Snapshot Report

Digital Tool

Digital model for assessment and design of integrated wastewater treatment & resource recovery

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Project Description

This project involved the development of a digital tool for preliminary sizing and economical evaluation of an integrated resource management facility, based on the concept of turning wastewater treatment facilities of red meat processors into resource recovery plants.

The Digital Tool focuses on increased environmental compliance and reduction of overall carbon footprint, achieved via reduction of nutrient emissions, wastewater recycling, minimisation of waste diverted to landfills and biogas energy production. The framework for the development of the digital tool considered aspects such as the scale and urgency of EPA wastewater issues for Australian red meat processors and adaptability for various sizes of red meat processors.
The model supports the red meat processing industry in making decisions around wastewater treatment and waste management while advancing towards net-zero goals, underpinned by resource recovery via the adoption of a circular economy.

Project Content

Red meat processors are required to use significant amounts of potable water in their operations due to their commitment to Australia's high standards in meat safety and the industry's long-held internationally recognised disease-free status in red meat. It's estimated that during 2020 the red meat processor sector consumed 27.65 GL in water intake which created 22.75 GL of wastewater.

The meat industry is often regarded as being more water intensive than other food groups. However, recent research found in the Australian context that fresh meats contributed less than 8% of the total dietary water footprint when regional Australian data on water scarcity was used[1].

In fact, Australian red meat processors achieved good reductions in both water intake intensity and water discharge intensity of 8% and 23% (respectively) between 2015-2020. However, this improvement came with a 10% increase in energy intensity. Similarly, improved processor water management and increased efforts in treating higher volumes of wastewater on-site don't seem to have been accompanied by more sophisticated bio-resource recovery outcomes, with a smaller than 1% increase in biogas and an increase in solid waste to landfill intensity occurring during this period[2].

Aligned with the United Nations Sustainable Development Goals (SGD30) and Australia's National Climate Resilience and Adaptation Strategy, the Australian red meat and livestock industry has set the ambitious target to be Carbon Neutral by 2030 (CN30). This target means that by 2030, Australian beef, lamb and goat production will make no net release of greenhouse gas (GHG) emissions into the atmosphere.

[1] Ridoutt B. Baird D. Anastasiou K. and Hendrie G. 2019, Diet Quality and Water Scarcity: Evidence from a Large Australian Population Health Survey, Nutrients
[2] 2020 AMPC Environmental Performance Review.

Concurrently, the environmental regulators across Australian states are requiring that red meat processors comply with stricter standards for water usage, wastewater treatment and waste management practices. A significant step-change on many fronts of the production chain is required in a short period to achieve simultaneously robust environmental compliance and dramatically reduce carbon emissions.

Most of the current wastewater infrastructure, which was designed and implemented over the past decades, is now based on outdated nutrient removal targets and has limited energy efficiency. Therefore, nationwide access to a tool that helps to illustrate targeted refurbishment options for wastewater and waste management systems is urgently required. Wastewater treatment plants need to align with the widespread movement away from effluent disposal, toward resource recovery.

To achieve this paradigm shift, the existing pond systems need to be replaced by appropriate engineered processes, where higher levels of process control are possible, leading to higher efficiency. The proposed new way to manage wastewater and organic wastes brings the added benefits of generating income and significantly reducing carbon footprint. While this approach is considered new in Australia, it is commonly used and well-proven in Europe and other developed countries.

The red meat processing sector, including its associated research centres, consultants, and suppliers, generally lack expertise in designing, building, and operating such systems, and the pace required to respond to demanded changes needs to be fast so that red meat processors can remain compliant and productive in the coming years while achieving net-zero goals.

By adopting this digital tool, red meat processing plants can benefit from having the initial assessment easily done, allowing for a faster-informed decision-making process.
Developing a tailor-made concept design for different scales promotes inclusive participation, helping smaller operators to undergo the required upgrades with lower levels of investment, and potential side-stream revenues.

This integrated approach can generate impacts beyond the processing facility, being integrated with the community as a training centre, events venue, and part of the local attractions for visitors. This will contribute to the development of higher awareness of the value of what was previously considered waste and normalise the recovery of valuable resources.

By implementing the proposed integrated Bio-resource recovery concept developed for the digital tool, the average Australian red meat processors can become financially attractive. Non-financial outcomes include:

- Development of a digital tool that informs small, medium, and large-scale red meat processors on their decision-making process on managing waste/wastewater streams from a different lens.
- Increased environmental compliance via reduction of the adverse effects of nutrient emissions to the environment

- Reduction of wastewater discharged to the environment and of waste diverted to landfills.
- Reduction of overall carbon footprint via bio-energy production using organic waste streams.
- Provide a tool for decision-makers to identify and select the most appropriate technical pathway according to the scale of their operations.
- Contribute towards a change in paradigm on how waste streams are managed in Australia

Individualised plant assessments, using the digital tool and supported by wastewater characterisation and plant situational conditions (i.e., species, throughput, climatic), were performed for each of the seven participants. These assessments aimed to demonstrate how the tool can be used to support an accelerated design outcome.

There is an option built into the digital model allowing for calculating the outputs either based on the default wastewater characteristics established for the industry (organic and nutrient loadings), volume flows and situational data or allowing the user to enter their values. The default wastewater quality was based on average values for the case studies and Australian industry averages, divided into three different strengths: Low, Moderate, and High. The outputs of the modelling served as inputs for creating an online digital tool, that will be made available online for members of the Australian Meat Processing Corporation (AMPC).

Project Outcome

The core concepts underpinning the integrated process design included:

- High-efficiency pre-treatment, aiming to recover carbon-rich organic material for processing in the biodigester and simultaneously offload the wastewater treatment process – hence requiring less energy for aeration
- Modular biological nutrient removal (BNR), targeting high efficiency/low energy Nitrogen removal
- No biogas recovery from wastewater streams, preserving the carbon for the denitrification step and eliminating the need for added carbon sources
- Chemical phosphorous precipitation, enabling very low TP concentrations in the treated water, and the possibility to recover Phosphorus.
- Ceramic ultrafiltration membranes as a post-treatment after BNR system, producing high quality clarified water
- Multi-barrier disinfection system to achieve log removals compatible with Class A water for non-potable reuse
- Management of all biodegradable solid streams using a Co-Digestion AD Plant, including sludge from save all/primary DAF, manure, paunch, and waste sludge from the BNR process.
- External waste streams were not considered, and the site-specific economic viability of Anaerobic Digestion and benefits of adding external wastes can be assessed in further studies.

The digital tool went live in July 2022 and is available for the AMPC membership base. The digital tool has a friendly interface for easy data input and easy access to the outputs of the simulation. The link to access the tool via webpage is:

https://vm7.uat01.oneit.com.au/tessele/ng/#/bio-resource-planner

In addition to the results presented on the webpage, the digital calculator has been equipped with an option for generating a report including all the data assessed and the outcomes produced. The purpose of this report is that after the simulation exercise, results can be shared with the user's team, and decision-makers in their respective facilities, to decide whether this type of system can be further developed and ultimately implement after a detailed assessment and design.

Benefit for Industry

The digital tool involved a comprehensive understanding of the unmet needs of the Australian red meat industry and involved an extensive collaborative effort between the processing plants, AMPC and the consultant. The integration of the wastewater treatment plant with a biogas plant, to process red meat wastewater and organic solid wastes, provides a unique opportunity to produce high-quality water with recycling potential and organic solid waste processing on-site, while producing energy in form of biogas (potential for conversion into electricity or heat) and fertilizer in form of digestate or even further improved high-value fertilizer products.

The developed digital tool for preliminary sizing and economical evaluation of an integrated resource management facility enables the easy assessment of best practices and possible outcomes for different scales of red meat processors, provides adequate waste management practices and creates an innovative approach for recovering resources in the industry.

The model allows for different inputs as drivers depending on the operational requirements, and focus on the outputs in terms of costs, level of complexity, returns on investment and carbon offsetting opportunities. The digital model was validated using real case studies from operating red meat processors and considered Australian conditions (climate, regulation barriers, etc.).

The digital tool contributes to closing the gap in the red meat industry on the path to achieving net-zero carbon, as well as robust environmental compliance via a bio-resource recovery approach, underpinned by Circular Economy principles.