Pre-Feasibility Study
to assess the potential to establish a BioHub
to service the Dubbo Region

June 2013

as financially supported by
NSW OEH Agreement # OEH-06-2013
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Preface

As a result of general discussions at a WMAA Industrial Ecology Network (IEN) meeting in early 2012, Renewed Carbon Pty Ltd was invited to address a Sustainability Advantage cluster meeting at Dubbo 8/05/12 to speak to an agenda item on biomass issues and possibilities that might be pertinent to the Dubbo region, and to introduce the Renewed Carbon BioHub concept.

The meeting stimulated considerable interest and Renewed Carbon organised with Dubbo City Council business development team to conduct a special community meeting 13/09/12, at which invitations went to a broad spectrum of potentially interested parties.

The interest generated stimulated a specific project “stakeholder” meeting, again in Dubbo City Council meeting rooms, to confirm general enthusiasm to support the production of a specific Pre-Feasibility Study (PFS). Stakeholders present committed to support such an outcome and to support a formal submission to NSW OEH SA program for supporting funding for the PFS.

Eco Waste Pty Ltd was then asked to prepare a specific funding request to OEH and the resultant contract to undertake the work was executed January 2013.

Supporting “stakeholder” group for the project included:

- Dubbo City Council
- NetWaste
- Orana CMA
- Western Plains Zoo
- NSW OEH SA Program
- A local agricultural service contractor
- Carbon Farming Australia
- Renewed Carbon Pty Ltd

The main commitment by stakeholders was to provide detailed data and information as required and/or to help scope solutions and/or market possibilities.

An “observer” group was also formed consisting of all other interested parties who had come to previous meetings or sought to better understand the potential for a national BioHub network. These included Orana Regional Development Australia, on behalf of the 54 other national offices, and DIISRTE, who are also keen to understand the potential and barriers to optimised biomass utilization, on a national basis, as a sector of potential competitive advantage for Australia.

The observer group have undertaken to at least review drafts of this PFS and provide considered comments to help inform the final document.

PFS Objectives

This project has as its focus, to determine the feasibility of a specific development proposal, and in doing so, is being assessed within the standard framework for a staged project development process.

This staged approach has been refined over time to optimise the exposure of scarce project development funding; to “sanity check” the original concept at discrete stages to ensure excessive expenditure is not exposed on projects that, but for some timely checking of the fundamentals, would have revealed “showstopper” issues or the need for a rescoping of the basic concept before
detailed engineering, modelling or design was undertaken. Briefly, these stages can be summarised as follows:

1) **Project Conceptualisation**

In this case a basic project concept has been provided by Renewed Carbon. This concept has been considered by the respective parties in the “stakeholder” group, and considered by NSW OEH as being a concept worthy of more detailed investigation in the form of this Pre-Feasibility Study.

2) **Pre-Feasibility Study**

If a conceptual project is to proceed to implementation, a detailed Feasibility Study will be undertaken to establish the factors, values, technologies and product market certainties.

Such feasibility studies can be a considerable expense to the project developers, and need to have been conducted to sufficient level of certainty to ensure the resultant capital funding will not be exposed to unnecessary risk. A Pre-Feasibility Study is the logical step to “sanity check” the original concept and to provide sufficient confidence in the project to attract the funding for the Feasibility Study itself. Spending on a feasibility study will often be an order of magnitude more than the Pre-Feasibility Study, and the Feasibility Study will visit all the issues and topics addressed in the Pre-Feasibility Study, but in complete and verified detail with previous “assumptions” fully tested and confirmed.

After summarising the functions and objectives of the BioHub concept being proposed by Renewed Carbon (Section 1), this Pre-Feasibility Study will primarily address:

i) Generic biomass categories (Section 2);

ii) Sources of regionally available/suitable biomass supplies and an estimate of the costs and likely commercial terms for receiving the materials identified (Section 3);

iii) The full range of final and/or interim products that are proposed and a realistic pathway to market for each and the expected revenues that are likely (Section 4);

iv) Conversion systems and technologies to convert ii) into iii) and the practical implementation issues, costs and options (Section 5);

v) First order financial model (say to a level of accuracy ±30%) (Section 6);

vi) First order risk assessment of the key factors and sensitivities revealed in i)-iv) above such that funding for the subsequent feasibility study can be attracted and the likelihood of the project proceeding to commercialisation logically evaluated (Section 7);

vii) The assessment at v) will scope and describe the detail and attention required in any subsequent feasibility study in response to the facts and issues identified in the Pre-Feasibility Study (Section 8).

This Pre-Feasibility Study will follow the scope as defined above and highlight issues and shortcomings, which if subsequently addressed, would support the transition to the full feasibility stage (Section 9).
Executive Summary

Summary of the BioHub Concept

Biomass is set to become an important raw material to provide the essential carbon based molecules that our complex industrial economy is dependent upon, in an age when the use of fossil resources (gas, oil, coal) is discouraged or too expensive or they are exhausted.

The fossil fuels that were originally made from ancient biomass have supported global industrialisation for the last 250 years. This rapid industrialisation has benefited from the fact that gas fields, oil wells and coal mines present in convenient concentrations, with high energy density. But recently grown biomass presents as ubiquitous but disparate, and at low energy and bulk density, much like most other agricultural commodities.

This means that although biomass can technically supplement or replace fossil fuels in almost every application, the essential harvesting, aggregating, processing and refining tasks to acquire biomass as a basic raw material or primary input are completely different to drilling for or mining fossil resources.

Before biomass based materials and products can present as “drop in” or direct replacement products and materials, they must first be gathered and transformed into such “drop in” products.

This essential harvesting, aggregating and conversion supply chain is effectively completely missing today. The systems and infrastructure to receive biomass as and whenever it presents to supply these new market opportunities is non existent; and where the products are needed is invariably very distant from where the biomass occurs; these low value raw materials cannot justify the extensive transport without being value added close to the providing source.

The BioHub national network is proposed as the essential and cost effective solution to this problem, the essential enabling systems and infrastructure response to unlock the full potential of sustainably generated biomass in a carbon constrained age.

Just as metal scrap yards occur throughout the community to receive scrap metals as and when they present for systematic resource recovery, so too BioHubs would be available to receive biomass, in all its forms, as and when it was available.

Once received, the BioHub would have all the essential process equipment to pretreat or process received materials into products for local use, or sufficiently processed and value added to afford the transport within the network to other specialist sites or Biorefineries or process plants.

This concept of locally available, network connected systems and infrastructure is universal in the agricultural sector. In the cropping sector, for example, the railhead silos effectively connect the individual growers to national and international value adding, processing, marketing and distribution networks. This is at the core of the actual and strategic services and capabilities that the BioHubs aim to provide, and which have been explored throughout this Pre-Feasibility Study.

Proposed BioHubs Functions and Services

As with railhead silos for the cropping sector, or scrap yards for systematic metals recovery, BioHubs will act as a “first point of receipt” in practical terms, and “receivers of last resort” in commercial terms. If the biomass generator has a more beneficial use for biomass under management, they will
be free to apply the material, but if not, the BioHub option will always be available to offer market based receival conditions for provided biomass.

At the BioHub, the quality assurance/control processes that will be essential for any final product(s) start with the materials being thoroughly checked for quality, quantity, and the sustainability status of yield. Received materials will then be graded and stockpiled with other materials of like quality in readiness for pre-treating/processing into either finished products for local use, or as interim but stabilized products for transfer to specialist sites within the network as required.

BioHubs are proposed to be established in three generic formats:

**Type 1 – Transfer BioHubs** – could be mobile or temporary, employing skid mounted equipment to address a seasonal or short term harvesting opportunity, and value adding the biomass for direct transfer to a “Standard” or “Producer” BioHub for final value adding/processing.

**Type 2 – Standard BioHubs** – a core regional facility servicing between 50-250k population and/or a 100 km radius catchment area, providing all basic biomass receival, sorting, pretreatment and basic product manufacturing capabilities.

**Type 3 – Producer BioHubs** – would be similar to Type 2 facilities, but with much enlarged product manufacturing capability to service a localised market by being supplied with additional biomass materials from other Type 1 or 2 facilities.

The proposed Dubbo BioHub would be a Producer BioHub, receiving partially processed biomass from outside the region to supplement local sources to satisfy the considerable regional demand for biochar based fertilizer products.

In addition to the physical capabilities, the proposed BioHubs, individually and as an integrated network, will provide a wide range of collateral services and economic benefits, including:

- **Sustainable yield assessment and certification** – this service will underpin the full value proposition for all and any resultant products;

- **Biomass trading and brokering** – this activity will go to establishing fair market value for all types of biomass in this emerging sector;

- **Value adding to primary activities** – by realising full value for the wastes, residues and by-products from the primary activities of the forestry, agriculture and urban waste activities, they will all benefit from improved viability;

- **Supply assurance** – many complex, advanced biomass processing and refining facilities are only possible or viable if secure and reliable supplies of tightly specified biomass is cost effectively available – a particular service the BioHubs aim to provide;

- **Encourage new technology development** – the entire biomass harvesting, processing and final product manufacture supply/value chain requires a wide range of new and improved technology solutions. BioHubs will provide real time functional Best Available Technology (BAT) implementation opportunities for new technology developers and vendors, and also provide opportunities for pilot or demonstration offerings to prove themselves in real life but non-critical circumstances;

- **Optimisation of agroforestry and sustainable land management practices** – many revegetation or woody weed management programs are limited by the availability of the
budgets to undertake these primary activities. The provision of BioHubs offering fair market value for any surplus biomass arisings over time will support much expanded activity in this area; and

➢ **Transforming how urban waste minimisation initiatives are achieved** – the ability to recover and reclaim the entire residual biomass fraction from urban waste streams (approx. 60%) for less than the current “true cost of disposal” will provide a “game changing” advance for state and local authorities.

**Biomass Sources**

Of the five generic potential sources of biomass identified, four; forestry and agriculture harvesting residues, forestry and agriculture processing residues and by-products, land management programs and urban waste arisings, produce sustainably yielded biomass as a currently undervalued secondary activity. For the fifth, specially generated oilseed corps, algae plantations etc., BioHubs provide a systematic opportunity to value add residues and by-products.

In the Dubbo region some 60 kt/pa of suitable biomass has been identified as being potentially available on a continuous basis and potentially able to be contracted as assured supply to initially capital justify the project initiation. Some 50 ktpa, or approx. 80% of this material currently presents as residual MSW, destined for landfill disposal. A further 17 kt/pa of occasional regional biomass arisings have been identified that might be attracted to such a facility if it was available on a going concern basis.

**Product Opportunities**

Three main product opportunities have been identified for specialist manufacture at the proposed Dubbo regional BioHub.

First, the manufacture of tailor made biochar based fertilizer product that could be efficiently applied via standard air seeder equipment at cost competitive prices, to provide not only the essential high analysis/NPK nutrients in full measure (and associated trace elements needed in each application), but delivered in a composite pellet with 30-60% biochar which not only provides unique soil fertility and carbon sequestration benefits, but also acts to extend and conserve the high cost NPK minerals for a net benefit for farmers.

The second product, metallurgical charcoals, could be manufactured from any low ash hardwoods that might arise from select C&I/C&D materials received, or woody weed/INS materials, or select local saw mill offcuts and sawdust.

The third product would be bioenergy, delivered as heat or steam if a suitable end user had a sustained demand close by the BioHub site. For example, if the BioHub or even the bioenergy part of the plant was located next to the Western Plains Zoo, heat could be provided to animal enclosures during winter.

**Suitable Technologies and Process Options**

Notwithstanding the ability of BioHubs to support and nurture continuous improvement and development of new and emerging technologies 1.4.4 below, the commercial imperative for a possible BioHub to service the Dubbo region will be to adopt only proven or “bankable” processes and technologies.
For example, the recovery of all the biomass from residual MSW streams may be achieved with proven AWT technologies or selected domestic organics collection services (source separation) or even an optimised combination of both.

Residual urban wastes are notoriously difficult to separate such that the reclaimed organic fraction can then be stabilized by composting, with a view to producing finished materials that can be beneficially applied as soil quality improvers.

In a combined scenario, the higher quality (source separated) materials could be applied for immediate composting (made locally, used locally at minimum cost) and the more entrained biomass/organics recovered mechanically for subsequent conversion into biochar products.

This combined approach could achieve the streaming/cascading outcome (above) whilst ensuring the “putrescible” load was removed from residual wastes, and that all the carbon and mineral nutrients were recovered for beneficial use.

( NB: It is recommended that this issue be the subject of a specific cost/benefit study (3.7.1 Table 3.4 below) before any subsequent feasibility study is undertaken).

Viability Assessments

The first order financial analysis demonstrates a satisfactory rate of return for a project of this type, but is currently based on an average assured gate fee of $50-$60/tonne received, but the majority of this income is currently predicated on a “true cost of landfill” amount of $70-$80/tonne to process the regional residual MSW arisings, and conservative, or market established price for the biochar based fertilizers of some $575/tonne. These products should be able to deliver the same or greater benefits to farmers as the $880/tonne high analysis products that they currently apply. So there is leeway in the model to recognise income from “merchant” activities and the provision of community services and in so doing, to place downward pressure on the initially sustaining income from the MSW processing function.

Next Steps

To progress this initiative it is proposed that:

Stage 1 – A prospective local investor group be established, who are attracted by the broad concept described herein, and who would commit to the staged provision of equity in the project, equal eventually to some 25% of the project capital cost. These funds would then be matched on a dollar for dollar basis with grant funding from appropriate state and/or federal programs.

NB: At this stage it is recommended that a supplementary study be undertaken to review the outcomes and recommendations of the “Organics Management Options for the NetWaste Region” – May 2013, to identify additional synergies that could be pursued and thus better inform any subsequent full feasibility study.

This particular study should compare and contrast alternative approaches (eg. Orange City Council) and review emerging initiatives in other regions, such as Griffith City Council (Riverina), or Lithgow/Blue Mountains City Council, or Tamworth/Armidale/New England, or Northern Rivers etc.

Stage 2 – This stage would involve the production of the detailed work plan that established to the satisfaction of both parties the total budget (with contingencies) to progress the project and identify the agreed dollar for dollar contribution required from both private equity and the grant fund party(s).
The product of this stage would be the establishment of agreed project development budget, and the performance milestones to schedule the progressive budget draw downs and the establishment of the agreed governance structures to manage the project as agreed. This structure would oversee the subsequent full feasibility study.

Stage 3 – On achieving financial close, the fully scoped project would then approach an appropriate party, such as the Clean Energy Finance Corporation for the final debt and equity funding to complete and commission the project.
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## Glossary

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<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Anaerobic Digestion</td>
<td>Microbial degradation of biodegradable materials in the absence of oxygen</td>
</tr>
<tr>
<td>Availability value</td>
<td>The value created by just being there to enable transactions that would otherwise not occur</td>
</tr>
<tr>
<td>Biorefineries</td>
<td>Highly specialised facilities that use biomass or biomass derived furnace to produce a range of specialty “drop in” petrochemical supplementary/replacement products or interim products</td>
</tr>
<tr>
<td>Blister pack</td>
<td>An industry separation standard – biomass (cardboard) from plastic (HCF)</td>
</tr>
<tr>
<td>CEC</td>
<td>Cation exchange capacity</td>
</tr>
<tr>
<td>Circular economy</td>
<td>An industrial economy that is restorative and in which biological nutrients re-enter the biosphere productively and technical nutrients circulate at high quality without entering the biosphere</td>
</tr>
<tr>
<td>“Drop in”</td>
<td>Biomass based products that can supplement or directly replace established fossil based products and services</td>
</tr>
<tr>
<td>Ecosystem services</td>
<td>Those natural systems that recycle nutrients, process wastes and provide clean air and water; all products and outcomes on which life on earth depends</td>
</tr>
<tr>
<td>F.E.E.D.</td>
<td>Front End Engineering Design</td>
</tr>
<tr>
<td>Merchant plant</td>
<td>A process plant built to manufacture products or provide services generally, without specific supply or off take arrangements in place as a condition of initial project finance</td>
</tr>
<tr>
<td>Producer BioHub</td>
<td>A BioHub focused to manufacture products in excess of the biomass availability from the local catchment</td>
</tr>
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1. Description of BioHub Concept to be reviewed in this PFS

1.1 Strategic and Economic Need

The basic rationale for the BioHub concept as proposed is based on a simple logic:

i) In the face of the related global agendas of:

   – Climate change;
   – Resource depletion, and the need to establish
   – Sustainable economic systems;

   one outstanding result is the need to limit the use of fossil fuel resources and so to reduce
   Greenhouse Gas accumulation in the atmosphere.

ii) Modern complex economies can not operate without the carbon based molecules currently
    supplied by fossil resources, for a wide range of uses including:

   – The complete range of chemicals and products from the integrated petrochemical/plastics
     sector;
   – Coke/coal/reductant materials that are essential for the metals manufacturing/smelting
     sector;
   – The agricultural fertilizer/soil productivity sector; and
   – Specialised and liquid transport fuels sector, including aviation fuels;

    And, if an efficient pathway can be found to recover Greenhouse Gases from the atmosphere,
    such that the build up generated in the last 200 years can be reduced to pre-industrial levels and
    re-sequestered into the earth’s crust (or even long life infrastructure etc.), then an important
    collateral benefit will accrue.

iii) Biomass was the original source that created the fossil reserves. If the use of such reserves is to
    now be limited, minimised, restricted or eliminated, the logical alternative source of the carbon
    we need to operate the economy is back to biomass itself. Biomass, representing “solar
    powered” CO₂ “harvesting” from the atmosphere, and presented in familiar lignocellulosic
    structures wherever photosynthesis can prevail.

    However, recently (<100 years) grown biomass presents at much lower bulk and energy densities
    than traditional fossil reserves; and rather than being geographically concentrated into efficiently
    extractable lodes, deposits or wells, biomass, whilst ubiquitous, is geographically disparate and
    presenting as more of an agricultural rather than industrially convenient raw material.

    So the basic logic of the BioHub proposal is that for biomass to achieve its essential role in
    supplementing or replacing fossil resources, as “drop in” alternatives in the economy, the standards
    for managing such biomass, and the systems and infrastructure to physically receive, aggregate and
    process such materials need to be developed to efficiently effect the change.

    In response to the “need”, the BioHub concept is proposing a network of facilities with a “Producer
    BioHub” facility servicing the Dubbo region as follows.
BioHubs, as a national network, have been proposed to address the broader receival, aggregation and incremental value adding objectives for the greater national benefit, but with each individual facility, such as the Producer BioHub proposed for Dubbo, generating capital justifying income locally in the provision of products and services will support the higher level all-of-network objectives cost effectively.

Further, the proposed BioHub to service the Dubbo region is anticipated to manufacture tailor made fertilizer products to suit each property and application.

1.2 Proposed BioHub Physical Capabilities

The following capabilities are proposed to respond directly to the practical considerations identified in the summary of need.

1.2.1 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 distances from the point of generation to the first point where the material will begin an iterative value adding process is as short as practical.

A 100km max. radius catchment for the Dubbo region is considered the right balance to ensure a critical mass of incoming material, with the least transport cost inherent in the transaction.

The “receiver of last resort characteristic” reflects the fact that of the five generic sources of potentially available biomass (Section 2), four of them 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.

There may be occasions where the easy access and transparently communicated BioHub option will present as a convenient and ready outlet for the available biomass, for fair value, when compared with other 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 a convenient and logical option for materials that might not otherwise be put to a fully productive use.

1.2.2 Quality Control and Creator of Critical Mass

A comparison with the scrap metal sector is a useful comparator. 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. So too 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 very basis for producing quality assured products at least cost (see “Biomass ain’t biomass” Discussion Paper EWDP 13-012 – attached A i).

If the proposed Dubbo BioHub is established as part of a national network of such facilities, or even if established as a stand alone facility, the capacity to accumulate like materials, as and when they are presented, could act as a basis for supporting the highest value markets for such materials, rather than being inevitably down-cycled with lower quality materials just for want of any other use or application.

1.2.3 Supporting a “Streaming/Cascading” Strategy

To realise the highest net resource value (HNRV) from all materials received or gathered into a BioHub, a foundation concept to generate maximum value and revenue 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, BioHubs would be ideally placed to offer “next best” opportunities, or cascading opportunities for materials presented, rather than be obliged to accept only a binary option of disposal or rejection or basic energy recovery alone (attached Discussion Paper EWDP 13-014 – attached A iv).

1.2.4 Pretreating

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:

- 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).

Pretreated materials can then present to be transported as “interim” products to other sites where product manufacture, based on these materials, is a specialty; or traded/brokered to specialist third parties.

1.2.5 Product Manufacturing

The Renewed Carbon Pty Ltd BioHub concept, when delivered as a network of cooperating regional facilities, will have the ability to address the inevitable imbalance where some regions can attract a surplus of biomass, maybe even of particular types, and some regions may be able to focus on supplying markets with finished products that far exceed the ability of the local region to supply the volume or type of biomass required.

Hence the pretreatment function at all fixed BioHub sites, and even the production of some basic products, such as bioenergy, in most locations. However, certain locations, such as Dubbo, will need
to focus on larger scale product manufacture, supplied not only from whatever biomass is available in the region, but also from the importing of intermediately processed products 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 looks to grossly exceed the capacity of locally sourced biomass to sustain.

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, and in so doing, supply a market that is potentially far larger than any single site or region to fully satisfy on their 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 pretreat materials but 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 for:

- Vegetation management services;
- Seasonal harvesting services; and
- Campaign based land management/clearing/Property Vegetation Management Plan (PVP) execution services etc.

Additionally, certain temporary BioHub sites (with skid mounted and transportable plant and equipment) might be established on an occasional/seasonal/campaign basis and operated only for weeks or months each year in any one particular location, the equipment being rotated to other sites afterwards as required.

1.2.6 Summary of Proposed BioHub Physical Capabilities

To meet the broader network needs, three types of BioHub are proposed, of which the full scale “Producer” BioHub version is proposed to service the Dubbo region.

Type 1 – Transfer BioHubs

These facilities are proposed for servicing special or occasional opportunities as might occur to respond to short term biomass arisings such as local forestry, local agricultural or community needs addressing low volume, seasonal or occasional arisings issues, maybe with mostly skid mounted/transferable capital equipment, making only interim/partially processed products. These facilities would offer biomass receiveal capabilities tailored to suit sporadic or light local demand due to low population, or seasonal availability of certain agriculturally sourced biomass, or specific campaign based availability as with forestry etc.

The basic site would be equipped with load checking (for type, quality and quantity) and storage bunkers for like materials. Process technology might be mobile or skid mounted such that sorting, shredding, screening could be performed by one piece of equipment that services multiple sites a day or two at a time. Similarly, any material that required stabilization could be processed by a fixed or mobile drying/torrefaction unit such that the processed material would be dried, energy
concentrated (torrefied), stabilized to eliminate odour or biological decomposition) and hydrophobic to facilitate any subsequent storage.

The product of such facilities would be predominantly value added feedstocks for delivery to other “feeder” or “producer” BioHubs in the network, for conversion into final products or even selling to specialist third parties as required.

**Type 2 – Feeder BioHubs**

These are the standard or typical BioHub format, servicing 100-200k population (metro) or 100 km radius catchment, and offering the full scope of biomass receival, sorting, pretreatment and basic product manufacture. These more standard facilities would offer all the same services to the local community as the “transfer” BioHubs but would include the fixed pyrolysis capability (or AD or other as required from site to site) so as to be able to produce finished products and bioenergy from locally sourced materials and partially process materials (from Transfer BioHubs). Feeder BioHubs will retain the capability to partially process some materials and forward to specialist “producer” BioHubs if required.

**Type 3 – Producer BioHubs**

These facilities will be similar to Type 2 facilities, but with a dedicated product manufacturing capability added on to service the locally identified opportunities, be they fertilizer products, specialty reductants, bioenergy or liquid fuel precursors.

Producer BioHubs would service 50-100k population for receival, but providing a nationally significant product manufacturing capability (quality charcoal (industry) or Biochar based all-in-one fertilizers (agriculture).

Producer BioHubs would retain the capabilities for receival and partial processing of biomass as with “transfer” and “feeder” BioHubs but would feature specialist product manufacturing capabilities for the supply to major industrial or agricultural markets.

To service the agricultural sector, “producer” BioHubs will be located to service discrete regional markets making customer specific, all-in-one, biochar based fertilizer products tailor made to suit individual soil types or farm management plans. To service the industrial sector, producer BioHubs would be located adjacent to major customer facilities to fully optimise by-product flows of heat/syngas/bio-oils etc.

Current estimates have identified that to fully service NSW, for example, some 30-40 Type 1 facilities would be required, that would feed into some 12-18 Type 2 facilities and some 4-6 Type 3 facilities for a gross capital cost of some $400 Million Capex. This considerable investment is nevertheless justified by the very high quality products manufactured as described in Section 4.

1.3 **The Proposed Services to be provided from Proposed Dubbo Region BioHub Facility**

With the physical capabilities established as a functioning BioHub entity, the operating business will be able to offer a range of collateral services that will be independently valuable or supportive of achieving the greatest potential value from the actual products manufactured.
1.3.1 **Sustainable Yield Assessment and Certification**

The drivers for optimising biomass as a sustainable source of carbon, to replace or supplement fossil resources, (2.1 above) 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) The observance of 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;
- The provision of sufficient food and fibre to sustain the global population;
- The provision of amenity and recreational services; and
- The provision of biodiversity and habitat.

In the face of a wide range of competing requirements and values, 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 amongst the wide range of competing uses and values of certain biomass supplies. As such, the sustainability of any such biomass yield needs to be assessed in absolute terms in relation to the absolute 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)\(^1\).

Whilst many parties and countries are currently grappling to establish bioenergy/biomass sustainable use and yield standards, the immediate driver, in the face of carbon being priced in the economy and carbon sequestration being valued and recognised, 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, or, if 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 fuels), it is ultimately the certifiable sustainability of the yield of the source biomass which enables the manufacturer to market the final product as having the claimed lower carbon profile, and to be able to request acknowledgement of the lower carbon emissions liability, in jurisdictions where a legislated price has been put on such CO\(_2\) emissions.

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

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1.3.2 Trading, Brokering – Establishing Fair Value in the Biomass Market

As discussed 3.2 below and Discussion Paper EWDP 13-012 (attached A i), biomass presents in a wide range of different forms, at different times and for different reasons, with each form being best suited to the manufacture of different materials, products or energy in response to varying market demand from time to time.

The wide range of biomass materials discussed and categorised (Section 3) are currently wasted, undervalued or simply lumped together into high level generic categories, considered only suitable for leaving on the ground in a passive attempt to return nutrients to the soil, or for simple composting or for energy production as a primary activity.

The active involvement of BioHubs, operated as described herein, either as individual sites servicing a local region, or as an integrated network supporting national markets, will not only raise awareness of the different properties, characteristics and values of the various biomass types presenting, but will also 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 can not yet be valued in this initial PFS.

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

Whilst it is the task of this PFS to assess and evaluate the viability of the core functions of the proposed BioHubs: to value add biomass and provide the essential systems, infrastructure and logistics to channel disparate biomass arisings towards specialised processors and end users, 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.

1.4.1 Adds Value to Primary Activities

By providing the cost effective and sustainable realisation of lasting value from wastes, residues or surplus biomass sources (2.1-2.4 below), the efficiency and sustainability of the respective primary activities will be enhanced and their viability improved.

Even biomass source 2.5 below will benefit from accessing established systems, infrastructure, markets and trading values.

1.4.2 Sustainable Yield Certification

One of the core drivers of the move to optimise the use of biomass as a raw material into a complex modern industrial economy is the need to negate or minimise the impact of the unsustainable release of fossil CO₂ to the atmosphere. In jurisdictions where a price has been attached to such carbon emissions, the switch to biomass resources will only qualify to offset or reduce such liabilities if the source of the applied biomass can be certified as arising as a sustainable yield and application.

As the first points of receival for such materials, BioHubs will provide tangible value to end users (or carbon liable parties) by providing an assured basis for all subsequent sustainability and carbon evaluations.
1.4.3 Supply Assurance for Specialist End Users

Many of the potential end uses and markets for specialist biomass derived products (Section 4) are currently unviable to initiate because suitable supplies, by quality and quantity, are not available in either absolute terms or for all practical purposes, due to geography and/or the lack of the logistics systems.

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

1.4.4 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:

i) 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

ii) 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.

1.4.5 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 simple products like 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.

1.4.6 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, biodiversity/wildlife corridors etc., are all activities that have a primary motive but which also have the potential to yield sustainable supplies of biomass as a supporting or resultant benefit.

Having a local BioHub as a receiver of last resort is proposed to open up options for land owners and managers that can improve the viability of the primary activity by ensuring that the secondary benefits of producing surplus biomass can be delivered for fair value to a local BioHub.

This provision of service by the BioHubs has a parallel in the cropping sector, where the installed capacity provided by the railhead silo infrastructure addresses the ready access to markets and
distribution infrastructure for the grower, who is 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 budgets available to address such issues, but with a regional BioHub offering fair value for the resultant biomass arisings and providing extension harvesting services, such crucial programs should be able to be much more dynamic and effective.

1.4.7 Direct Support for Urban Waste Minimisation Programs

Australia currently produces some 30 Mt/pa of urban waste. Some 60% is “biomass” and, if this material is separated from the balance of the material (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 present in 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.

1.5 Summary of BioHub Services and Benefits

This PFS will not be able to fully confirm the cost and benefit of the collateral benefits that are proposed to be provided as above. The detailed business modelling will need to occur at any subsequent full scale Feasibility Study stage, especially where a related F.E.E.D. process has established accurate Capex/Opex values as an outcome of a detailed vendor enquiry process. Nevertheless, primary viability can be estimated based on establishing a net value for available biomass inputs, projected values for all products and direct services provided and the best estimate values for providing and operating the essential equipment necessary to achieve the conversion processes.

However, to support any subsequent economic analysis, or cost/benefit assessment, the various collateral benefits are listed in Table 1.1 for reference.
### Table 1.1: Collateral services and benefits offered by BioHubs

<table>
<thead>
<tr>
<th>No.</th>
<th>Service or Benefit</th>
<th>Potential Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Assessment and certification of the sustainability status of the materials presenting at the BioHub</td>
<td>To be assessed and valued in final Feasibility Study</td>
</tr>
<tr>
<td>2</td>
<td>Platform to trade or broker biomass resources, as presented or partially processed, to third parties (eg. local compost operations) or between other BioHub facilities in the emerging network</td>
<td>To be assessed and valued in final Feasibility Study</td>
</tr>
<tr>
<td>3</td>
<td>Value adding various primary activities (forestry, cropping, grazing, waste management or land management) by placing a market value on current by-products or residues</td>
<td>To be assessed and valued in final Feasibility Study</td>
</tr>
<tr>
<td>4</td>
<td>Providing “supply” assurance to high value product manufacturers (eg. liquid fuels, reductants, petrochemical precursor chemicals etc.) to enable them to capital justify expensive and specialist operations secure in the knowledge that the necessary and appropriate biomass feedstocks will be available</td>
<td>To be assessed and valued in final Feasibility Study</td>
</tr>
<tr>
<td>5</td>
<td>Support for specialist technology developers and vendors by: i) Providing functional specification information direct from the supply chains to inform their respective focus and activities; and ii) Offering approved sites for pilot and demonstration activities, where inputs and off takes are readily available.</td>
<td>To be assessed and valued in final Feasibility Study</td>
</tr>
<tr>
<td>6</td>
<td>Providing receiver of last resort facilities for biomass materials recovered from urban waste streams</td>
<td>To be assessed and valued in final Feasibility Study</td>
</tr>
</tbody>
</table>

**Economic value of these services** $?
2. The Generic Biomass Categories

Regional biomass arisings have been addressed under five generic headings. These headings have been developed to differentiate the physical and commercial characteristics of the biomass, and to facilitate a subsequent analysis of the cost and conditions of such materials if they were to present at the gate of the proposed BioHub.

2.1 Forestry and Agricultural Harvest Residues

These refer to the primary harvesting residues where the tops, roots, straw or reject material are left on the forest floor or in the paddock, because they have insufficient value to be worth harvesting (separately from the primary material) and/or they can at least offer nutrient retention and/or erosion mitigation benefits.

Various strategies are available to greatly improve the harvesting efficiency of these materials, but nutrient retention, soil protection and erosion control are important benefits and vital sustainability outcomes to be observed. If such secondary harvesting is to occur, it must be conducted such that the essential criterion of sustainable yield is achieved. (Discussion Paper EWDP 13-012 – attached A).

These materials can present as relatively homogeneous and therefore valuable biomass supplies into a biomass based, product manufacturing sector. However, such materials will usually present occasionally, on a campaign basis, or seasonally, at harvest time, and therefore the post harvest, first point of receival systems and infrastructure to optimally value add these materials must be established with these inherent supply characteristics in mind.

Recent estimates (2011)\(^2\) suggest that SE Australia generates some 3.5 Mt/yr of forest residues and some 750 kt/yr of agricultural residues. These statistics need to be confirmed, and then discounted to reflect what could be economically collected and what should be left at source for soil quality protection purposes.

2.2 Forestry and Agricultural Processing Residues and Wastes

These materials refer to all the post harvest processing residues and by-products, including bark, offcuts, sawdust, shavings, husks, pulp and sludges that arise from the entire post harvest to final product wholesale of the food, fibre, pulp and paper, saw log and wood chip sectors.

These materials are addressed quite separately from harvest residues above because they present in quite different forms and at various levels of homogeneity, assured quantity and reliability/regularity of supply. In many instances on site energy production from such materials is common (eg. bagasse, saw mills and timber processing for green wood curing, and heat and power production for internal use and even export).

But just as often, such materials present as low value by-products or wastes to be removed to avoid constraining the primary activity. However, in cases where secondary value adding activities can be established, basic heat and power raising may be shown to be a suboptimal end use for such materials.

\(2\) Australian Bioenergy Roadmap, Clean Energy Council, 2008
Such materials can present into the emerging biomass economy as homogeneous and reliably supplied and as an attractive input material for subsequent value adding when combined with similar materials from multiple sources. Higher value product manufacturing may well be viable when compared with the current and traditional practices. Establishing biomass value adding facilities adjacent to, or in collaboration with such major agricultural or forest products manufacturing facilities, such as sugar mills (bagasse), feedlots, piggeries, chicken sheds, saw mills, pulp and paper plants etc. may well provide an important critical mass for such operations.

**NB:** In passing it is worth noting that this logic assumes that the primary focus of the forestry or agricultural activity is the production of food or fibre, which represents a higher purpose and market value than simply providing biomass feedstocks (predominantly basic lignocellulosic materials – Discussion Paper EWDP 13-012 – attached A i) for conversion into predominantly industrial products or services. However, there may be situations, for example, where a cereal crop has spoiled or been otherwise degraded so as to render it unsuitable for its respective primary food or fibre application, or maybe it is a surfeit, in an oversupplied market and worth more as an occasional source into the prevailing biomass market. In these circumstances, the available material will present with similar characteristics as the other materials in this category but would benefit from being able to access “receiver of last resort” facilities where a fair market price is available for the “spot” biomass supplies, within the locale, to avoid unnecessary transport or logistic complexity.

These potential feedstocks into the emerging biomass value adding sector present as relatively homogeneous, reliably available in quantifiable volumes and often at a competitive price/gate fee, since they are not core products for the generator. Incrementally improved end uses can present as commercially attractive options where the basic core business is the focus of management time and resources, and where the value adding opportunity arises from particular specialisation and aggregation of multiple such sources.

### 2.3 Urban Waste Streams

These materials represent the post consumer residues that were originally supplied by the agricultural and forestry industries (food, fibre, pulp and paper products, wood/timber materials after various stages of conversion and complex transformation, even biosolids). The only new material presenting in these waste streams that didn't originate in the original agricultural and/or forestry sectors is domestically/locally generated green/garden/vegetative material for which council composting schemes often provide the most cost effective post consumer solution.

These materials are currently managed and handled as wastes, where the emphasis is on minimising the costs and impacts of collection and disposal, with some limited attempts at composting certain materials. This is mainly because composting is a least cost processing option, rather than because the highest value products have been systematically identified and the necessary production processes adopted.

These materials currently present as costly waste disposal material flows, and as such, could present with a positive gate fee for a properly established biomass value adding processing facility. These materials are also produced 365 days/yr and therefore could provide feedstock certainty for emerging biomass converting facilities.

To optimise the utility and quality of these materials, the existing waste management sector should be encouraged to adopt “streaming and cascading” strategies. In this way, waste generators are encouraged to source separate biomass material flows so that they can present with the least amount of contamination from other residual wastes as possible/practical, and simultaneously...
provide cascading or “next best” process options for materials not presenting for their highest net resource value (HNRV) end use (Discussion Paper EWDP 13-014 – attached A iv).

Recent estimates (2011 – EPHC Waste Policy), when extrapolated, indicate that the South East area of Australia (SA, VIC, NSW, ACT and SE Qld) generates:

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Amount (kt/yr db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic fractions of MSW (putrescible)</td>
<td>3,700</td>
</tr>
<tr>
<td>Garden/green waste (domestic/parks and gardens etc.)</td>
<td>900</td>
</tr>
<tr>
<td>C&amp;I/C&amp;D biomass fraction (mostly wood waste)</td>
<td>1,350</td>
</tr>
<tr>
<td><strong>Approx. Total</strong></td>
<td><strong>6,000</strong></td>
</tr>
</tbody>
</table>

These materials are low/negatively valued and often putrescible, meaning that they need to be processed close to source and daily, to avoid public health issues or odour etc. This characteristic alone means that localised receival and primary processing facilities need to occur to directly address the specific issues related to these potential feedstocks.

### 2.4 Land Management and Development Sources

These materials present in at least two main categories:

**a) Development/infrastructure clearing/maintenance operations**

This occasional, project specific source of biomass occurs where vegetation is cleared to allow new (green field) development or infrastructure construction and/or the maintenance of such infrastructure installations such as maintaining clearance under powerlines, or along transport corridors etc.

These initial development sources occur once only, but often in substantial quantities and are often relatively homogeneous and of high quality. The production of regular maintenance volumes of biomass can occur to a regular schedule, but often in remote or inaccessible areas.

For these materials to be reliable feedstocks into a biomass economy, the first point of receival facilities need to be readily accessible and conveniently located, and able to realise fair value for the materials being presented, as and whenever they arise.

**b) Woody weed/land management sources**

Whether crown land, council land or private land, the management of invasive species, weeds or unwanted regrowth etc. has the potential to generate significant volumes of sustainably yielded biomass supplies, as a by-product of the primary activity. This optimises the utility, value and productivity of the affected lands.

The most appropriate interface between the emerging biomass based economy and these two potentially sustainably yielded sources would appear to be the provision of dedicated harvesting/vegetative management contracting services, operating out of or for local fixed processing facilities.
This way the mobile collection/harvesting equipment can work to supply which ever fixed processing plant is the most convenient for any one contract opportunity.

2.5 Special Purpose/Industrial Farming, Plantations, Agroforestry or Intensive Algae Production etc.

These materials all have a common characteristic in that they have been planted/grown for the primary or predominant objective of providing the emerging biomass economy with quality feedstocks for a fee. As such, they may well present as the highest quality feedstocks available to the emerging biomass processing sector and be available as contractually assured. However, this high quality and assured supply will present at the highest price to the local processor. In essence, suppliers of such materials would do so as their primary activity, and so look to generate their primary return on investment from the sale of these materials. This contrasts with the commercial circumstances pertaining to the provision of the alternative sources described above (2.1-2.4) in that available biomass from these sectors will present as by-products.

a) Agroforestry sources

An existing agricultural enterprise may be considering revegetation of portions of their property for a wide range of collateral benefits, such as:

- Replanting ridge lines, riparian zones or as wind breaks etc. to achieve erosion mitigation benefits, river bank stabilization, shelter, biodiversity outcomes, or even native fauna migration corridors or a combination of all benefits, but an eventual outcome will be an inevitable short, medium or long term yield of surplus biomass to be optimised as an integral factor in the overarching property management plant.

Such materials may well be produced on too sporadic a basis to justify dedicated downstream processing facilities in their own right, but in aggregate, could present as a reliable baseline of biomass supply into facilities that were established and capital justified on other (as above) available biomass sources in the first instance.

- Dedicated biomass plantings on the less productive portions of such properties where the return from select biomass production can demonstrate commercial benefits when compared with the primary activity (food, fibre) of the specific property.

Such plantings may well be undertaken only where assured off take arrangements can be contracted as a precondition of the planting in the first place.

b) Dedicated plantings and plantations

This source of biomass is a common supply option for the existing forestry sector, where the volume, location, species and harvesting schedules are determined by the requirements of the local pulp, paper, saw mill or export opportunity. In many cases this activity generates harvest residues (2.1 above) and value chain by-products (2.2 above), however with the emergence of a fossil resource replacement biomass processing sector, even the primary plantings could be produced for profit for these new processing facilities. In these circumstances different species’ harvesting schedules and collateral benefits may inform what is actually grown, where planted and how managed, but the essential activity will be very similar to the plantation activity we currently recognise. Such sources of dedicated production will be essential if the emerging biomass processing sector is to reach its full commercial potential. Nevertheless, whilst the prospective markets are being established and the conversion technologies are becoming
incrementally more efficient and cost effective, this potential biomass supply source may well present as too expensive, even though the quality and reliability could be of a premium standard.

This source of biomass might become progressively more attractive to land holders needing to adjust to the regional and localised effects of climate change. In these circumstances, marginal food and fibre production land may turn out to be best applied for biomass production where careful management plans are developed to address the full range of sustainable land use issues and the sustainable provision of ecosystem services, whilst recognising the potential for simultaneous, selected mixed species biomass production as the basis for alternative local commerce.

A corollary of changing national land use could also include the development of previously marginal lands (in the heavier rainfall northern zones?) such that selected development clearing would also produce a significant supply of biomass (2. 4 (a) and (b) above).

c) *Algae or other such highly industrialised methods of biomass production*

Such biomass production techniques hold considerable promise for large scale, highest value/quality assured and industrial levels of reliable supply; they also demonstrate the highest levels of solar conversion efficiency into biomass. However, such technologies are developing and emerging, and should be considered as medium to longer term prospects.

Nevertheless, their eventual commercialisation pathway will benefit from being able to access convenient and existing markets and biomass conversion facilities, if not for their primary products, then at least for secondary or by-product outputs.

2.6 **Generic Biomass Sources Summary**

Table 2.1 summarises the various types and sources of biomass that are, or could be, available to support Australia’s apparent competitive advantage as a producer of high quality biomass based products and services. However, future viability for utilizing these materials will revolve around efficient aggregation pathways. At least two options present.

The first can utilize the platforms created by existing industries, such as sugar and/or pulp and paper, and the second requires a completely new suite of systems and infrastructure to provide the logistics framework common to most agricultural systems. For example, rail head silos as first-point-of-receival for cereal growers.

This issue revisits the fact that biomass presents with low energy and bulk density, and high moisture content when compared to the fossil resource reserves, with which so many of the eventual product outcomes are physically, chemically and economically compared. For example, in the Australian sugar industry in Northern NSW the three mills were erected in the three adjacent valleys to serve the three separate cane growing areas. In other forms of industry one larger mill to service the three regions might have been considered. This highlights the critical production cost of moving bulky, low value cane in proportion to the processing cost and the value of sugar products.

In Qld by comparison, a light rail system was established to alleviate this issue based on the statistic that sugar yield is only some 7% of the weight of harvested cane.

However, since the sugar industry has now created a viable harvesting and aggregation system, both the finished sugar and the homogeneous and high quality bagasse by-product stream now present as a practical platform to value add both materials.
A similar argument can be advanced in the pulp, paper and saw log industries, where process plants are located surrounded by the essential forestry resource. In both cases it could be argued that the situation is exacerbated by the fact that both industries only produce “commodity” priced sugar, wood chip, or sawn timber in the first instance, with the result that both have now been identified as sustainable supply platforms for optimised value adding of these basic “commodity” products.

This situation in the established sugar and forestry industries not only presents a platform for growth and value adding, but also highlights the vital issue of the lack of any systematic aggregation and value adding facilities and infrastructure for most other sources of biomass as summarised in Table 2.1.
## Table 2-1: Essential Biomass Supply Characteristics

<table>
<thead>
<tr>
<th></th>
<th>1 Sustainability of biomass yield</th>
<th>2 $ Value/gate fees likely to be realised at the gate of the initial processing centre (or BioHub)</th>
<th>3 Reliability / predictability of supply or availability</th>
<th>4 Relative quality of material</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Agricultural &amp; forest residues</td>
<td></td>
<td>-200 0 200+</td>
<td>365 days/yr Regular but seasonal</td>
<td>Homogeneous Heterogeneous</td>
</tr>
<tr>
<td>2.2 Downstream processing of agricultural &amp; forest materials</td>
<td></td>
<td>(30)------150</td>
<td>X X</td>
<td>X X</td>
</tr>
<tr>
<td>2.3 Urban wastes</td>
<td>Essential prerequisite for all sources if the benefits over using fossil resources are to be fully achieved and monetized.</td>
<td>(100)--0</td>
<td>X</td>
<td>X X</td>
</tr>
<tr>
<td>2.4 Land management residues</td>
<td></td>
<td>(50)--0</td>
<td>X X</td>
<td>X X</td>
</tr>
<tr>
<td>2.5 Special purpose plantings</td>
<td></td>
<td>(60)--0</td>
<td>X</td>
<td>X X</td>
</tr>
<tr>
<td>a) MSW organics</td>
<td></td>
<td>(20)---50</td>
<td>X X</td>
<td>X X</td>
</tr>
<tr>
<td>b) Green/garden wastes</td>
<td></td>
<td>(20)---50</td>
<td>X X</td>
<td>X X</td>
</tr>
<tr>
<td>c) C&amp;D/C&amp;I wood wastes</td>
<td></td>
<td>0-----80</td>
<td>X</td>
<td>X X</td>
</tr>
<tr>
<td>a) Development/infrastructure maintenance operations</td>
<td></td>
<td>50---150</td>
<td>X X</td>
<td>X X</td>
</tr>
<tr>
<td>b) Woody weed/land management sources</td>
<td></td>
<td>50---150</td>
<td>X X</td>
<td>X X</td>
</tr>
<tr>
<td>c) Agroforestry</td>
<td></td>
<td>50---150</td>
<td>X X</td>
<td>X X</td>
</tr>
<tr>
<td>c) Dedicated plantations</td>
<td></td>
<td>50---150</td>
<td>X X</td>
<td>X X</td>
</tr>
<tr>
<td>c) Algae and similar</td>
<td></td>
<td>50---150</td>
<td>X X</td>
<td>X X</td>
</tr>
</tbody>
</table>

### NOTES:

**Column 1:** A primary purpose of stimulating and then optimising biomass based activities to supplement or replace fossil resource sources of carbon/energy, in the economy, is to achieve ecological sustainability. Useful reference documents include:

**General:**

**Urban Wastes:**
- Sustainability Guide for EFW Projects and Proposals – WMAA, 2004

**Column 2:** In the early stages of the development of the emerging biomass processing sector, the markets are nascent and the technology is in early stage commercialisation, so that for most first-of-type, initial processing facilities, commercial viability relies on the operator receiving a gate or receival fee, even if in time, such facilities will be able to afford to pay growers/suppliers for the higher quality biomass available.

**Column 3:** A fixed processing plant needs to operate as continuously as possible to ensure early stage viability and this will require reliable and continuous supplies of suitable feedstocks. Materials that are available all year, preferably under contract, are essential to establish an initial plant. However, when such a basic capability is established the same facility can proactively schedule receipt of materials (usually agricultural residues) only available on a seasonal basis (cropping cycles – bagasse, straw etc.) and also operate contract biomass harvesting operations to exploit sporadic or campaign based sources such as green field, development clearing activities, woody weed management or even power line and transport corridor maintenance contracts.

**Column 4:** Homogeneous materials provide a higher quality process feedstock and are best suited to the production of the highest quality end products. Mixed or indeterminate or heterogeneous materials tend to be only suitable as generic carbon sources for blending or for lower value product manufacture.
3. **Actual Regional Biomass Arisings**

3.1 **Introduction and Context**

As discussed in Section 2, BioHubs are intended to provide a first point of receival/receiver of last resort service. For many potentially available sources of biomass it is the availability of the option created by establishing a BioHub that will stimulate certain non critical sources of biomass to be presented at the gate. To seek to contract defined quantities of such non critical sources of biomass will require both generator and receiver to define terms and outcomes, which may be best agreed upon, on a case by case basis, especially in the early stages when the opportunity has yet to be fully entrenched in the forward planning of both parties.

However, even the basic BioHub facility can not be capital justified or established without having a basic minimum commercial operation, that whilst receiving biomass for a fee and making basic products to sell, can then provide the more discretionary services outlined in Section 2.

In reviewing the potential sources of biomass arising in the Dubbo region, some can only be discussed in broad terms, as being logically available, and therefore worth consideration only in a “going concern” context. Other biomass sources that could support the minimum business model and therefore support the establishment of a basic operation and capability will be described in sufficient detail as to provide a platform for subsequent negotiations between the parties.

3.2 **Forestry and Agricultural Harvesting Residues**

3.2.1 **Forestry**

There is negligible forestry activity in the 100 km radius of Dubbo. The closest forestry regions to Dubbo are the Bathurst/Oberon/Orange areas in the South and from Coonabarabran in the North and from Mudgee and New England area in the East; all of which are beyond the regional focus of this PFS.

Any limited forestry or plantation residues that might arise in the region from time to time should be considered in the PFS as a purely opportunistic arising that might be attracted if such a facility was available on a “going concern” basis.

3.2.2 **Agricultural**

There are some 22,000 km² of cropping activity within the study area.

The cropping activities generate some 2.5 Mt/pa of straw (AEMO) but as some 70% of properties are now “no till” operations, straw and stubble is predominantly left on/in the ground for nutrient retention and erosion control objectives. Where straw presents in excess of such requirements it is baled (approx. $70/t) and sold into the established market for straw. Where spoil or low value degraded straw arises, the usual outlet is to the mushroom growers for composting, where the degraded characteristic is a benefit. The current price for such material is some $130/t.

If surplus straw is generated in a good year, or excess, spoilt or degraded straw presents to a BioHub, it should be considered in the PFS as a purely opportunistic arising.

Grazing activity is not considered as a significant source of harvesting residues.
Cotton Trash

Currently Auscott Ltd generates approx. 5,000 t/pa of cotton trash at Warren and Trangie respectively.

These materials are generated from April to July each year\(^3\).

Current approaches are to compost the material for reapplication to the paddocks as a soil conditioner.

As produced, cotton trash has a low bulk density which is a disincentive to transporting this material any significant distance.

However, if it was viable to pretreat the material to improve energy/bulk density and value, and a tailored “fertilizer” product was available for return and reapplication, this material should be considered as a reliable potential source of biomass for a “Producer BioHub” servicing the Dubbo region.

3.3 Forestry and Agricultural Processing Residues

3.3.1 Forestry

There are four local saw mills, which seem to have their saw dust and off cuts streams under control, but there is a 60 t/pa “saw dust” amount presenting at the landfill. However, whatever the current situation, the BioHub “receiver of last resort” capability will provide an option to the local saw mills, once a BioHub is established; but no carry forward amount can be justified at present.

3.3.2 Agriculture

Local flour milling, food processing and the abattoir have all made their own arrangements to process any residues – mostly composting.

Again, once a BioHub is established it may offer value and convenience to this sector, but there are currently no pressing waste issues of sufficient immediacy as to provide foundation support for a BioHub.

Feedlots and poultry sheds are either slightly outside the study area or have existing arrangements; but once a BioHub is established, value might be demonstrated without this sector being foundation stakeholders.

The sale yard wastes would be very attractive inputs to the proposed BioHub facility, if existing approaches ever proved unacceptable.

All considered opportunistic supplies available only at this time.

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\(^3\) Direct correspondence with Chris Hopendyk – Auscott, 30/05/13
3.3.3 Zoo Poo

Currently the Western Plains Zoo is managing all manures and green waste with onsite composting. However, with the increased population of elephants (and a new baby white rhino) along with expansion plans for growing additional forage on site, some 2,500 t/pa of surplus manure, bedding and inedible forage stalks could be usefully processed at the proposed BioHub as a potential carry forward amount (subject to mutually agreeable gate fee conditions)\(^4\).

3.4 Urban waste Streams

3.4.1 MSW and C&I

Dubbo City Council operates its own landfill facility, the Whylandra Depot, to the north of the city. It has plenty of future capacity but the effective “true cost of landfill”, with all relevant indirect externalities included, was estimated in a survey conducted by Impact Environmental as between $60-$100/t Figure 30, p. 50.

Table 3.1 reflects the gross volumes currently received at Whylandra Depot.

The volumes of similar wastes generated in Narromine and Gilgandra, not currently received at Whylandra Depot are included to indicate potential regional volumes if a BioHub was established that could process these materials for a more sustainable regional outcome that was attractive to Narromine and Gilgandra respectively.

Table 3-1: Regional residual urban waste flows

<table>
<thead>
<tr>
<th></th>
<th>Approx. t/pa received</th>
<th>Totals t/pa</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MSW</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dubbo City Council</td>
<td>23,000</td>
<td></td>
</tr>
<tr>
<td>Wellington</td>
<td>3,000</td>
<td></td>
</tr>
<tr>
<td>(Gilgandra)</td>
<td>2,700</td>
<td></td>
</tr>
<tr>
<td>(Narromine)</td>
<td>3,300</td>
<td></td>
</tr>
<tr>
<td><strong>Total MSW</strong></td>
<td></td>
<td>32,000 t/pa</td>
</tr>
<tr>
<td><strong>C&amp;I – organic fraction &amp; wood wastes etc.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dubbo City Council</td>
<td>Approx. 20,000</td>
<td></td>
</tr>
<tr>
<td>Wellington</td>
<td>To be assessed</td>
<td></td>
</tr>
<tr>
<td>Gilgandra</td>
<td>To be assessed</td>
<td></td>
</tr>
<tr>
<td>Narromine</td>
<td>To be assessed</td>
<td></td>
</tr>
<tr>
<td><strong>Total C&amp;I</strong></td>
<td></td>
<td>20,000 t/pa</td>
</tr>
<tr>
<td>Approx. current totals available for more cost effective treatment and value adding at regional BioHub if established as proposed</td>
<td>52,000 t/pa</td>
<td></td>
</tr>
</tbody>
</table>

\(^4\) Personal telecon with Gary Dawson, WPZ
If a regional BioHub was to accept such urban wastes for processing, presumably the following conditions would need to apply:

1) That the BioHub could provide the service at a cost no more than the agreed “true cost of landfill” and provide long term certainty that receiptal costs would escalate at no more than CPI, thus providing budgetary certainty for council customers;

2) That the processing option was proven, reliable, robust and “unbreakable” with no risk of unacceptable effects, impacts or emissions;

3) That any alternative to landfill solution could accommodate future population growth and even demonstrate an attraction to ongoing economic development in the region; residential, commercial and industrial;

4) That such arrangements could remove all the organic/putrescible material from the residual waste stream such that remnant fractions could be applied as resources rather than wastes for disposal. Such an outcome might reflect:
   - Organic fraction – approx. 50-60% – to present as a supplementary ingredient at the BioHub for the manufacture of biochar products;
   - High calorific/residual plastics – approx. 20-30% – off site application as fuels, steel making ingredients and/or specialty products;
   - Metals – approx. 4% – to existing scrap sector; and
   - Inerts – approx. 15-20% – civil/base course applications.

   NB: In this scenario, only hard waste (product stewardship) collections would remain for disposal or other industry promoted arrangement.

5) Limit or avoid any potential exposure to Council for process or market risk; and

6) Provide maximum convenience for residents to optimise (source separation) participation rates.

3.4.2 Biosolids

The excellent facilities at Greengrove where the locally produced biosolids are used to grow lucerne, under centre pivots supplied with waste water, demonstrates significant investment that is producing HNRV outcomes for the community. A prospective BioHub could offer only back up or “bypass” receiptal services in the event that the current arrangement required such an outlet. Similar services could be offered for saleyard waste if current arrangements were constrained at any stage.

3.5 Land Management/Development Biomass Arisings

3.5.1 Greenfield Clearance Arisings

Each time land is cleared for housing, roads, infrastructure or development of any kind, public or private vegetation is likely to be removed.

These materials are currently being handled by the proponents, or perhaps windrowed and burnt, or they feature in the vegetation statistics presenting at the landfill.
In any event, if a BioHub is established, it will provide a convenient and cost effective first point of receival, however potential volumes can not be defined for the purposes of this PFS, other than as a deemed estimate.

3.5.2 Vegetation Management Services

Biomass arisings from this activity include everything from parks and gardens maintenance, and roadside clearing, to under power lines clearing etc. In some instances, such as power line clearing, the biomass is left on site, being too difficult to recover, especially without a strong market for the material if extracted.

Again, these arisings do not currently present as an assured input into a proposed BioHub, but some will if a BioHub is available.

3.5.3 Woody Weeds/Invasive Native Species (INS)

This source of biomass has significant potential to supply biomass to a BioHub in both a raw/directly harvested form for materials arising within the 100 km radius catchment, and as pre or partially treated materials, even pre-charred, as an extension service for arisings outside or on the border of the proposed catchment area.

However, the logical or optimum yield of this material is complicated by the historical context and existing policy and regulation, as well as the lack of the appropriate value adding facilities to fully explore this opportunity for sustainable biomass yields.

A very brief background to the peneplain/woody weed/INS issue is as follows:

i) The peneplain area is described in Figure 3.1.
Before European settlement, the region consisted of woodland with grassy understorey which had been maintained in this form by thousands of years of Aboriginal “fire stick” farming (Fig. 3.2).
iii) Europeans then reduced burning and ringbarked the woodlands. After a combination of devastating fires, rabbits, some high rainfall seasons, and over grazing, the net result was that the cypress pines grew back quickly and crowded out grassland and slower growing species.

iv) This overcrowding has caused a loss of ground cover and exposed the ancient soils to erosion.

v) In recent times, proactive land management practices and strategic clearing has demonstrated the ability to restore the land to pre European grassy woodlands, ideal for sustainable and productive grazing once again.
vi) However, in restoring the grassy woodlands, the cleared vegetation is windrowed and burnt.

vii) The invasive native species to be managed include a wide range of timbers, some slow growing hardwoods and some “early adopter” less valuable timbers (Table 3.2).

**Table 3-2: Invasive Native Species**

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia aneura</td>
<td>Mulga</td>
</tr>
<tr>
<td>Acacia homalophylla</td>
<td>Yarran</td>
</tr>
<tr>
<td>Callitris endlicheri</td>
<td>Black Cypress</td>
</tr>
<tr>
<td>Callitris glaucophylla</td>
<td>White Cypress</td>
</tr>
<tr>
<td>Dodonaea viscosa subsp. angustissima</td>
<td>Narrowleaf Hopbush</td>
</tr>
<tr>
<td>Dodonaea viscosa subsp. spatulata</td>
<td>Broadleaf Hopbush</td>
</tr>
<tr>
<td>Eremophila longifolia</td>
<td>Emu Bush</td>
</tr>
<tr>
<td>Eremophila mitchelli</td>
<td>Budda, False Sandalwood</td>
</tr>
<tr>
<td>Eremophila sturtii</td>
<td>Turpentine</td>
</tr>
<tr>
<td>Eucalyptus intertexta</td>
<td>Red Box</td>
</tr>
<tr>
<td>Eucalyptus populnea</td>
<td>Bimble Box, Poplar Box</td>
</tr>
<tr>
<td>Geijera parviflora</td>
<td>Wilga</td>
</tr>
<tr>
<td>Sclerolaena birchii</td>
<td>Galvanised Burr</td>
</tr>
<tr>
<td>Senna form taxon ‘artemisioides’</td>
<td>Silver Cassia</td>
</tr>
<tr>
<td>Senna form taxon ‘filifolia’</td>
<td>Punty Bush</td>
</tr>
</tbody>
</table>
Currently the area is regulated under the Native Vegetation Act 2003 which contains provisions that hamper the systematic re-establishment of these areas to grassy woodland, but negotiation with the local property owners and their local land care groups, the Cobar Shire Council, the Cobar Rural Lands Protection Board and all NSW Farmers branches in the area, operating as the Cobar Vegetation Management Committee, is working productively to resolve the situation.

This work will assist the Western Region CMA to make informed decisions on the “maintain or improve” criteria (see Discussion Paper #1) which, where strategic clearing and grassing is adopted, could generate a sustainable yield of > 40,000 t/pa of mixed species.

Some of these low ash hardwoods could be suitable as fine furniture timbers, or high density metallurgical charcoals and reductants. Some lower quality timbers could be suitable for biochar production, with bioenergy as a major by-product, which could have a valuable local application in the Cobar “end of the line” power market.

In summary, a BioHub servicing the Dubbo region, and on the main transport routes back to the industrial markets of some of the value added products could well draw some reliable supplies of appropriate biomass to sustain whatever resultant product mix is adopted. Perhaps a Dubbo “Producer” BioHub supplied from mobile Transfer BioHub facilities would be the most cost effective.

Woody weeds, mostly cypress, also occur in significant stands in the immediate Dubbo region and as discussed 2.4.6, such INS management is always constrained by the public budget available to manage such issues proactively. With a local BioHub converting the harvested INS yield into value added products, the viability of more extensive woody weed management is improved.

Certainly an estimated volume of woody weed/INS material can be carried forward to the final biomass availability estimate 3.7.

### 3.6 Dedicated Biomass Generation

This source of biomass is characterised as being produced to provide oil seeds or lignocellulosic feedstocks as the primary activity, not as a by-product as 3.2-3.5 above.

As a primary activity, the product will tend to be of the highest quality and value but require basic return on investment from the primary activity. The products are likely to be dedicated to a particular and pre-contracted end use, such as liquid fuels or platform chemicals.

Such sources include dedicated plantations, algae, oil seed crops etc. Where such materials are processed for their primary yield, biomass residues will arise, and these may well be best processed at a local BioHub.

However, in the absence of any such activity in the Dubbo region, this category of biomass source will only be considered as a potential BioHub feedstock if some such development were to occur.

### 3.7 Potential Biomass Feedstocks

Table 3.3 summarises the likely or potential biomass arisings that could support the development of a region Producer BioHub in Dubbo.
### Table 3.3: Estimate of potential biomass arisings

<table>
<thead>
<tr>
<th>Stream #</th>
<th>Category</th>
<th>Potential at start up</th>
<th>Potential on going concerns basis</th>
<th>Quality Issues</th>
<th>Most suitable resultant product</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Dates / tpa</td>
<td>Date / tpa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Forest Harvest (3.2.1)</td>
<td>Opportunistic</td>
<td>Opportunistic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Agricultural Harvesting (3.2.2)</td>
<td>Opportunistic</td>
<td>Jan-Mar / 2,000, July-Sept / 2,000</td>
<td>Homogeneous, High ash</td>
<td>Biochar &amp; bioenergy</td>
</tr>
<tr>
<td>3</td>
<td>Forestry Process (3.3.1)</td>
<td>Opportunistic</td>
<td>12 mths / 500</td>
<td>Homogeneous, Low ash</td>
<td>Reductants &amp; bioenergy</td>
</tr>
<tr>
<td>4</td>
<td>Agricultural Process (3.3.2)</td>
<td>Opportunistic</td>
<td>12 mths / 2,000</td>
<td>Homogeneous, High ash</td>
<td>Biochar &amp; bioenergy</td>
</tr>
<tr>
<td>5</td>
<td>Zoo Poo (3.3.3)</td>
<td>12 mths / 2,500</td>
<td>12 mths / 3,000</td>
<td>Homogeneous, High ash</td>
<td>Biochar &amp; bioenergy</td>
</tr>
<tr>
<td>6</td>
<td>Cotton Trash (3.3.4)</td>
<td>Apr-July / 10,000</td>
<td>Apr-July / 10,000</td>
<td>Homogeneous, High ash</td>
<td>Biochar &amp; bioenergy</td>
</tr>
<tr>
<td>7</td>
<td>MSW 50% residue, 50% organic (3.4.1)</td>
<td>12 mths / 48,000</td>
<td>12 mths / 52,000</td>
<td>Heterogeneous, High ash</td>
<td>Biochar &amp; bioenergy</td>
</tr>
<tr>
<td>8</td>
<td>Development Arisings (3.5.1)</td>
<td>12 mths / 2,500</td>
<td>12 mths / 3,000</td>
<td>Homogeneous, High ash</td>
<td>Biochar &amp; bioenergy</td>
</tr>
<tr>
<td>9</td>
<td>Vegetation management (3.5.2)</td>
<td>12 mths / 2,500</td>
<td>12 mths / 2,500</td>
<td>Homogeneous, High ash</td>
<td>Biochar &amp; bioenergy</td>
</tr>
<tr>
<td>10</td>
<td>Woody weed/INS (3.5.3)</td>
<td>12 mths / 10,000</td>
<td>12 mths / 12,000</td>
<td>Homogeneous, Ash various &amp;/or Biochar &amp; bioenergy</td>
<td></td>
</tr>
</tbody>
</table>

The information in Table 3.3 supports a range of conclusions or assumptions to be taken forward into Section 4 – Products, Section 5 – Generic Process Flow Description and Section 6 – Financial Model.

#### 3.7.1 General Observations

**Assured Supply**

Only streams 5 (Zoo Poo – 2.5 kt/pa) and 7 (MSW Urban waste streams – Organics fraction – 24 kt/pa) have the potential to be contracted to be processed over the 12 months of the year.

(NB: A recent consultancy for NetWaste (Impact Environmental Pty Ltd) “Organics Management options for the NetWaste Region” has identified that some 15-30 kt/pa of domestically sourced organics could be available for each of the three regional processing centres – Lithgow, Orange and Dubbo. This estimate accords with the 24 kt estimate derived from the Dubbo City Council recent audit data and is based on a similar 100 km radius basis for the estimate).

One additional possibility is the regular arising of Stream 6 (Cotton Trash – 10 kt/pa) from April to July each year but collection and transport issues vs. onsite pre-processing would need to be addressed.

All other potential biomass arisings (Streams 1, 2, 3, 4, 8, 9 and 10) are unlikely to be directly contracted, as assured inputs to a potential regional BioHub, but would most likely seek to observe a BioHubs “receiver of last resort” service. Over time, as mutually advantageous trading arrangements have occurred, tailored supply/receival contracts might eventuate, but with the single possible exception of stream 10, woody weeds/INS materials, none would provide initial supply assurance to capital justify the initial establishment of a local BioHub project.
In the case of stream 10, woody weeds/INS receipt and processing for highest value, perhaps a minimum usage/“availability” arrangement could be negotiated. The driver for such an initiative would hinge on the local CMA seeking to improve the viability, cost effectiveness and scope of systematic woody weed/INS management plans, by securing highest value destinations for removed biomass, and so supplement any budget (public funds and land owner contributions) to support an ever more extensive program.

For the BioHub operator, being able to rely on even minimum and regular flows of materials would support the “bankability” of a start up BioHub project. The ability to then accept and value add additional amounts of material by arrangement within the “preferential access” provisions in such a contract could provide a mutually beneficial basis to achieve and support both parties’ respective ambitions, at least cost and greatest net benefit.

**MSW Pretreatment**

Stream 7 – the residual urban waste arisings contains not only mixed residual (red bin) wastes but also C&I wood waste arisings and some green/garden waste material that is not suitable for higher value mulching/composting.

For the organic/biomass fraction from these materials to be available as a useful input into the core BioHub product manufacturing processes, it must first be separated from all the other non-biomass materials such as plastics, metals, inerts and gross contaminants. Facilities that aim to achieve this task are commonly referred to as Alternative Waste Treatment (AWT) facilities.

Residual urban wastes are notoriously difficult to separate such that the reclaimed organic fraction can then be stabilized by composting, with a view to producing finished materials that can be beneficially applied as soil quality improvers.

Usually such materials, processed mechanically at ambient temperatures, struggle to pass minimum legislated standards for application to land, especially where food production or direct human contact is inevitable. Because certain residual chemical, metal, glass and plastic contamination is entrained in such final “composted” products, they are only allowed to be used in selected, non critical applications such as mine site remediation or perhaps forestry. This approach and outcome can be considered as the “least harm” waste treatment outcome. The alternative option proposed, by including selected, graduated thermal processing at BioHubs, is to process the same materials with the objective of manufacturing value added carbon based products that, when processed with other selected biomass inputs, produces genuinely valuable and market driven end products (adopting the philosophy explained in Discussion Paper EWDP 13-013 Products from Wastes – attached A ii).

The issue then, to be addressed in Section 5, is to identify and cost, the process techniques and systems to separate the organic fraction from the non-organic residuals such that the non-organic fraction is effectively no longer putrescible and available for independent processing for further resource recovery (synthetics, plastics, metals recovery etc.) or at least simple storage in the short term so as to be available for such processing in the medium to long term.

The separated organic fraction will then be available for subsequent thermal processing at the BioHub to produce first a dried and torrefied inert and stable intermediate product that can then be blended and supplemented into a finished product manufacturing process where the specific properties of the MSW originated materials can add qualities to the final products rather than detract or jeopardise final product quality, and where the organic carbon and valuable mineral
content can be presented as concentrated, to overcome the transport problem for bulky moist “composts”.

**Domestic Organics Collections**

One approach often adopted to recover residentially generated food and garden wastes is to provide a regular “green bin” collection service, whereby residents are encouraged to source separate food and/or garden organics for discard into the specialised service. Such source separation is an ideal way of avoiding subsequent product cross contamination with chemical and non-organic materials, but experience has shown (comparison of Penrith and Liverpool Councils’ organics recovery approaches and net cost/benefit) that the sought after outcome is not necessarily dependent on the systems and processing technologies, but more often on the detailed and compliant participation of the residents. In other words, the design of an organics recovery system can be greatly informed by starting with a demographic assessment first.

For example, a recent assessment by the ACT authorities into whether to roll out a universal “green bin” service to residents (Hyder, 2012) concluded that since the ACT residents were so disciplined in home composting and self hauling garden waste to established facilities that made the highest quality composts, the considerable cost and environmental impact of a green bin service could have negative impacts, i.e.:

- Some residents currently home composting and/or self hauling garden oversize, might stop this practice to use the new service – Demographic A;
- Those residents who, currently, were not conscientiously managing food and garden waste optimally, might start using the new service, with a likely increase in net volume collected, but a crucial diminution of quality – since this non participating demographic were the most likely to use the new service inappropriately – Demographic B;
- The likelihood then is that the contaminated extra volumes arising from Demographic B would be collected and mixed in the same collection vehicle as the “clean” material now presenting form Demographic A.

If organics collection services are going to need substantially the same post collection separation and decontamination effort as separating the organic fraction from MSW, the eventual cost/benefit will need detailed analysis to derive tangible benefits for each respective community.

Whilst it is not within the scope of this PFS to undertake such analysis, the matrix in Table 3.4 provides a useful starting point to analyse the cost of proposed green waste separation strategies in individual communities.

**Table 3-4: Preferred organics Collection Strategy Assessment Matrix**

<table>
<thead>
<tr>
<th>Waste Audit Data</th>
<th>Demographic Survey Data</th>
<th>Home</th>
<th>Multi Occupation</th>
<th>Council owned parks &amp; gardens</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conscientious, motivated, active</td>
<td>30%</td>
<td>40%?</td>
<td>30%?</td>
</tr>
<tr>
<td>Mixed putrescible (…)%?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vege food preparation (…)%?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small garden (…)%?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large garden (…)%?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood/stumps (…)%?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Potential values to be then compared with the status quo and the cost/benefit of the alternative schemes*
It is recommended that a study of this sort occur prior to the initiation of a subsequent Feasibility Study or as an initial stage of such a study, since the confirmation of the most cost effective and sustainable solution will greatly inform the final project viability assessment.

**NB:** Such a study should build on the questionnaire responses and data collected in the recent NetWaste “Organics Management Options for the NetWaste Region” report and even compare and contrast the projected cost/benefit outcomes with the current organics management arrangements, soon to be commissioned at Orange City Council.

One advantage of installing a suitable organics from non-organics separation AWT capability is that the residual organic material still presenting in the non-organics fraction will be minimal. In other words, all biomass is recovered in support of the streaming/cascading strategy objective (1.2.3), whereas, basing an organics recovery strategy providing a green bin service to all can deliver perverse outcomes:

- The residual MSW still contains significant quantities of organics and still needs to be treated as a fully putrescible material;

- The collected organics can present as needing detailed AWT style separation to achieve the quality that would support the materials being applied as genuine quality, “true-to-label” products; and

- The potential can be realised that those “streaming” their organics to home composting and/or dedicated self haul facilities can a) have their materials degraded, or b) they stop adopting the higher order separation behaviour in favour of expediency.

However these issues can have an objective and determined resolution if assessed as suggested above.
4. Products and Outcomes

4.1 Product Philosophy

As described in Section 1, the proposed BioHub will initially perform as a “receiver of last resort” for most materials arising in the Dubbo region. And in accordance with the “steaming/cascading” philosophy adopted, biomass generators will be free to stream their materials for highest and best use, only presenting materials to the BioHub if they are unable to derive a higher value outcome by themselves.

Under this scenario, biomass may be left on the ground at harvest time, or minimised during subsequent processing, or avoided from presenting in post consumer waste streams; and when generated by households, the quality source separated material can be applied to sustain the quality compost manufacturing sector. The proposed BioHub is intended to even support these higher order outcomes with brokering services for trading biomass to assist with feedstock security of supply issues where practical. However, after streaming materials for their highest use, the BioHubs provide the cascading alternative to extract full value from all such residual materials to avoid the binary outcome of waste and disposal as the alternative.

Materials presenting at a BioHub will be managed to support highest order product outcomes by assessing every load of material presented for quality, origin, type, quantity and regularity of supply and directed for subsequent management or processing with the prevailing demand for a full range of carbon based products as the basis of directing preferences on the day.

Post assessment options will include:

i) Trading/brokering to off site composters/digesters if appropriate and cost effective;

ii) Aggregating materials like-with-like to generate critical mass both on site, or within a BioHub network if appropriate. If materials present as biologically unstable (eg. manures, food waste/sludges, MSW organics etc.) they will be at least pretreated and stabilized into recognised interim products immediately to eliminate potential odour/leachate issues ever arising;

iii) With accumulated quantities of stabilized biomass materials available, the full suite of products will be manufactured to the exact specifications established and tailored to achieve general market or specific customer requirements; and

iv) Initial product range as proposed by Renewed Carbon in the original proposal, the subject of this PFS:

- High density, low ash biomass channelled towards high value metallurgical grade charcoals and reductants;
- High/medium ash biomass channelled towards agricultural biomass based products, as a range of essential ingredients in specialty fertilizer products;
- Torrefied solid fuel products available if demand exists;
- Bioenergy as a by-product of all such product manufacturing activity; and
- Pre-processed materials for specialist third party specialty demand and fuels manufacturers.
To support the development of this PFS, Renewed Carbon has provided detailed information on current product development activities, in both the metallurgical charcoals and biochar based fertilizer sector which can be summarised as follows.

4.2 Metallurgical Charcoals and Reductants

Over the last three years, Renewed Carbon has been working with the various companies in the metals manufacturing/smelting sector. Nine specific metallurgical charcoal and reductant product specifications have been established.

Whilst these product specifications are confidential, Renewed Carbon will make them available to any future BioHub project servicing the Dubbo region.

Suffice to record in this PFS, national demand for such products, if the domestic market is fully satisfied, requires some 25-30 Mt of low ash hardwood or manufactured equivalent to be dried, torrefied, densified and pyrolysed slowly at a range of elevated temperatures to achieve the required finished product density, ash content, moisture content, volatile matter values, trace mineral maximums, and particle size, and all delivered to be cost competitive with currently used coke and coal derived alternatives (see CSIRO “Resourceful” magazine p. 8 attached B).

NB: The size of the market is such that few individual products can be cost effectively supplied from any one geographic region, on any one BioHub facility, such that collaboration between facilities in diverse regions will be required to satisfy all but the smallest number of these specific products (Steel industry paper – attached C).

It is recommended that a BioHub located in the Dubbo region specialise in the manufacture of certain specific products, especially if a collaborative supply line can be established with the managers of the potential regional woody weed/INS supplies.

4.3 Biochar based Tailor Made Fertilizer Products

As part of Renewed Carbon’s contribution to the production of this PFS, as a stakeholder, all the experience gained by Renewed Carbon in the manufacture and product development of biochar based materials has been made available and will be provided in detail to the owners or operators of any future BioHub servicing the Dubbo region.

Biochar is a term referred to in this PFS for all such semi activated, usually high ash, char products manufactured for use on land as soil productivity improvers and amendments.

Biochars manufactured by slow pyrolysis within the 450-600°C temperature range (usually closer to 450-500°C for optimum yield and effectiveness) provide a range of beneficial mechanical properties to soils, including:

- Improved water retention and penetration and thus reduced nutrient loss;
- Improved CEC; and
- Support for elevated levels of soil microflora activity.

Entrained mineral elements sourced as ash from the original biomass source, or added later can provide essential NPK and trace elements and beneficially modify pH.

Certain entrained clays and/or rock dusts can provide enhanced catalytic services for soil microflora to convert certain essential mineral plant nutrients from the mineral to the bioavailable form.
And in its stable pyrolysed form, the biochar can present as a long term carbon bio-sequestration product whilst increasing net soil carbon with every kilogram so applied.

Renewed Carbon is currently developing a proprietary biochar based all-in-one fertilizer product specifically tailored to the expressed needs of the regional cropping sector. Renewed Carbon has been greatly assisted in this work by another of the originating project stakeholders, Saxa Spreading Services.

The Renewed Carbon concept is to develop an all-in-one biochar based fertilizer product that is pelletised and suitable for broadcasting or, especially, applied via air seeder to the root zone of each new crop as shown Figure 4.1.

Figure 4-1: Air seeder

The proposed biochar based pellets will be designed to:

- Supply “starter” nutrients to support germination;
- Replace nutrients removed by the previous crop;
- Supply high analysis, slow release fertilizers to sustain the new crop; and
- Supply catalytic minerals to stimulate soil microbial activity and overall soil quality
- Provide a substantial biochar component in each pellet, equivalent to a broadcasting rate of approx. 10 t/ha, but supplied only to the root zone to improve cost effectiveness.

Such products could be delivered in liquid or pellet form and by delivering the product direct to the root zone, only the exact amount of nutrient will be supplied to minimise the run off and loss of nutrient value.

The development of these specific “Dubbo mix” products is being jointly developed by Renewed Carbon and UNSW under an ARC Linkage Grant (No: LP120200418) with a project titled: “Development of the next generation of organo-mineral fertilisers utilising domestic and commercial waste products”.

Pre-Feasibility Study, June 2013
### 4.4 Bioenergy

Whenever pyrolysing biomass to produce products such as 4.2 and 4.3 above, surplus heat and syngas is produced equivalent to some 50% of the CV inherent in the original dry weight of the biomass. For this PFS an assumption will be made that this energy source is converted to “green” power via gas engines and returned to the grid.

A subsequent full scale feasibility study will need to identify the most cost effective pathway to monetise this energy product, which could be applied simply as heat if a suitably convenient use or application could be identified. Such a heat source might be beneficial to Western Plains Zoo to heat certain animal enclosures during winter.
5. Technology and Process Flow Description

In this section we review the operational capacity for the proposed BioHub.

To provide the services outlined and justified in the previous sections, and as a platform to manufacture the products and services proposed, Renewed Carbon has provided a concept block flow diagram (BFD) (Figure 5.1) that has been proposed with the full and cost effective achievement of the project objectives as described and justified in previous sections.

For this PFS, the respective technologies proposed for each stage will be discussed and described as numbered in Figure 5.1.

Figure 5-1: Block flow diagram for proposed Dubbo “producer” BioHub

1) Urban wastes as described 3.4.1.

2) Generic “drum” style AWT to receive mixed residual wastes, provide an opportunity to recover HHW and/or bypass dry recyclables, process material to separate organic (<40mm) from non-organic (>40mm) materials (the “blister pack” separation standard) and post treat both major streams for inerts/heavy particle removal and ferrous/non-ferrous metals recovery.

The generic Block Flow Diagram for this facility is shown in Figure 5.2.
Figure 5-2: Drum AWT Block Flow Diagram

A Enclosed Receival Hall where incoming material is checked by small FELs for gross contaminants before being pushed onto the in-floor plate feeder which will convey materials to the Bag Opener.

B Bag Opener where materials are released and exposed for the subsequent picking line.

C Picking Line – this capability is proposed to remove any obvious HHW materials and recover any obvious dry recyclables that were not more correctly discarded via the kerbside “yellow bin” service or originated in the C&I stream.

D Conditioning Drum – by managing moisture, feed rate and particle rotations, the materials will be conditioned without shredding in preparation for subsequent trommel screening.

E Trommel Screens process the conditioned materials such that the <40mm material will be predominantly the organic fraction (including conditioned cardboard and paper etc.), the <40mm to 150mm material will be predominantly the “plastic” High Calorific Fraction (HCF) and the >150mm oversize fraction will present for wood recovery from what otherwise will be a reject/inert fraction.

F Magnets remove ferrous metals from both the <40mm and >40mm lines.

G Eddy Current removal of non-ferrous metals.

H The Destoner or ballistic separators remove inert materials such as glass, ceramics and masonry fragments, which being now separated from the putrescible, organic fractions, will be suitable for select civil applications.

I Baler preparation of HCF for transport for sale or storage.

J Organics Interim Storage or inventory control, will balance the urban waste derived biomass inflow with the subsequent BioHub drying/torrefying process outflow as an inline process to avoid the aerated organics generating potential odours.

3) Inert or non-putrescible materials will be suitable for select civil applications, perhaps blended with C&D masonry or crushed concrete for under-course applications.

4) Recovered metals for direct delivery to local scrap metals facilities.
5) The high calorific fraction (HCF) will present as an RDF or PEF product for subsequent processing for kilns, EfW facilities or more specialised secondary plastics processing to create petrochemical industry platform products such as Naphtha.

NB: Facilities to process these plastics for such high value outcomes don’t exist in Australia at present. One reason is that systematic and assured supply of such HCF materials cannot be demonstrated at present. So wherever such drum AWT facilities are established to supply biomass to a BioHub, or other, the short term use may be as baled and stored at landfills, and/or supplied as RDF to specialist facilities, but in the medium to long term they will begin to demonstrate assured supply to potential developers of such higher order facilities.

6) Other regional biomass arisings as described Table 3.3.

7) Drying/Torrefying (approx. 280-300°C) is the initial step in the thermal gradient of process stages from raw, wet biomass up to final slow pyrolysis temperatures (450-500°C).

Figure 5-3: Concept drying/torrefaction plant

8) Pyrolysis Plant

Figure 5-4: Pyrolysis plant concept graphic
This facility accepts prepared materials to produce a char product and syngas. If supplied with quality, low ash materials, the unit can produce metallurgical grade charcoal products. If supplied with high ash materials, the same unit can produce biochars for fertilizer manufacture. The proposed pyrolysis capability would be commissioned in discrete operational modules – usually 1, 2 and 4 t/hr feed rates, such that parallel units could be processing different feed streams concurrently.

**NB:** The main thermal units 7 Torrefaction, 8 Pyrolysis, 9 Fertilizer manufacture and 12 Green Power Generation would all be linked by a common heat exchange system, for optimum waste heat recovery and reuse, and a common gas supply system and all terminating in a single stack/emissions point to ensure better than EU W.I.D. minimum emissions standards.

9) Final fertilizer product manufacture – Working closely with the cropping sector, their preferred agronomists and their contract spreaders, it has become clear that the opportunity to apply biochar in board acre applications needs to directly address the entire fertilizer needs holistically. That whatever the benefits and values of biochar, each crop needs measured applications of high analysis NPK, select trace elements, soil microbial activity stimulants as well as the biochar and sundry catalysts and binders.

This fertilizer manufacturing facility will accept hot, fresh biochar and quench the material by mixing with all the other “moist” ingredients and binders to create the individual products for each customer, in the product binding, pelletising process, and then dispatch quality assured products to each property, tailor made to exactly match their express requirements.

10) Hoppers of third party ingredients to blend into the finished products.

11) The proposed Dubbo BioHub will be located where the demand for finished fertilizers and other products will significantly outstrip the availability of local biomass supplies. This opens up the need to import partially processed/torrefied materials from elsewhere to provide chars of the required specifications to supplement supply.

12) Syngas generated by the pyrolysis processing will be applied first, to power the pyrolysis process itself, and provide final energy balance to the drying/torrefaction process, and then all excess syngas will be diverted to modular gas engines, similar to those currently used to convert landfill gas.
**Figure 5-5: Pyrolysis processing**

**NB:** Single stack for on site emissions to ensure better than EU-WID emissions standards as a minimum and full waste heat recovery for the drying processes.
6. Financial Summary

The proposed BioHub facility BFD described in Section 5 has been modelled (attachment D) and summarised as Table 6.1.

Table 6-1: Analysis Summary

<table>
<thead>
<tr>
<th>Analysis Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Input data - Dubbo Phase 1</td>
</tr>
<tr>
<td>Feedstock from MSW C&amp;I</td>
</tr>
<tr>
<td>Supplementary feedstock from forest waste</td>
</tr>
<tr>
<td>Network Materials</td>
</tr>
<tr>
<td>NPK and additives</td>
</tr>
</tbody>
</table>

2. Output data - Dubbo Phase 1

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inerts sorted out by drum</td>
<td>&lt;5,000 tpa</td>
<td>Returned to Council for landfill</td>
</tr>
<tr>
<td>Metals sorted out by drum</td>
<td>&gt;2,000 tpa</td>
<td>Sold at scrap market price</td>
</tr>
<tr>
<td>HCF sorted out by drum</td>
<td>&lt;3,000 tpa</td>
<td>Baled and sold at market price</td>
</tr>
<tr>
<td>Product sales - NPK substitute</td>
<td>&lt;16,000 tpa</td>
<td>Sold to Farmers</td>
</tr>
<tr>
<td>Green Electricity</td>
<td>1.5 MW</td>
<td>Sold as Green Power under a FIT agreement</td>
</tr>
</tbody>
</table>

3. Sources and use of funding - Dubbo Phase 1

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Equity</td>
<td>$5,000,000</td>
<td>25% Equity</td>
</tr>
<tr>
<td>Phase 1 Grant Funding</td>
<td>$5,000,000</td>
<td>Generation of employment plus $2m in tax rev p.a</td>
</tr>
<tr>
<td>CEFC and Bank Funds</td>
<td>$59,700,000</td>
<td>Commercial Terms</td>
</tr>
<tr>
<td>Total CAPEX Phase 1</td>
<td>$69,700,000</td>
<td>+/- 10%</td>
</tr>
</tbody>
</table>

4. Strategic Partner project Provisions

<table>
<thead>
<tr>
<th>Provisions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site for 2 phase plant</td>
<td>Provided by local owners at peppercorn rent to project.</td>
</tr>
<tr>
<td>Offtake Agreement - NPK replacement</td>
<td>By local farmers and spreading contractors</td>
</tr>
<tr>
<td>Offtake Agreement - green energy</td>
<td>By Diamond energy or similar (to be tendered)</td>
</tr>
</tbody>
</table>

5. Financial summary - Dubbo Phase 1

<table>
<thead>
<tr>
<th>Financial details</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule used in modelling</td>
<td>12 month build, 12 month ramp up</td>
</tr>
<tr>
<td>Annual net revenue when operating</td>
<td>$510 million/year</td>
</tr>
<tr>
<td>Employment when operating</td>
<td>Direct Management and Staff - 20 FTE’s</td>
</tr>
<tr>
<td>Debt Repayment</td>
<td>By end of year 7 of operations</td>
</tr>
<tr>
<td>Phase 1 IRR</td>
<td>21%</td>
</tr>
<tr>
<td>IRR Sensitivity to +/- $50 end product price</td>
<td>3%</td>
</tr>
<tr>
<td>IRR Sensitivity to +/- $10/MW electricity price</td>
<td>1%</td>
</tr>
<tr>
<td>IRR sensitivity to +/- $20$ waste “gate fee” price</td>
<td>2%</td>
</tr>
<tr>
<td>IRR sensitivity to +/- 10% CAPEX variation</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Based on feedstock samples provided to and tested by RC and others in March 2013
*See report for details of tangible/intangible benefits. Conservative CO2e assumptions have been used in the modelling
*Based on party estimates, allowing for site set-up, project development, FEED etc.
*Renewed Carbon does not have an AFSL. This data is provided for information only & not for investors/others.
*Assumed interest rate is based on riy adjusted & blended CFEC and commercial bond+ rate.
*NPV’s have been calculated at various discount rates to provide an IRR approximation.
*Based on 2 phase project being designed at outset. Takes BioHub to sustainable economies of scale/meet demand and be the full validation model for the national roll out of BioHub transfer processing centres scheme.
The key features of this case study that support the projected profitability indicated by the 20% IRR include:

i) Initial sustaining gate fee income is directly related to providing a systematic urban waste processing service for the local community (the Council).

This essential service is presented as a cost effective alternative to Business As Usual (landfill) approach and securing the service at less than the actual “true cost of landfill”.

For initial BioHub facility development this income producing function is crucial to justifying the construction of the facilities. But once established, the facility is then able to offer a wide range of “merchant” services that when fully commercialised, will provide a framework where the dependence on the MSW processing fees will be reduced. In addition, the community will be in a position to negotiate lower waste processing fees as the installed capabilities derive supplementary revenue by receiving and value adding these third party biomass materials.

ii) The highest value products will be manufactured from the third party biomass materials, but this potential will not be realised without the urban waste processing function securing the initial investment to create the BioHub in the first place.

iii) This study demonstrates that productive, strategic and commercial synergies are created where the organic, or biomass fraction of urban wastes are processed for highest product value as an integral part of a wider biomass processing approach. This approach presents in stark contrast with the alternative approach where urban waste biomass and the more general third party arisings operate as separate sectors.

Just for interest and reference, if this “Dubbo” scenario is accepted as a reasonable proposition, that could be replicated, then Table 6-2 presents a possible “roll out” scenario for the whole of NSW, if the BioHub concept was delivered as a network across the State to address all such “last resort” biomass arisings.

Table 6-2: Concept model of BioHub network to service NSW

<table>
<thead>
<tr>
<th>BioHub Type</th>
<th>Approx. No./530 km² of suitable land for NSW</th>
<th>Receiveal, sorting, screening, pretreatment &amp; torrefaction</th>
<th>Pyrolysis &amp; energy recovery</th>
<th>Final Product manufacturing and wholesale</th>
<th>Approx. Capex $M each</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Mobile&quot; Feeder BioHub</td>
<td>14</td>
<td>✓</td>
<td></td>
<td></td>
<td>$5</td>
</tr>
<tr>
<td>Standard BioHub</td>
<td>35</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>$19</td>
</tr>
<tr>
<td>Producer BioHub</td>
<td>5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>$34</td>
</tr>
<tr>
<td>Totals</td>
<td>54</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>$905M</td>
</tr>
</tbody>
</table>

Facilities processing: min. 70 ktpa (Capex $19M), max. 250 ktpa (Capex $34M)
Processing estimate 6,500 ktpa; 54 facilities processing an average of 120 ktpa biomass each
Average Capex/BioHub - $16.75M
Further, again for interest and reference, if this “NSW” scenario based on the prospect of the 54 facilities processing some 6,500 ktpa supplied from generic biomass sources 2.1-2.4, (Table 2.1) above was implemented nationally, Table 6-3 indicates the scope of a national network, of which Dubbo could be an integral part.

For assessment purposes, the NSW model can be extrapolated for all other states (Table 6-3).

Table 6-3: Extrapolated BioHub network Capex based on NSW model (Table 6-2)

<table>
<thead>
<tr>
<th>State</th>
<th>Total/serviced area km² '000</th>
<th>Population/% '000</th>
<th>#Producer BioHubs</th>
<th>#Standard BioHubs</th>
<th>#Transfer BioHubs</th>
<th>Totals #</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW</td>
<td>800/530</td>
<td>7350/32</td>
<td>5</td>
<td>35</td>
<td>14</td>
<td>54</td>
</tr>
<tr>
<td>VIC</td>
<td>227/200</td>
<td>5680/25</td>
<td>4</td>
<td>18</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>QLD</td>
<td>1730/700</td>
<td>4610/20</td>
<td>5</td>
<td>20</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>WA</td>
<td>2530/350</td>
<td>2472/11</td>
<td>3</td>
<td>7</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>SA</td>
<td>983/200</td>
<td>1662/7</td>
<td>2</td>
<td>7</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>TAS</td>
<td>68/30</td>
<td>512/2</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>NT</td>
<td>1350/300</td>
<td>236/1</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>ACT</td>
<td>2.5/2.5</td>
<td>380/2</td>
<td>–</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Medium term expectation of facilities rollout 196

Say average Capex $16.75M . basic Network Capex $3,283M

Such a medium term national BioHub network is proposed based on a core focus to realise full value from the “by-product” biomass sources 2.1, 2.2, 2.3 and 2.4 in Table 2-1.

All specially grown biomass sources (2.5, Table 2-1) would be entirely extra or additional to the already available biomass sources 2.1-2.4 (Table 2-1). However, once established and capital justified on existing biomass supplies, the same BioHub network would greatly assist and enhance the proactive biomass creation activities described 2.5 (Table 2-1). In fact, it might be anticipated that a strong level of parallel development would occur once early BioHub facilities demonstrated strategic and commercial viability.
7. Proposed Implementation Plan

This PFS has needed to direct considerable attention to more thoroughly describing the inherent need and detail behind the BioHub concept than would usually be the case for a more traditional PFS.

The outcome is that although the need is now well described and defined, and the benchmarks for success described in terms of both the tangible and “greater public good” collateral/economic benefits (Table 1.1), and the BioHub concept demonstrated as directly addressing the need cost effectively within the framework of some essential scoping principles (attachments A i-iv), the lack of detail in relation to:

- Actual BioHub site process design;
- Better than ±30% Capex accuracy;
- Final product testing and broad acre trials;
- Finally confirmed market demand; and
- Additional “network” char supplies from a separate metropolitan based BioHub facility,

results in this PFS being unable to conclude with a sufficient level of project affirmation to immediately support the significant expenditure expected for a full feasibility study (approx. 2-3% of projected Capex – say $500k-$700k).

However, the project clearly has merit, and has demonstrated the ability to cost effectively provide and support the provision of the missing systems and infrastructure to link the range of potential biomass sources with the equally well defined end uses and market opportunities.

It is suggested that a staged or gates and milestones approach is adopted to progressing the project as follows:

**Stage 1** – A prospective local investor group be established who are attracted by the concept described herein and who would commit to the provision of equity up to 25% of the projected capital cost if these funds are matched with grant funding from an appropriate source, state or federal.

**Stage 2** – The accumulated budget then be drawn down against a pre-agreed gates and milestones schedule of works. This would include detailed work to undertake the full feasibility study:

- Confirm and describe all committed biomass supply arrangements;
  
  This work could begin with a detailed cost/benefit analysis for regional green waste collection and value adding options as described in Table 3.4 and as a logical extension of the findings of the NetWaste Organic Options report.

- Process design to progress from current concept to completed F.E.E.D. – as a crucial function of the subsequent full feasibility study;

- Complete biochar product development with UNSW and then made up trial batches for broad acre trials;
Renewed Carbon invites third party involvement and participation in the current ARC Linkage project to ensure the optimum results and outcomes.

➢ Secure off take agreements for finally confirmed biochar based fertilizer products; and

➢ Complete licencing and approvals process.

Stage 3 – On achieving “financial close” the project proponents would then seek to attract project completion funding from more traditional debt and equity funding sources.

Such a project would appear to be a direct fit with the brief of the Clean Energy Finance Corporation (CEFC) who should be approached at this time as possible project participants.

This approach has been adopted in the Initial Project Model attached D.
8. **Summary and Conclusions**

If constructed and operated as proposed, such a BioHub would be profitable, returning an IRR of approx 20% for what is in effect basically a public service infrastructure project with some “merchant” capabilities and service offerings that are only viable because the basic facilities can be capital justified on the basis of the core service offering to the local community.

This basic MSW processing benefit can be delivered for no more than current “true cost of landfill”, and within a commercial framework that could be constructed to:

a) Provide predictable, no more than CPI escalation into the future;

b) Remove local CO₂-e liabilities that could accrue to the existing landfill operation;

c) Provide for a de-escalation of future gate fees as the “merchant” activities became established and started generating an alternative source of assured BioHub revenue; and

d) Provide a strategic platform whereby the existing Whylandra Waste and Recycling Centre could be operated simply as a regional materials management centre that need no longer fill up or have a defined lifespan as it would no longer be required to treat residual MSW by sanitary landfilling. The site could instead be a productive employment centre for market pulled, materials processing and quality product manufacture.

The Dubbo model, (commercially anchored on processing the local MSW as a priority input, so that all the other merchant activities can be conducted, and collateral service benefits realised), could be replicated in most regional centres throughout Australia, where a basic population of >35,000 could create critical mass within a 100 km radius of a “standard” facility.

Possibilities currently in early stage discussion include:

- Northern Rivers, NSW;
- New England, NSW;
- Mid North Coast (Kempsey), NSW;
- Orange, NSW;
- Lithgow, NSW;
- Wagga Wagga, NSW;
- Griffith, NSW; and
- Albury/Wodonga, NSW/Vic.

But many groups of metropolitan councils are also suitable for similar strategies.

The other main feature of this proposed Producer BioHub is the addition of the specialist fertilizer production onto what would otherwise be a “Standard” BioHub configuration.

A standard BioHub could be expected to produce biochar products worth $100-$250/t and a bioenergy output only, but with the product manufacturing capability, the locally sourced biomass is effectively doubled in value ($200 to $550/t) and a demand is created for additional biochar supplies from other “Standard” or “Feeder” BioHubs elsewhere in the proposed “network”. In fact the proposed Dubbo BioHub could support a number of satellite “Feeder” BioHub facilities that could access and pretreat a wide range of biomass arisings in the extended area, including forestry residues (to the North East), manures (from the North East), cotton trash (from the North) and INS
biomass (from the West and South West). This presents as a real possibility because of the extent of the apparent demand for the proposed fertilizer products.

To progress this Dubbo proposal, a group of local business interests need to commit to supporting the project through full project feasibility studies and FEED on a dollar for dollar basis with appropriately sourced grant funding.

The initial tasks include:

- Reviewing green waste collecting and value adding options as an extension of the NetWaste Organic Options report; and

- Completing the existing UNSW work to confirm the commercial viability of the proposed all-in-one fertilizer product.

As and when the project achieves a commercially viable and strong financial close, suitable project funding and third party debt and equity funds will the need to be identified.

This project could present as an ideal candidate for CEFC support at that time, and in the event that the Commonwealth “Industry Innovation Precincts” program progresses as planned, this Dubbo project could present as a beacon project.
Attachments:

A  i) Discussion Paper 13-012: Biomass ain’t Biomass


   iii) Discussion Paper EWDP 13-011: The Business of Sustainability

   iv) Discussion Paper EWDP 13-014: Highest Net Resource Value (HNRV)

B. CSIRO “Resourceful” Magazine – Issue 1, July 2012


D. Initial Project Model