Commercial Life Cycle Assessment for Loganholme Gasification Facility

Summary Report

Author: Catriona Sutcliffe, Logan Water

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DISCLAIMER AND ACKNOWLEDGEMENT

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This report is a summary of the 'Life Cycle Analysis (LCA) of the Logan City Council Gasification Facility' study, prepared by Bridle Consulting (October 2022)

1. Introduction

Logan City Council (LCC) operates the Loganholme Wastewater Treatment Plant (WWTP) at Logan, southeast Queensland, which is the largest of its 4 WWTPs. Each WWTP produces two products, namely treated wastewater and excess sludge (biosolids). Currently all of the biosolids produced at Loganholme WWTP are mechanically dewatered on belt filter presses and trucked off-site for reuse on agricultural land about 250 km away. LCC, with financial support from the Australian Renewable Energy Agency (ARENA), conducted a semi-full-scale trial of biosolids gasification in 2020 at the Loganholme WWTP, and this trial was very successful, resulting in a commitment from LCC to installing a full scale commercial biosolids gasification facility at their Loganholme WWTP for operation in 2022.

2. Goal and scope of the study

The commercial Life Cycle Assessment (LCA) has been developed based on the requirements as outlined in the ARENA guidance document *Life Cycle Assessment of Bioenergy Products and Projects* (ARENA, 2016). This guidance document is based on international standards including ISO 14040 and ISO 14044.

This LCA study has been prepared to:

- Understand the life cycle greenhouse gas (GHG) inputs and emissions during the treatment and disposal of biosolids at Loganholme WWTP, under business as usual (BAU) case and with the installation of a biosolids gasification facility.
- Meet ARENA requirements as part of the funding agreement for the gasification facility.
- Provide cradle to grave LCA to inform future applications for carbon credits associated with biochar.
- Provide verified environmental performance data to potential users of the biosolids gasification process and the broader public, with particular emphasis on calculating the reduction in greenhouse gas emissions compared to the BAU approach of land application of dewatered biosolids.

Th biosolids gasification facility is currently (December 2022) in commissioning stage, with proof of performance testing scheduled for January 2022, after which full scale production can occur. The gasifier equipment has an estimated life of 20 years.

3. Assumptions and calculation approach

The following assumptions have been adopted during the LCA:

- The final LCA is based on process performance data from the pilot and commercial gasification facility as well as updated biosolids generation predicted volumes to the year 2042 (20-year life cycle).
- For both BAU and gasifier case, GHG emissions from transporting the biosolids cake and biochar is based on the assumption that:
    - trucks transporting biosolids have a capacity of 40 tonne of biosolids cake or biochar
    - diesel truck CO_2 emissions are assumed to be 1 kg per km travelled.
- It is assumed that 100% of emissions are in the form of CO_2, and that negligible emissions of higher order greenhouse gases are produced during the life cycle.

Project inputs and data sources are listed in Table 1.

Table 1: Input data and sources

Parameter	Units	Gasifier Value	BAU Value	Data source
Wet Biosolids Cake Mass	Wet tonnes	695,039	1,122,754	Calculated
Cake total solids	%	21	13	Laboratory data
Dry Biosolids Feed	Dry tonnes	145,958	145,958	Calculated using historic data and population projections
Biosolids Carbon Content	%	41.50	41.50	Laboratory data
Biosolids Nitrogen Content	%	7.40	7.40	Laboratory data
Biosolids Sulphur Content	%	0.59	0.59	Laboratory data
Facility Power draw from Grid	kWh/dry t	704	69	Meter data
Power generated by Solar Farm	MWh/a	2,409	2,409	Design basis
Diesel Fuel use for start-ups	Litres	24,000	0	Operational estimate
Return distance to Biosolids reuse site	km	NA	500	Average from existing data
Carbon mineralisation from biosolids to land	%	NA	80	CSIRO CRC
Return distance to Biochar reuse site	km	500		Assumption
Carbon mineralisation from char to land	%	0		Scientific literature
Char Yield	% of dry feed	42		Design assumption
Char Production	Dry tonnes	61,302		Design assumption
Char Carbon Content	%	37.20		Laboratory data
Urea Use	% of dry feed	1.50		Design assumption
Mg(OH)2 Use	% of dry feed	0.60		Design assumption

4. Summary of LCA results

The life cycle emissions comparison between gasification and BAU is presented in Table 2, comparing the life cycle emissions in tonnes of carbon dioxide equivalent (tCO2-e) per tonne of dry biosolids feed.

Table 2. GHG Emission Summary for the LCA

Source of GHG emission	Gasification Value (t CO2e/20 years)	BAU Value (t CO2e/20 years)
Biogenic Emissions		
Carbon mineralisation- land application	0	222,101
CO2 from gasifier stack	138,484	0
Sub-total	**138,484**	**222,101**
Fossil Emissions		
Facility power draw	14,080	1,378
GHG Credit from Solar Farm	-48,180	0
Diesel use in gasifier	63	0
Transport of biosolids to reuse site	0	14,034
Transport of biochar to reuse site	766	0
Imbedded emission from Urea use	1,598	0
Imbedded emission from Mg(OH)2 use	1,401	0
Sub-total	**-30,271**	**15,412**
TOTAL	**108,213**	**237,514**

Emissions total (t CO2e/t dry biosolids)	**0.741**	**1.627**

5. Discussion and interpretation

It is evident that the Loganholme WWTP Gasification Facility will significantly reduce the carbon footprint associated with processing of the biosolids from the Loganholme WWTP, reducing emissions from 1.627 to 0.741 tCO2-e/t dry biosolids. Over the 20-year life of the gasification facility GHG emissions will be reduced by 129,301 tonnes. This is a 54% reduction in emissions compared to BAU.

Of even more significance is that reuse of the biochar produced by the biosolids gasification facility will increase agricultural soil carbon content by 22,804 tonnes. This carbon is sequestered in the soil for millennia which increases soil productivity and hence increases crop growth significantly.

All of these factors will help Australia to meet its international GHG reduction targets.

6. Use of the results

The results from the Loganholme biosolids gasification facility will help facilitate a national Australian transition to low carbon emission biosolids processing facilities. Australia currently produces about 500,000 dry tonnes of biosolids annually. If all of Australia's biosolids is processed via gasification, or other similar thermal technologies, it is likely that nearly 76,000 tonnes of carbon can be sequestered in Australian agricultural soils every year.

A significant benefit of this project is the pioneering work being undertaken by LCC to obtain the necessary legal approvals for reuse of char generated from biosolids in agriculture. LCC is currently in the process of developing an End of Waste (EoW) code for biochar that will increase the market and uses for biochar. All State legislation is currently silent on the requirements for reuse of char generated from biosolids in agriculture.