Techno-economic consideration of a scaled-up meat waste biorefinery system: a simulation study

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Key discussion points

- A review of the background and motivation of this study.
- Value extraction from meat processing waste: methodologies employed.
- The justification of the present work.
- Results.
- Conclusion.

Motivation for utilising meat processing waste as a feedstock biochemicals and biofuel production

- Significant masses of dissolved air flotation (DAF) sludge, (~2.8×10^6 tonnes) and stockyard (SY) waste are generated (>15×10^6 tonnes) annually by New Zealand meat processing industry.

- These DAF sludge and the SY waste streams constitute a major waste management issue (Richard Stapel, personal communication, 2015).

- There are limitations associated with current waste management approaches. These limitations include the generation of unpleasant smells from direct land disposal and sludge composting and the high energy drying operations prior to waste incineration.

- We seek to promote resource-recovery (circular economy) as a viable strategy in organic waste utilisation.

Research hypothesis

It was hypothesised that,

- It is possible to generate useful products from high moisture containing meat processing waste streams while also circumventing the conventionally employed high energy preliminary drying operation.

- Resource recovery from the meat processing waste streams constitutes an environmentally sustainable process.

- Multi-product generation from the proposed biorefinery will result in improved economic performance compared to the economic performance of stand-alone biomass conversion systems.

Such a unified approach in generating useful product streams using biomass as the feedstock is essentially the application of the biorefinery concept.

Previous studies undertaken for processes in Fig. 1 (next slide)

- We have explored the utilisation of DAF sludge as a sustainable feedstock for **biodiesel** production via an integrated hydrolysis and esterification process (process numbered 1).

- The possibility of enhanced **biomethane** generation via the introduction of synergising effects during the AD of the substrate mixture of stockyard waste and the wet hydrolysed DAF sludge residue (after in-situ hydrolysis) has also been demonstrated (process numbered 2).

- The HTL processing of the digestate was established as a viable resource recovery from digestate for **biocrude** and **biochar** production (process numbered 3).

Value extraction from meat processing waste

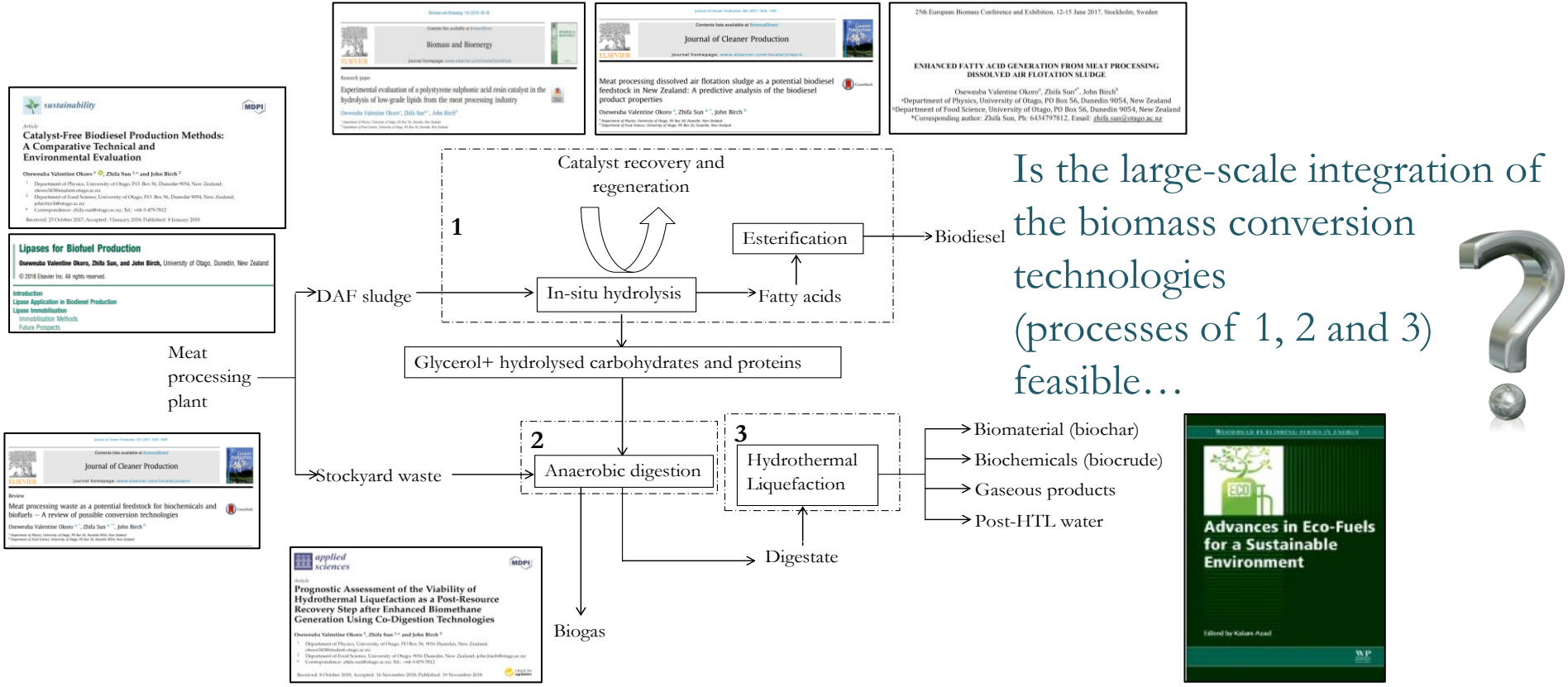


Fig. 1: Biorefinery design for meat processing waste conversion to biofuels and biochemicals.

Biorefinery model proposed

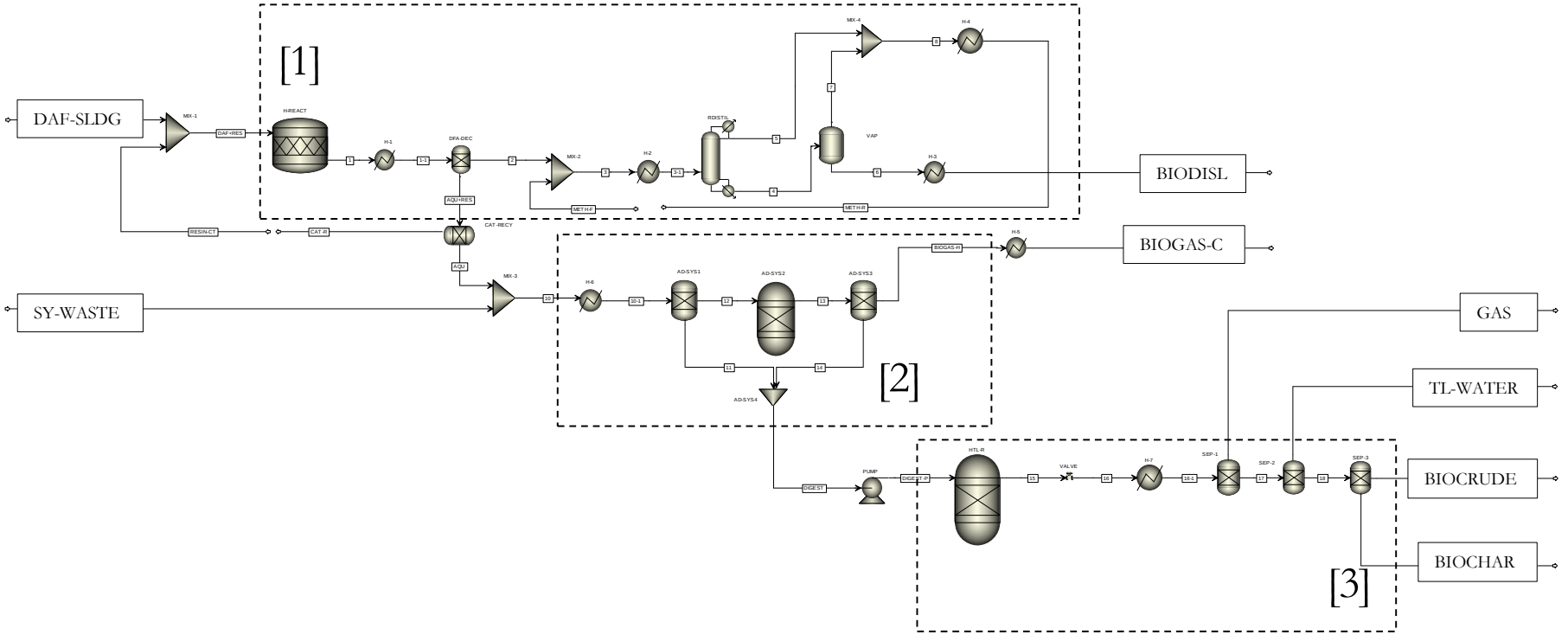
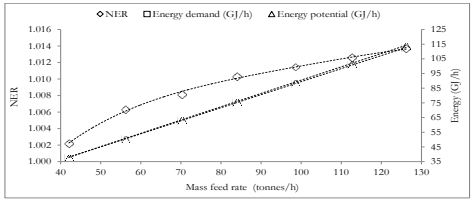


Fig. 2: The simplified process flow sheet for the simulated meat processing waste biorefinery for biodiesel production process [1], anaerobic digestion process [2] and hydrothermal liquefaction process [3].

Biorefinery model proposed



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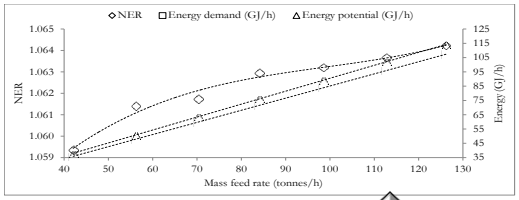

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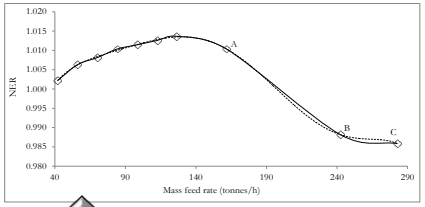

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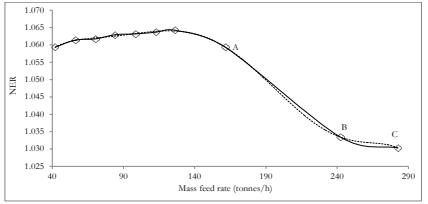

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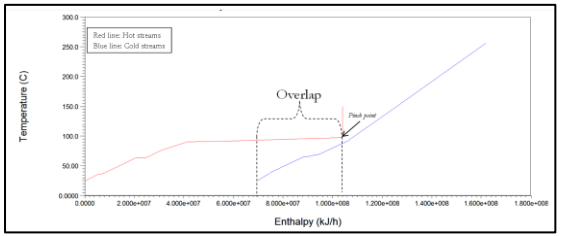

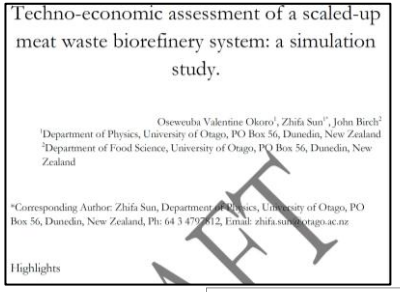
Techno-economic assessment of a scaled-up meat waste biorefinery system: a simulation study.

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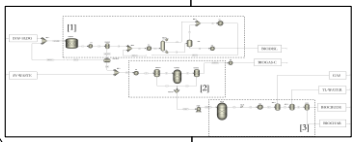
Highlights

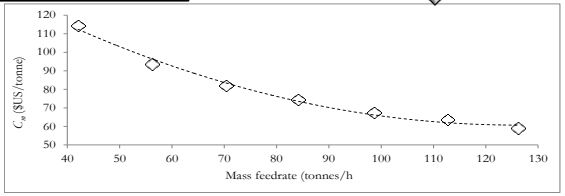
Anticipated Output

$$NER = \frac{\sum_{j}^{n}\left(HHV_j \times P_j\right)}{\left[\frac{\sum_{i}^{x} E_{i-E,j} + E_{p-E}}{\eta_{H-E}}\right] + \frac{\sum_{i}^{N} E_{H-f,j}}{\eta_{C-H}}}$$



$$C_{m,j} = \frac{C_{T,j}}{\sum_{i=1}^{n} m_{p,i}}$$

- Multiobjective optimisation of the environmental performance and the economic performance.
- Methodologies considered in this study include genetic evolution algorithms and the desirability function approach.



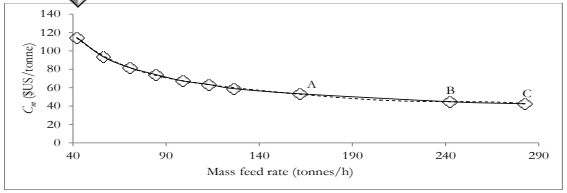


Fig. 3: Simulation of the proposed biorefinery system.

Results showing the unit production cost of the products

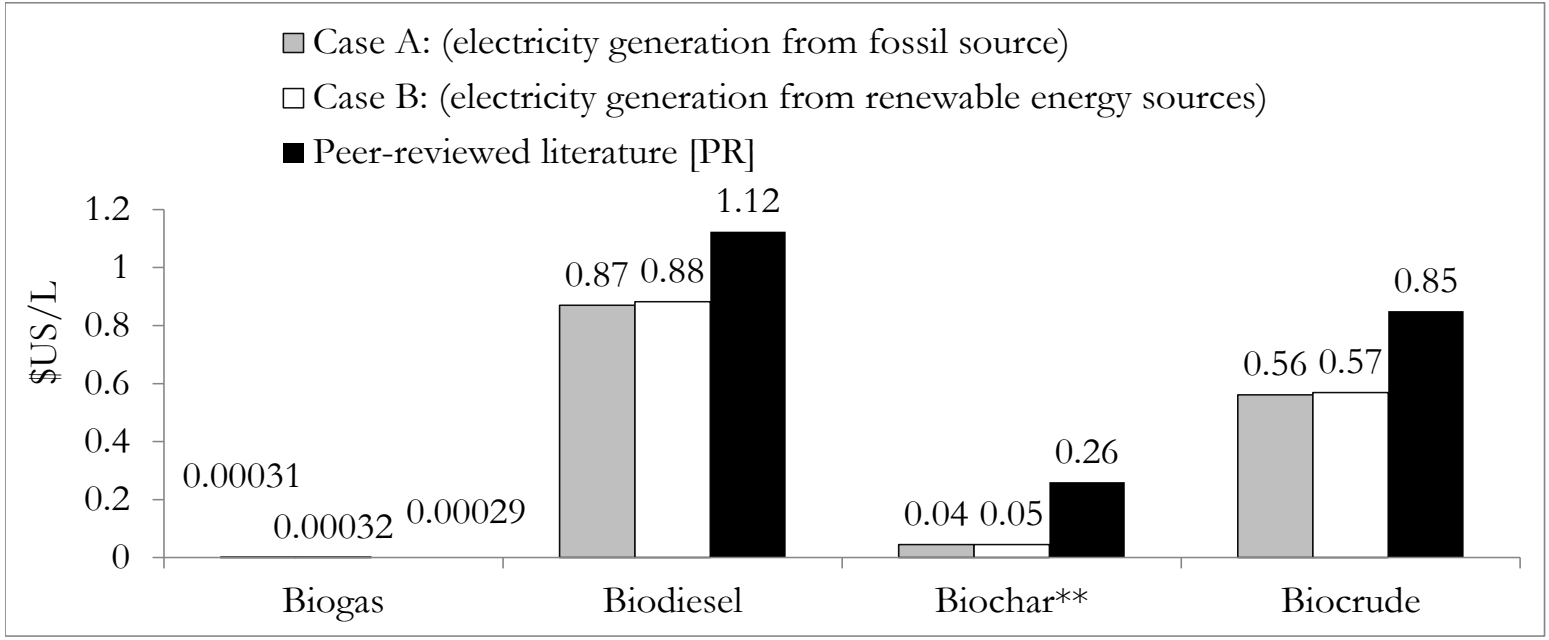


Fig. 4. Comparative assessments of the unit production cost of useful products of biogas, biodiesel, biochar and biocrude; in cases of A (NER of 1.01) & B (NER of 1.06); crucially the need for environmental sustainability is upheld; the unit production cost of biogas is significantly lower than the unit production cost of biodiesel, biochar and biocrude.

**Volumes estimated using bulk-density data

Conclusions

- The possibility of a sustainable and economical value extraction from high moisture waste biomass streams of the food industry was demonstrated.
- Meat waste valorisation presents opportunities for the production of biofuels and biochemicals using the proposed biorefinery.

Some issues may however limit the immediate employment of the proposed biorefinery system (**Fig. 1 & Fig. 2**):

- Due to technical risks associated with upscaling the complex biorefinery system, investors may limit their participation in such long term strategic projects.
- Also, current low crude oil prices may limit motivation for investing in a biorefinery system due to lower production costs, in the short term. In the long term however, global warming and the depletion of fossil sourced constitute significant issues.

Thank you

Questions