to resolve the issue forthwith.

Sections 1.3 and 1.4 established some proven project development concepts and principles that have fully informed preparation of this PFS and ultimately, demonstrated how to achieve the HNRV bio-product values that underpin the entire transition from 'least cost disposal' for all the biomass materials considered to the multimillion (Billion?) dollar outcomes that can be achieved by managing all such materials as crucial bio economy inputs, rather than wastes and residues.

By applying these same principles to this 'elephant in the room' issue, C&I wood waste would appear to be the only potential bio energy feedstock that can truly present as 'having no higher resource value than to be applied to raise heat/steam' and the issues that made such an option possible originally, can now be overcome, in terms of technology and contaminant management/ recovery. It is our view, that even a logical pathway to licencing and environment approvals now exists, if the proposal is addressed thoroughly and sensitively and through the appropriate channels.

Assuming that C&I wood waste could be sustainably and cost effectively added to the potential fuel mix for one or other (or both) of these Co Gen plants, then the most valuable strategic and commercial role that this 'installed capacity' would play in the medium term would, not only involve extracting the HNRV from such C&I wood waste, where only wasteful disposal current presents as a disposal option, but the facilities would also pay a crucial role in absorbing all/any cane trash, bagasse, saw mill and forest residues etc. that were surplus to the needs of higher order bio processors and against this background, the potential to develop specially grown energy crops could emerge with a well-established pricing benchmark.

On the one hand, this issue may appear to be just the concern of CBP as a private company, operating in its own self-interest for the benefit of its shareholders, but, because of the project defining impacts such a business could and will have on the much broader Regional Bio Economy outcomes, the wider community interest must be advanced and a solution as proposed herein could be a defining positive outcome, for both the private and public interest, if approached and managed against sustainable principles.

7.8 Manure slurries collection systems

As collated Table 2.20, some 40-100kt/pa of manure slurries, STP bio solids and regional food processing wet wastes are generated in the study area.

Currently all are managed for 'least cost disposal' outcomes. This results in all the energy generating potential being systematically dissipated to atmosphere and the resultant nutrient streams being spread to land, more as an extension of the 'least cost disposal' approach with "compliance" issues to be continually managed than as a systematic pasture yield optimisation approach.

To address this loss of potential value certain centralised processing capabilities need to be established (Figs. 4-1, 4-2, 4-3 and 4-4). And as described (Figs. 3-1 and 3-2) the capital justification for this considerable expenditure, for such new facilities, should be founded on the greatly increased returns from the end products, rather than by increasing the 'least cost disposal' costs for the current waste generators.

These slurries and wet wastes are generated at some 150 individual sites throughout the region and the strategic objective revolves around the concept that individually these point sources of material are too small as to support optimised energy and nutrient recovery alone, so aggregation of these materials into efficient centralised plants needs to be explored.

Since piping all such opportunities is impractical in the terrain of the region, and due to the distances involved, a truck based collection system is the only other logical alternative.

The actual collection system has been provisionally estimated by a specialist liquid waste company, starting with one single axle vehicle to begin with, growing to three vehicles if the entire 150 point sources were all to participate over time.

However, the practicality and cost effectiveness of this proposal must involve:-

i) Understanding the 'criteria for success' for each individual slurry generator, given their respective circumstances, needs and ambitions (an interview process);

ii) And assessment of their respective effluent systems, existing solids traps, current and future energy needs;

iii) Identifying what upgrade to existing solids and nutrients traps would be appropriate in each circumstance, given that basic 'drop in' solids traps would be the minimum requirement, with 'over pass' screening systems as the next order of efficiency, and the activated carbon nutrient and minerals recovery as the ultimate screening system – all needing to be scoped and budgeted as a base line enabling system and infrastructure requirement, including the necessary interim/collection tankage for the collection vehicles to draw from when passing;

iv) CNG return arrangements and tankage and linked generation units to be scoped and budgeted; and

v) Pasture fertilization requirements to be assessed and any necessary storage silos quantified.

Once this survey and assessment work has been completed, the true cost of delivery of the slurries to centralised plants can be entered into the respective viability calculations (Section 5).

7.9 Camphor Laurel

This issue/opportunity will attract a broad range of 'social licence to operate' issues before the concept can be given serious consideration. However, even before addressing such issues, the viability and cost benefit of such a proposal should be much more thoroughly assessed. The crucial issues include:-

i) What is the actual 'disbenefits' cost of the 'do nothing' or 'do very little' options;

ii) What are the essential criteria that should be included in the proposed harvesting techniques that could/should be adopted (as 2.5.2);

iii) What are the costs of harvesting this material [as (ii)];

iv) Confirmation of the market values for the proposed range of 'bio' products suggested;
v) Best estimate cost/benefit of the proposal before even starting a community consultation process, which would be of little value of itself if conducted without at least the basic information (i) – (iv) above to inform the discussion and debate.

However, as 2.5.2, the potential to create a billion dollar industry over 50 years whilst thoroughly addressing an apparently intractable issue and providing a solid commercial platform to support the logical, interactive and integrated development of a fully functioning Bio Economy in the Northern Rivers region seems to favour at least better understanding of the potential before discounting the concept.

Attachments Schedule

Attachment A – Generic Project Development Process

Attachment B – Discussion Paper: Strategic options for the 'all of waste stream' management of urban wastes arising in the North East Waste area (and any participating neighbouring Councils)

Attachment C – www.ecowaste.com.au Sustainability Issues BioHubs/ DIIRSTE document

Attachment D – www.ecowaste.com.au Sustainability Issues WSROC document

Attachment E - A sample of academic papers on the uses and benefits of biochar in soils