Unlocking Circular Economy Potential via Anaerobic Digestion for BioResource Recovery for the Australian Red Meat Sector

F., Tessele; K., Ferraro*; L., Marinho**

*WA, Australia, fabiana@tessele.com
** WA, Australia, kendall.ferraro@tessele.com
*** WA, Australia, leticia.marinho@tessele.com

Abstract: This research project details the creation of a revolutionary digital tool tailored for the initial sizing and economic evaluation of an integrated resource management facility within the Australian red meat sector. The tool's core concept centres around the conversion of abattoir wastewater treatment facilities into resource recovery plants, emphasizing environmental compliance, and carbon footprint reduction. This model addresses crucial issues faced by the Australian red meat processing industry, providing support in decision-making processes concerning wastewater treatment and waste management. The ultimate aim is to guide the industry toward net-zero goals, grounded in the principles of a circular economy.

Keywords: Red meat processor industry; Circular Economy; Bio Resource Recovery

Introduction

The red meat and livestock industry, contributing $17.6 billion to Australia's GDP in 2018-19, plays a pivotal role in the nation's economy. However, responsible for 11.8% of Australia's greenhouse gas emissions, the industry faces a transformative challenge to align with global sustainability goals. With the objective of achieving Carbon Neutrality by 2030, the red meat and livestock sector must implement significant change. Achieving this target involves a comprehensive transformation of practices, especially concerning wastewater treatment and waste management. Simultaneously, stringent environmental regulations demand a rapid overhaul of wastewater treatment and waste management practices. The outdated infrastructure, designed in past decades, necessitates targeted refurbishment options to transition from effluent disposal to resource recovery. This well-established concept in Europe requires accelerated adoption in Australia to meet compliance and net-zero goals. The industry's lack of expertise necessitates swift and informed decision-making processes. The digital tool presented here serves as a solution, offering initial assessments for various abattoir scales, promoting inclusivity, and fostering resource recovery aligned with circular economy principles.

Environmental Challenges

Most existing wastewater infrastructure, designed and implemented over past decades, is based on outdated nutrient removal targets and exhibits limited energy efficiency (Warnecke, 2008). The need for a paradigm shift from effluent disposal to "resource recovery" is pressing (Tessele et al., 2020). This shift requires replacing existing pond systems with engineered processes that offer higher levels of process control, leading to increased efficiency. The proposed approach not only manages wastewater and organic wastes effectively but also brings additional benefits, including income generation and a significant reduction in carbon footprint. While this approach is relatively new in Australia, it is well-established and proven in Europe and other developed countries.

Material and Methods

The digital tool's development drew upon data collected from seven anonymous real-case studies of red meat processing plants (RMPs) across Australia, as presented in Table 1. The

technology selection focused on maximizing the recovery of treated water, energy from organic streams, and the production of bio-based fertilizers. The tool offers individualized plant assessments based on wastewater characterizations and situational conditions, enabling accelerated design outcomes. Users can input default industry wastewater characteristics or customize values based on their specific requirements. The resulting outputs fed into an online tool accessible to members of the Australian Meat Processing Corporation (AMPC). The schematic diagram (Figure 1) illustrates the integrated Bio-Resource Recovery Facility, centred around the Anaerobic Digestion process, a pivotal element in adopting a circular economy approach for bio-resource recovery.

Results and Conclusions

The developed digital tool represents a comprehensive understanding of the red meat industry's unmet needs, fostering collaboration between processing plants, AMPC, and consultants. Integrating wastewater treatment with a biogas plant provides a unique solution for on-site water recycling, energy production, and organic waste processing. The tool's outputs encompass best practices and potential outcomes for different abattoir scales, focusing on waste management practices, innovative resource recovery, and achieving industry-specific goals. Validated using real case studies and considering Australian conditions, the model contributes to the red meat industry's journey towards net-zero carbon and robust environmental compliance through a bio-resource recovery approach underpinned by circular economy principles.

The digital tool, born out of collaborative efforts, offers a transformative approach to the Australian red meat industry's challenges. By integrating wastewater treatment with biogas production, it presents a holistic solution for resource recovery, energy generation, and waste management. The model's flexibility allows for different inputs, tailoring outcomes to operational requirements while considering costs, complexity, returns on investment, and carbon offsetting opportunities. Validated through real case studies, the digital tool addresses a critical gap in the industry, steering it towards net-zero carbon and robust environmental compliance through a bio-resource recovery approach grounded in circular economy principles.

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Table 1: Facilities assessed by the digital tool.

Case	**Animal type**	**Capacity** (tHSCW/year)
1	Cattle	88,490
2	Sheep/Cattle	25,500
3	Cattle	58,708
4	Lamb/Sheep	16,200
5	Lamb/Sheep	77,740
6	Lamb/Sheep	47,000
7	Lamb/Sheep + Cattle	47,000

[1] *tHSCW = tonne of hot standard carcase weight*

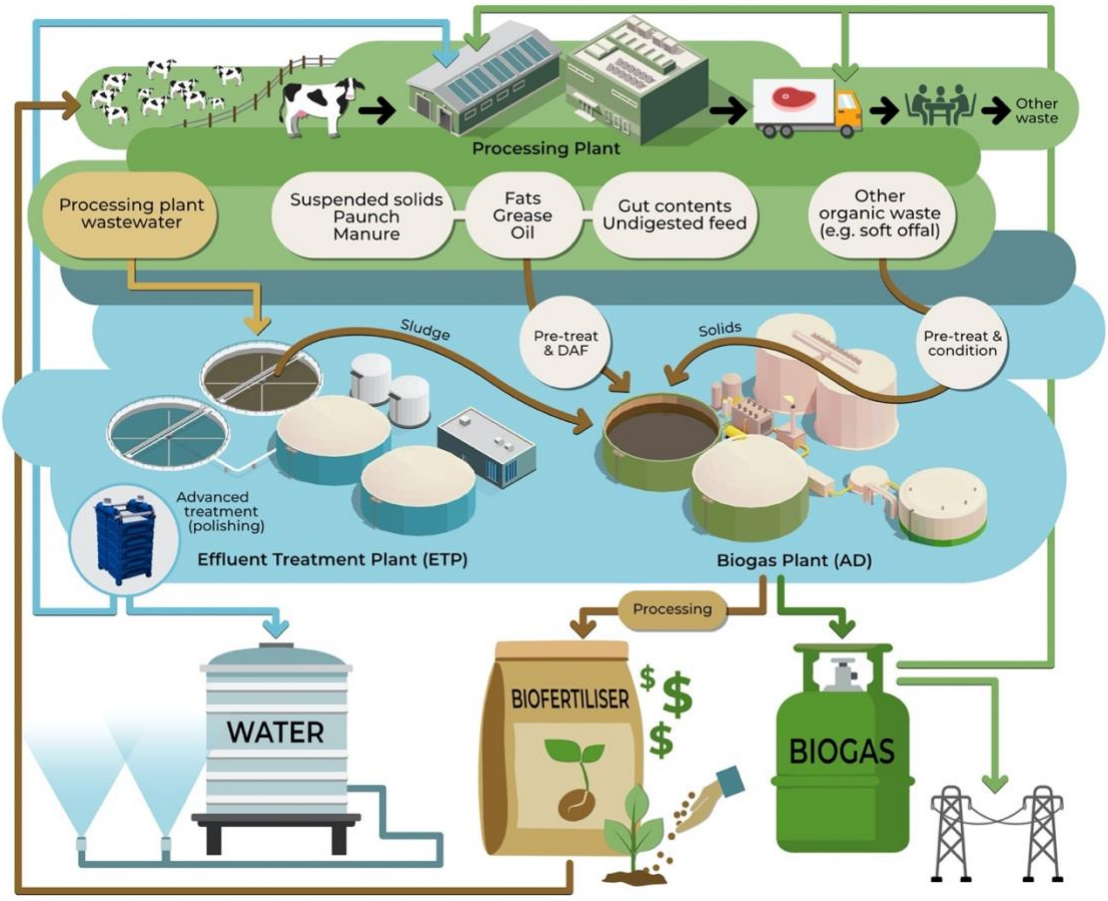

Figure 1: Schematic diagram of the integrated system, or Bio-resource Recovery facility used as a basis for the digital tool development, based on Circular Economy principles.