Snapshot Report

AUSTRALIAN MEAT PROCESSOR CORPORATION

Snapshot Report

Bio-resource Recovery Centres

Project Code	Prepared by	Date Submitted
2023-1013	TESSELE CONSULTANTS	30/07/24

Project Description

The Bio-resource Recovery Centres (BRRC) project introduces a new approach to managing wastewater and organic wastes at red meat processing facilities, integrating the production of recycled water, renewable energy, fertiliser, CO_2 as dry ice and a reduced carbon footprint. This innovative system generates impacts beyond the processing facility, including benefits to the community and capacity building. This project proposes to perform detailed engineering and cost assessments, a peer review and a comparison of business models, aiming to de-risk and optimise the proposed model and increase the likelihood of adoption. This project will help establish the first Bio-resource Recovery Centres through the following actions:

- Create a design for a modern integrated WWTP and organic waste management at a red meat processor plant. The designs will include cost and revenue estimates with financial analysis
- Engage a third-party peer review and consider feedback
- Review the designs and select the most appropriate project for further optimisation and implementation
- Conduct a mapping and analysis exercise of potential stakeholders (i.e. site owners, investors, funders, off-takers, technology providers, partners, tenants, and authorities) for the selected project
- Approach, present and discuss the project opportunity with stakeholders
- Finalise the optimised design and stakeholder support
- Complete a comparison of the levelised cost of resource recovery based on various funding models
- Select the funding model and negotiate any heads of agreement that support the funding model, design, investment structure and funding model to the owner of the site to enable the adoption of the first of two Bio-resource Recovery Centres

The project focuses on the feasibility and design of integrated BRRCs at two case study facilities, in Western Australia (WA) and New South Wales (NSW), aiming to provide a model for broader adoption across Australia's red meat processors. The methodology includes comprehensive analyses of water and solid wastes, engineering designs for Wastewater Treatment Plant (WWTP), Anaerobic Digestion (AD), CO_2 recovery, and Bio-based fertiliser components, carbon abatement assessments, cost estimates, revenue estimates, financial modelling, and business case development. The BRRC considers potential income from the production of recycled high-quality non-potable water, energy, bio-based fertiliser, dry ice and carbon credits, in addition to reduced disposal issues and costs. The concept of the Bio-resource Recovery Centre is shown in the figure below. A peer review validated the project’s approach, and extensive stakeholder engagement ensured alignment with industry needs. The methodology provides a robust foundation for implementing BRRCs at red meat processing facilities in Australia, promising significant environmental, social, and economic benefits.

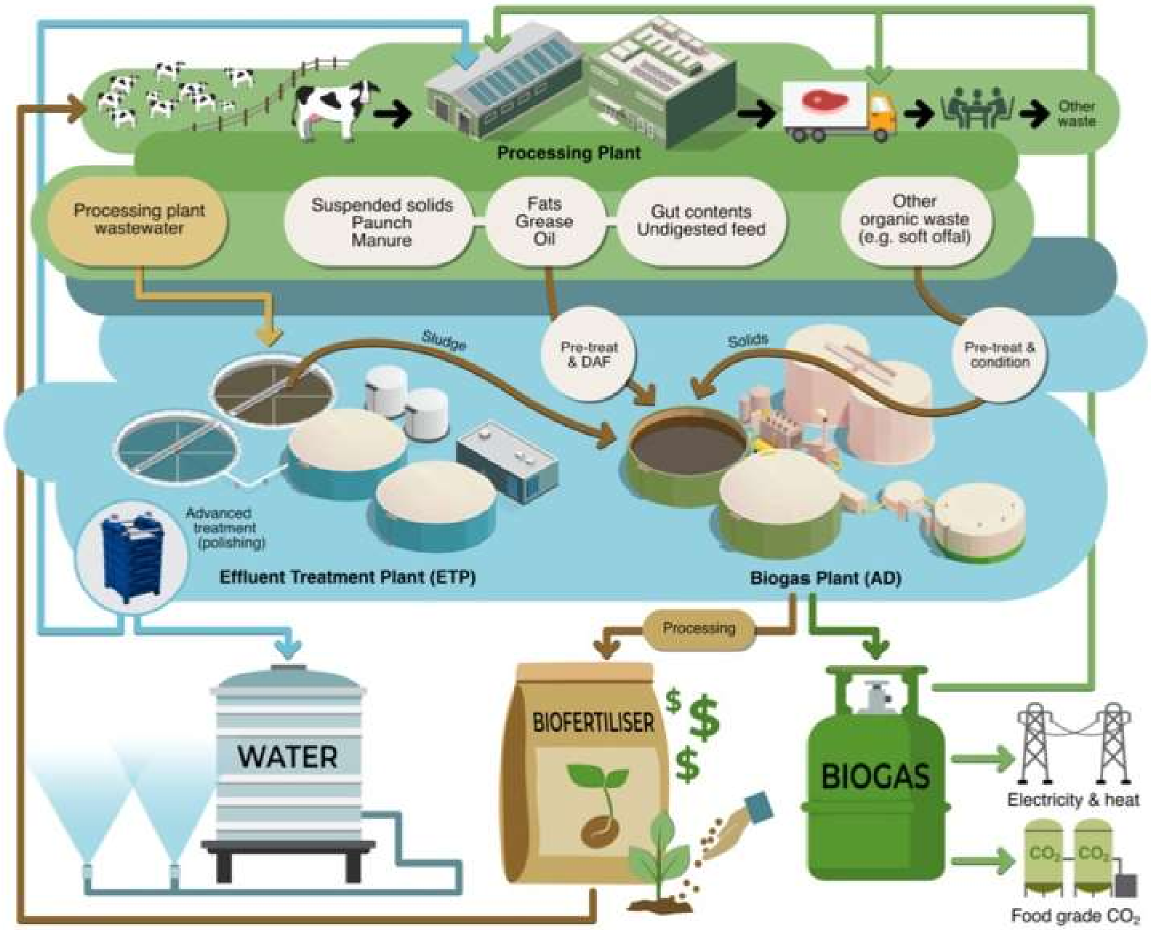

Figure 1. Consolidated model of the Bio-resource recovery centres

Project Content

The key project drivers for implementing a Bio-resource Recovery Centre at the WA and NSW case study facilities are summarised below.

Table 1: BRRC project drivers

Driver	Case Study Facility	Project Drivers	BRRC Solution
Water – Limiting Factor for Expansion	WA	Existing WWTP is at capacity and insufficiently treating the treated wastewater quality to regulatory standards. It is unable to handle increased flows from expanded processing, limiting facility growth potential.	BRRC presents improved wastewater treatment to a higher-quality, suitable for reuse options and irrigation, facilitating facility expansion.
	NSW	Limited processing water supply due to supplier infrastructure limitations, restricting facility expansion due to insufficient water supply which may be needed for higher meat processing throughput.	BRRC produces high-quality non-potable water for reuse, such as livestock washdown and onsite irrigation, reducing the demand on the limited potable water supply which can be reserved for required site potable-water needs, enabling facility expansion.
Power	WA	Occasional power outages occur due to interruptions in electricity supply from the grid, leading to financial losses from	BRRC will generate surplus energy to the needs of the BRRC, enabling BRRC self-sufficiency with behind-the-meter electricity and reducing dependence on the grid. It has

Driver	Case Study Facility	Project Drivers	BRRC Solution
		wasted produce and operational disruptions.	the potential to fully meet its energy needs independently with co-digestion or supplementing with other renewable energy initiatives.
	NSW	High energy costs and market volatility in recent years, particularly in eastern Australia, have increased operational costs.	BRRC can provide a source of self-sufficient behind-the-meter energy supply, reducing costs and exposure to market fluctuations. It has the potential to fully meet the red meat processor's energy needs independently with co-digestion or supplementing with other renewable energy initiatives.
CO_2 Recovery	NSW	Reliance on unreliable external supply for food-grade CO_2 for dry ice leads to production disruptions. Supply shortages have been seen from the limited number of CO_2 producers in Australia and significant price surges have occurred in recent years.	On-site recovery of food-grade CO_2 through BRRC provides a reliable and cost-effective supply, also reducing Scope 3 carbon emissions from transportation of externally supplied CO_2.

Key priorities

For the WA case study facility, the primary focus is on resolving wastewater disposal issues, particularly nitrogen removal and managing hydraulic load, to support significant processing capacity expansion. Addressing power reliability issues is also of interest.

For the NSW case study facility, the main drivers include securing a reliable supply of food-grade CO_2, addressing water availability limitations for processing, and managing high energy costs.

Objectives for Expansion

Both case study facilities are interested in expanding their operations to increase revenue, boost local economic development, and reduce reliance on live exports in accordance with government directions. The successful implementation of the BRRC is essential for overcoming current challenges and achieving these expansion goals. Improved water quality and self-generated energy, in addition to a self-supply of food-grade CO_2, will improve environmental regulatory compliance, improve the reliability of continuous production operations, create additional revenue streams and increase profitability, making the facilities more resilient to external market conditions.

Methodology

The objective of the Bio-resource Recovery Centres project is to design an integrated facility encompassing advanced technologies for water treatment, organic waste management, and energy production, aimed at optimising resource recovery and sustainability. The facility reduces disposal issues, resulting in environmental, social and economic benefits, by producing high quality non-potable water, biogas converted into electricity and heat, bio-CO_2 recovery and bio-based fertiliser production. The project's methodology is comprehensive, encompassing technology refreshers, analyses of water and solid wastes, engineering designs, carbon abatement assessments, revenue estimates, cost estimations, funding and financial modelling, and the development of a business case, all summarised in this report.

Technology Refresher Trip: A key component of the methodology involved targeted technical visits to Europe. These visits included participation in IFAT trade fairs, renowned for showcasing cutting-edge solutions in water and waste management, and tours of facilities specialising in biogas production. These activities provided critical insights into the latest technologies and operational practices, informing the design and equipment selection for the project.

Water Sampling Campaign and Updated Flows Estimate: A water sampling campaign was conducted at both case study facilities to update flow and concentration data, which are essential for accurate design calculations.

Organic Solid Wastes Audit and BMP Tests: The project included an audit of organic solid wastes at two facilities, where samples underwent physicochemical analysis to determine Biomethane Potential (BMP) and other key metrics. These analyses, alongside data on organic by-product volumes, allowed for estimations of biogas production potential. This data is vital for designing the biogas plant and assessing its feasibility.

Wastewater Treatment Plant Design: For the WA and NSW facilities, the wastewater treatment plant design was refined using updated flow and chemical data, with BioWin modelling employed for process and hydraulic calculations. Initial assumptions were revised and a sensitivity analysis conducted, to ensure the wastewater treatment designs could accommodate variations in flow rates and concentrations.

Biogas Plant Design: The anaerobic digestion plant design, for the production of biogas, was optimised to enhance efficiency and reduce capital costs, including modular implementation for scalability. Additionally, the NSW facility explored innovative CO_2 recovery to produce dry ice, expanding the scope of resource recovery and contributing to plant reliability and economic feasibility.

Bio-based fertiliser Plant Design: The bio-based fertiliser plant component designs were refined using a technology selection deemed appropriate for both case study facilities and expected to be suitable for a variety of red meat processors across Australia. This design was informed by analysis of anaerobic digester substrates. The designs involved estimating the anticipated digestate quantity and developing processes for converting it into marketable bio-based fertiliser, with FEED drawings and equipment specifications supporting the design.

Cost Estimates: Cost estimates for the integrated Bio-resource Recovery Centres were updated, considering inputs from preferred suppliers.

Carbon Emission Assessment: A detailed carbon emission assessment was performed to evaluate the environmental benefits of the project, including potential reductions achieved through the bio-resource recovery centre.

Revenues Estimate: Several new revenue streams were considered in the analysis, including recycled non-potable water, energy (from biogas), bio-based fertiliser, carbon credits and savings on waste disposal. Furthermore, revenue generated from CO_2 recovery for the use as dry ice was also considered, which addresses concerns about supply reliability and high commodity costs, which are significant issues for some red meat processors.

Peer Review and Relevant Updates: A reputable external consultant was engaged to conduct a third-party peer review of the design and cost estimate. The peer review endorsed the overall concepts and methodology, and resulted in minor improvements made to the design details based on the consultant's recommendations.

Stakeholder Engagement: The project also involved extensive stakeholder engagement, mapping potential stakeholders and seeking their feedback on the project.

Financial Modelling: An economic assessment was undertaken, using capital and operational costs, in conjunction with revenues from the recovered resources. Various funding and financial models were explored, including private investment and government grants, to ensure the project's financial viability.

The methodology employed in this project ensures a thorough evaluation of the technologies and processes involved, aiming for a holistic and sustainable approach to resource recovery and environmental management. The findings and design optimisations provide a solid foundation for moving forward with the implementation of integrated Bio-resource Recovery Centres at red meat processors across Australia.

Key Findings

Key findings include:

1. Facility Throughput and Waste Management
    a. The Bio-resource Recovery Centres design accommodates an annual red meat processing throughput of 73,921 t.HSCW/year for the WA case study facility and 135,200 t.HSCW/year for the NSW case study facility.
    b. The facilities manage significant wastewater and solid by-products, transforming them into valuable resources like biogas, bio-based fertiliser, and CO_2 for use as dry ice.
2. Energy Production
    a. The biogas plants can produce 4 million Nm^3/year at the WA case study facility and 8 million Nm^3/year at the NSW case study facility, generating significant electrical and thermal energy.
    b. The produced energy can offset onsite natural gas, coal and grid electricity consumption, resulting in financial and production reliability benefits, in addition to environmental stewardship.
3. CO_2 Recovery
    a. The CO_2 recovery plant planned for the NSW case study facility recovers CO_2 for dry ice production, ensuring supply reliability and reducing costs. This approach can be extended to other facilities.
4. Bio-based fertiliser Production
    a. The bio-based fertiliser plant processes digestate, produced from the biogas plant, into high-quality bio-based fertiliser pellets, providing an additional revenue stream, reducing disposal issues and costs, and supporting a circular economy.
5. Reduced Carbon Footprint
    a. Implementing a BRRC significantly reduces a red meat processor’s carbon footprint, helping them transition towards net-zero goals.
6. Financial Viability
    a. The financial model projects strong returns on investment (ROI) for the BRRCs, with a payback period of nine years and a 25-year design life Net Present Value (NPV) of $70 million for an example facility processing 40,000 tHSCW/yr. The larger the facility, the greater the potential for financial returns and environmental benefits.
    b. Implementing the BRRC helps red meat processors turn necessary upgrades into profitable ventures, reducing reliance on potable water, generating a reliable, economical source of renewable energy, carbon credits and producing valuable by-products.
7. Main Benefits

a. The key benefits of implementing a BRRC at red meat processing facilities include significant environmental, social and economic benefits.

The Bio-Resource Recovery Centre model not only addresses critical aspects of sustainability but also ensures that the Australian red meat processing industry is well-equipped to meet future challenges and opportunities in a sustainable, economically viable, and socially responsible manner.

The Bio-resource Recovery Centres initiative not only supports red meat processors in achieving net zero carbon targets but also enhances environmental sustainability and economic viability. The project's comprehensive design offers significant social, economic, and environmental benefits, providing investor confidence and making a strong case for implementing a Bio-resource Recovery Centres at the case study facilities and other red meat processors across Australia.

Project Outcome

This snapshot report summarises the findings of the Bio-resource Recovery Centres project, outlining the design and feasibility of implementing integrated Bio-resource Recovery Centres at red meat processing facilities across Australia. The report utilises two case study facilities—one in WA and one in NSW—to illustrate the integration of a wastewater treatment plant, biogas plant, bio-based fertiliser plant, and CO_2 recovery plant. The CO_2 recovery plant, highlighted in the NSW case, represents an additional, and currently lucrative, opportunity that could be extended to facilities in WA and other states.

Metric	WA Case Study Facility	NSW Case Study Facility
Red Meat Processing Throughput for BRRC Design (t.HSCW/yr)	73,921	135,200
Design Wastewater Throughput (kL/yr)	480,340	919,800
Solid By-products to Anaerobic Digestion (tonnes/yr)	36,500	101,835
Biogas Production (Nm3/yr)	4,015,000	8,305,940
Total Energy Production from Biogas (GJ/yr)	88,330	182,733
Relative Energy Production from Biogas (GJ/tHSCW)	1.2	1.4
Electrical Energy from CHP (MWhe)	1.05	2.37
Thermal Energy from CHP (MWht)	1.1	2.42
Liquid CO2 recovered (tonnes/yr)	-	9,194
Biofertiliser Pellets Production at 90% TS (tonnes/yr)	2,028	5,656
BRRC CAPEX	$38M	$57M (includes CO2 plant)

Figure 2: Outcomes of implementing a Bio-resource Recovery Centre at two case study facilities, in WA and NSW

Financial Metrics	Example 40,000 tHSCW/yr Facility
NPV	$69,659,081
ROI	342%
Annualised ROI	6%
Payback Time	9 yrs

Figure 3: Economic assessment for a BRRC at an example facility processing 40,000 tHSCW per year

The payback time decreases, with NPV and ROI increasing with scale for the larger red meat processing facilities.

The wastewater treatment plants are designed for estimated future flow rates but have the flexibility to handle different flowrates and concentrations, within reason. The design enables the treated effluent to be recycled for uses for livestock washdown, onsite irrigation and off-take by third parties, reducing the red meat processors' reliance on potable water and addressing potential supply concerns. The higher-quality treated effluent will also improve red meat processors' ability to meet environmental license requirements for irrigation.

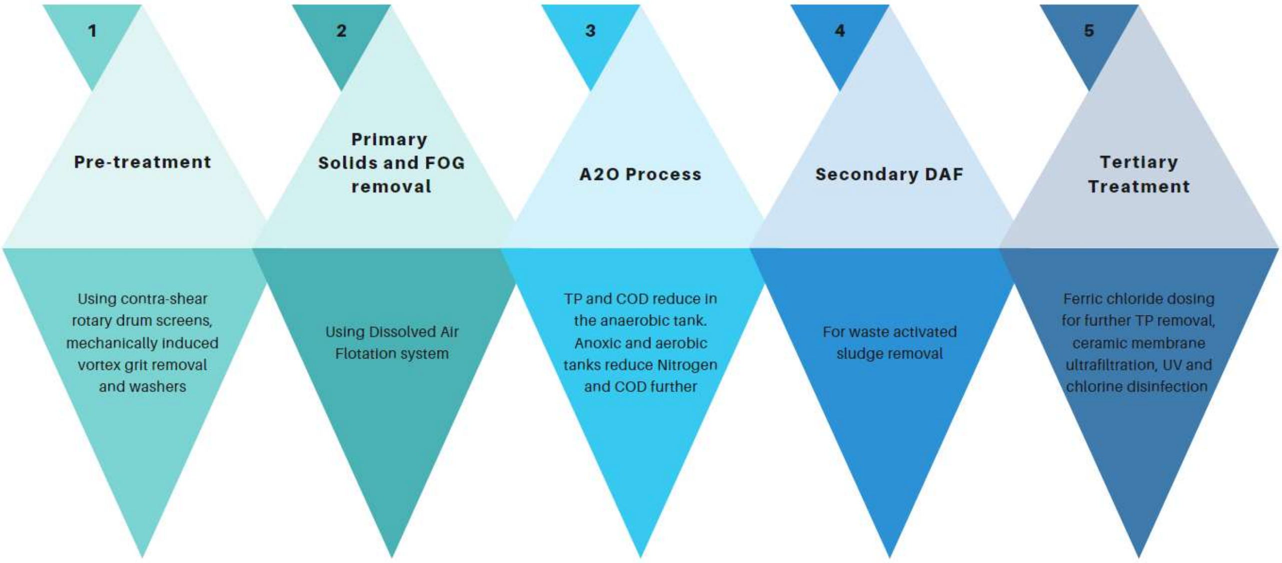

Figure 4: Wastewater treatment plant design summary

The solid streams audit and BMP tests used to validate the biogas plant design identified several organic by-products that could be redirected from waste or underutilised uses to more valuable applications as feedstock for anaerobic digestion. This includes solids from various sources such as screens, render bins, paunch, manure, B-grade products, inedible offal, wastewater treatment plant (WWTP) sludges, and other organic solids present on the land, like crop stubble.

The biogas plant design, validated by information obtained in the solids streams audit and BMP testing, incorporates modular units to enhance redundancy and supports future expansion, with an energy production capacity of 1.2 to 1.4 GJ per t.HSCW. The generated energy of reduces onsite gas and electricity consumption, contributing to environmental stewardship and financial efficiency.

The CO_2 recovery plant design, detailed for the NSW facility according to their needs, aims to enable the production of the site's own dry ice, enhancing supply reliability and significantly reducing the high costs associated with externally supplied dry ice. The recommended CO_2 recovery option, that is both cost-effective and almost perfectly meets typical onsite CO_2 demand, is post-CHP combustion CO_2 recovery using the chemical absorption method with amine. The concept design for CO_2 recovery using chemical absorption via amine is included in the report, and outcomes summarised below.

The bio-based fertiliser plant design characterises and quantifies processed biomass, proposing technologies for digestate processing with an overall energy demand lower than the biogas plant's output. This facility not only reduces controlled waste disposal costs but also generates additional revenue and completes a circular economy loop.

Recommended Bio-based fertiliser Technology

The recommended bio-based fertiliser recovery technology for implementation is mechanical dewatering to ~22% TS, thermally drying and pelletising the digestate into bio-based fertiliser pellets ready for third-party off-take.

Implementing the full integrated Bio-resource Recovery Centre (BRRC), including wastewater treatment, biogas, CO_2, and bio-based fertiliser plants, offers the highest return on investment, helping to offset red meat processor energy consumption and support carbon neutrality.

It is recommended to conduct Front-End Engineering Designs (FEED) and economic analyses, including sensitivity analyses on both the engineering and economic aspects, for each red meat processor planning to implement an integrated Bio-resource Recovery Centre. For the two case study facilities, it is advised to proceed with the subsequent stages of project implementation. This includes optimising resource recovery pricing and refining assumptions used in the design, such as wastewater flow rates and concentrations. Additionally, precise measurement, analysis, and projection of the quantities and quality of solid organic by-products should be undertaken.

Overall, implementing a Bio-resource Recovery Facility at red meat processors in Australia transforms necessary wastewater treatment plant upgrades—otherwise a financial burden needed for regulatory compliance—into a profitable venture. The BRRC initiative provides a positive return on investment by integrating bio-resource recovery components that recycle high-quality non-potable water, generate renewable energy from biogas, recover food-grade CO_2 for use as dry ice, and produce valuable bio-based fertiliser.

By recovering food-grade CO_2 for use as dry ice, the facility enhances supply reliability, reduces the amount of lost production revenue associated with potential supply issues, and mitigates reliance on expensive liquid CO_2 or dry ice prices. Additionally, the Bio-resource Recovery Centres (BRRC) initiative generates carbon offsets, supporting red meat processors in their goals to achieve net zero targets. It promotes environmental stewardship, eases pressure on potable water supplies in a drying climate, improves regulatory compliance, and supports a circular economy.

The comprehensive design of the BRRC offers social, economic, and environmental benefits, strongly supporting the rationale for advancing to the next phases of the project at the case study facilities, and at other red meat processors across Australia.

Benefit for Industry

The output of the project is a robust engineering design, cost estimate and economic analysis for the implementation of the integrated Bio-Resource Centre of Excellence. Furthermore, in addition to the individual red meat processor project drivers, red meat processors will be interested in the BRRC's ability to provide the Environmental (E), Social (S), and Economic ($) benefits outlined below.

WWTP

- Additional revenue stream from high quality, non-potable water **$**
- Improved environmental compliance and reduced fines **$E**
- Reduced demand on limited potable water supplies, by re-using their own water for livestock washdown and irrigation **$E**
- Ability to expand processing facility capacity once WWTP and water supply aren't limiting factors; results in increased revenue from meat processing, and reduced live exports **$S**

Biogas plant

- Offsetting all energy for WWTP, biogas and biofertiliser plants **$**
- Offsetting a portion of electricity and natural gas (or coal) costs of red meat processing facility **$**
- Includes carbon offset from replacing fossil fuels **$E**
- Reliable energy sources of biogas, electricity and heat – no risk of rolling blackouts or tariffs on peak usage **$E**
- Consistently priced source of energy – not subject to volatile market shifts **$**
- Carbon neutral energy production **$E**
- Opportunity to become fully self-sufficient and carbon neutral using biogas produced via codigestion **$E**

Biofertiliser plant

- Removed sludge and meat processing solids disposal costs **$**
- Easier to manage and regulate a solid biofertiliser product **$E**
- Additional revenue stream from biofertiliser **$**
- Carbon credits for the product **$E**
- Circular Economy Business Model **$ES**
- Offsetting the use of synthetic fertilisers **$ES**
  - Reduction of phosphate mining
  - Reusing nutrients instead of fossil fuels for nitrogen
  - Nutrients acquired locally, reducing fuel usage
  - Biochar and biofertiliser return carbon to the soil

BRRC Overall

- Creation of local jobs and subsequent economic growth **$**
- Flagship for sustainability and innovation, encouraging visitors and tourists to the locality **S**
- Expansion possibilities unlocked **$**
- Environmental, Social and Economic benefits **ES$**

Figure 5 Bio-resource recovery benefits, by component