

# Merlin Biomethane Plant

## CO<sub>2</sub> Analysis Report

February 2019

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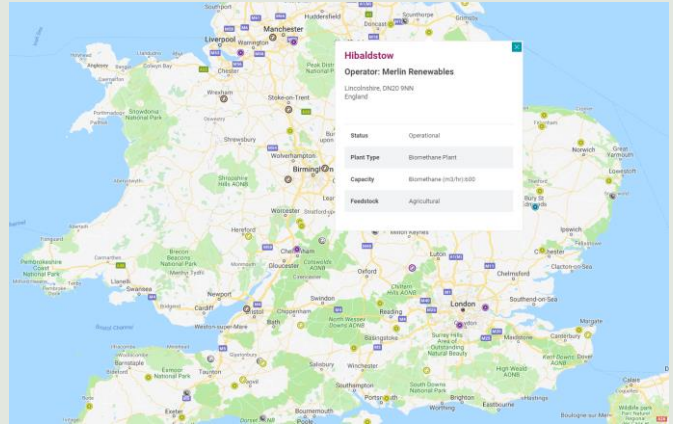
## CO<sub>2</sub> Analysis Report

### Executive Summary

Aardvark Certification Ltd (ACL) has been instructed by John Laing Environmental Assets Group Ltd to assess and report against the carbon savings achieved by the 450m<sup>3</sup>/hr Merlin Biomethane Plant located at Hibaldstow Airfield, North Lincolnshire, DN20 9NN. This assessment considers the CO<sub>2</sub> savings made as a result of this biogas plant as well as the wider environmental benefits the project has delivered.

### Asset Introduction

The Merlin Biomethane Plant is fed on a menu consisting of 39,180 tonnes per annum of agricultural feedstocks including maize and rye silage, sugar beet and sugar beet pulp. The biogas plant has a designed maximum export capacity of 550m<sup>3</sup>/hr biomethane with all biomethane produced exported directly to the national gas grid. A 500kW CHP provides heat and power to meet the energy requirements of the plant. The plant was commissioned in September 2014 and to date has exported 17,765MWh of renewable electricity and a further 174,211MWh of biomethane.



### CO<sub>2</sub> Savings from Biomethane

Biomethane offsets significant CO<sub>2</sub> emissions compared with fossil fuel derived gas and electricity. Conversion factors for fossil fuel derived electricity, natural gas and biomethane are shown below:

- UK Generated Electricity: 0.28037 kg CO<sub>2</sub>e per kWh
- Natural Gas: 0.18396 kg CO<sub>2</sub>e per kWh (gross CV)
- Biomethane: 0.00037703 kg CO<sub>2</sub>e per kWh (gross CV)

The calculated CO<sub>2</sub> savings shown within this report are based on the actual savings achieved by the site.

### Greenhouse Gas Emissions

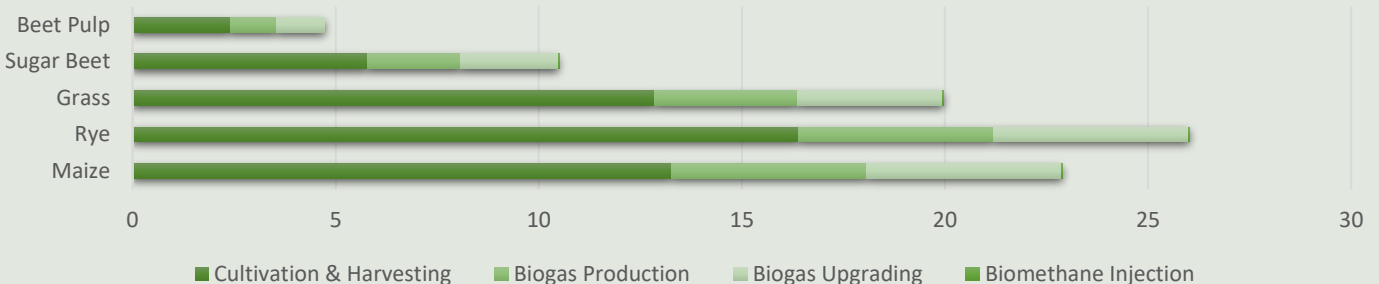
The Merlin Biomethane Plant uses a range of agricultural feedstocks to produce energy which comprise of purpose grown crops. The cultivation, harvesting and conversion of the crops to energy requires an element of fossil fuel use. The actual CO<sub>2</sub> savings achieved therefore need to account for the associated GHG emissions produced through the use of the crop based feedstocks. A simplified illustration of the fuel chain shows each step at which GHG emissions are produced through use of crop based feedstocks.



### GHG Emissions by Feedstock

Each feedstock has been assessed to determine the specific GHG emissions associated with their use with indicative emissions at each step in the fuel chain shown below based averages for crop type. Manures and residues are deemed to have zero emissions:

#### GHG Emissions per Feedstock (gCO<sub>2</sub>eq/MJ biomethane)



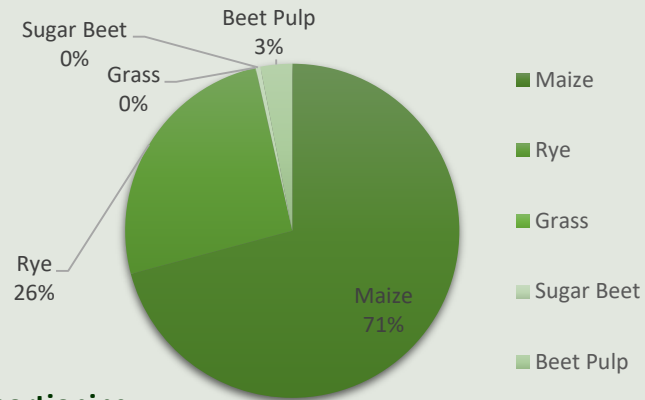
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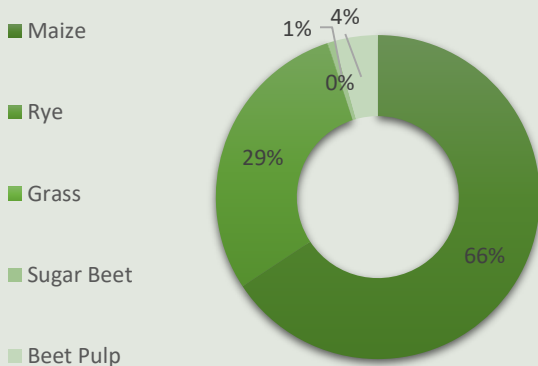
### Biogas Apportioning

As the Merlin Biomethane Plant uses a range of agricultural feedstocks, it is necessary to understand what proportion of the biogas produced is derived from each feedstock in order to quantify the CO<sub>2</sub> savings achieved by the plant. To do this we apportion the biogas across the range of feedstocks based on their individual biogas yields.

### Biogas Apportioned by Feedstock



### CO<sub>2</sub> saved by Feedstock



### CO<sub>2</sub> Apportioning

In order to account for the associated GHG emissions resulting from the use of purpose grown crops to produce the electricity and biomethane, it is necessary to apportion the CO<sub>2</sub> emissions saved as a result of the operation of the biomethane plant by feedstock type. This shows that whilst some feedstocks contribute more to overall biogas production than others, these are not necessarily delivering equivalent levels of CO<sub>2</sub> savings for the plant as emissions associated with their production can be greater or other feedstock types have zero emissions.

### CO<sub>2</sub> Savings

With the preceding analysis, it is possible to calculate the CO<sub>2</sub> savings the plant has achieved over its lifetime had the equivalent quantity of energy derived from fossil fuel sources. Total CO<sub>2</sub> emissions which would have come from an equivalent quantity of electricity or natural gas from fossil fuel sources in the UK is shown below along with CO<sub>2</sub> savings made through energy production from the biomethane plant. This shows a total saving to date of 3,504tCO<sub>2</sub>e has been saved by the Merlin Biomethane Plant through electricity production used onsite and a further 17,569tCO<sub>2</sub>e has been saved through biomethane production.

Total Energy Produced			UK Generated Electricity		Biogas Generated Electricity	
Electricity	17,765	MWh	Conversion factors	0.28037		
			CO <sub>2</sub> Equivalent (kg CO <sub>2</sub> e)	4,980,733		1,476,398
			CO <sub>2</sub> Difference (kg CO <sub>2</sub> e)		3,504,335	

Total Energy Produced			UK Natural Gas Emissions		Biomethane Emissions	
Biomethane	174,211	MWh	Conversion factors	0.18396		
			CO <sub>2</sub> Equivalent (kg CO <sub>2</sub> e)	32,047,946		14,478,333
			CO <sub>2</sub> Difference (kg CO <sub>2</sub> e)		17,569,613	

### CO<sub>2</sub> Forecast

An anaerobic digestion plant is typically designed with a 20 year operational lifetime. In practice this may go on well beyond the planned 20 years. Based on the expected 20 year operational forecast, Merlin Biomethane Plant is expected to save a total of 97,264tCO<sub>2</sub>e. This forecast is based on the current GHG emissions associated with the production of feedstocks and operation of the plant. In practice it is expected that improved technology and efficiencies over the remainder of the lifetime of the plant will enable it to reduce its own emissions thereby increasing the overall CO<sub>2</sub> savings it contributes.

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### What do these savings mean?

The CO<sub>2</sub> savings achieved by the project can be difficult to comprehend and relate to real world understanding. We therefore equate the savings to every day scenarios such as vehicles, and homes to assist readers in interpreting the data.

The Merlin Biomethane Plant has to date offset 21,074tCO<sub>2</sub>e since commissioning and is expected to offset at least 97,264tCO<sub>2</sub>e over its operational lifetime. This equates to:

- Equivalent emissions produced by a mid-sized diesel car driving around Earth's equator 13,986 times over the lifetime of the plant
- Removing 2,232 mid-sized diesel cars from UK roads every year over the lifetime of the project
- Providing gas for heating and cooking in 2,079 UK homes for twenty years

### Other Environmental/Social Benefits

The Merlin Biomethane Plant delivers other environmental benefits, namely offsetting fossil fuel derived fertilizer use and improving soil health.

The resultant digestate from the plant is used on local farmland as a valuable biofertilizer. The liquid fraction has been particularly useful for establishment of cover crop, oilseed rape and grass.

Use of the digestate as a direct replacement for traditional fertilisers offsets an estimated 390 tCO<sub>2</sub>e per annum.

The use of energy crops as feedstock for the biomethane plant has not resulted in any change in land use type.

In addition to the environmental benefits the project delivers, Merlin Biomethane Plant also contributes to a local community fund. To date over £15,500 has been donated to the local community. This has included contributions to support the 'Village Voice' community magazine, the Redbourne Fire Engine Restoration Fund, the St Hybalds Church Tower restoration fund as well as donations to the local parish council.

### Methodology

This report has been prepared in good faith by Aardvark Certification Ltd based on data obtained from the owner/operator of the asset reviewed. Our calculations of GHG emissions associated with the production of biogas from the plant has been through the UK Solid and Gaseous Biomass Carbon Calculator (B2C2), V2 Build 36 updated in October 2015. Our GHG emissions assumptions for this plant are based on an annualised average emissions value for the plant by feedstock type. Biogas yield data is based on that reported by the plant operator over a 32 month period.

Our calculations of CO<sub>2</sub> savings are based on IFI Approach to GHG Accounting for Renewable Energy Projects. Baseline Emission Factors used in this analysis are taken directly from the Department for Business, Energy & Industrial Strategy Greenhouse gas reporting: conversion factors 2018.

Energy usage statistics are taken from OfGEM - <https://www.ofgem.gov.uk/gas/retail-market/monitoring-data-and-statistics/typical-domestic-consumption-values>

Mileage travelled per vehicle in the UK was taken from the RAC Foundation.

Digestate NPK values sourced from Defra's Fertiliser Manual 2017 (RB209) 9<sup>th</sup> edition

### Liability

This document contains information and may contain conclusions and recommendations. Every effort has been made to ensure that the information is accurate and that the opinions expressed are sound. However, Aardvark EM Limited cannot be made liable for any errors or omissions or for any losses or consequential losses resulting from decisions based on the information.



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