Grass-to-Gas: Road-Verge Biomass for Anaerobic Digestion

Storage, Pre-Treatment and Application

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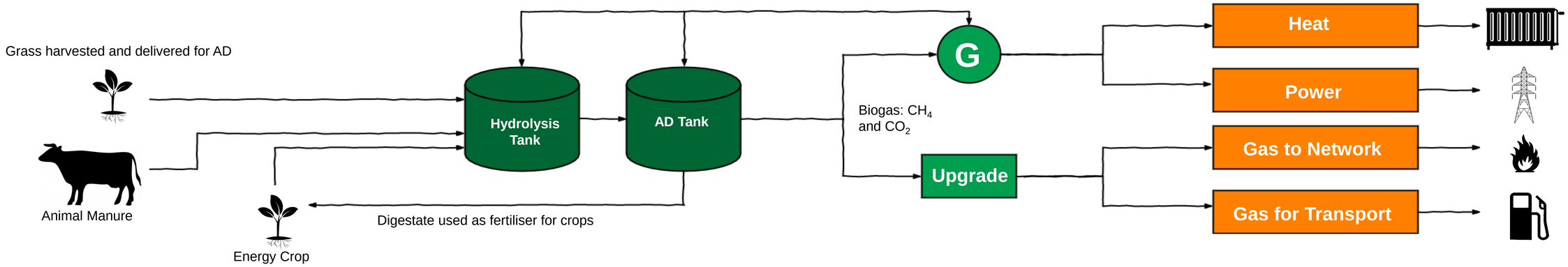
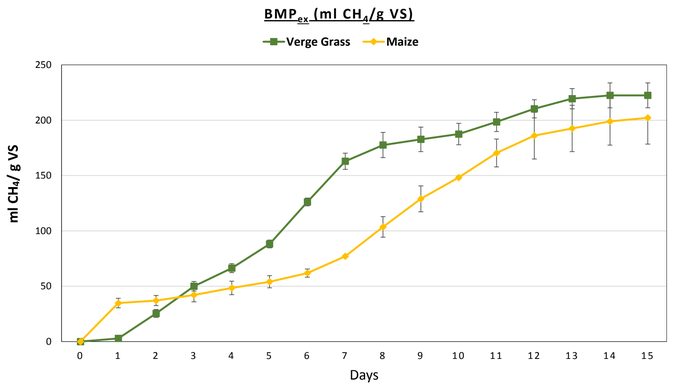


Local councils maintain public land for aesthetic and functional reasons, and roadside verges are maintained for safety [1]. Grass clippings are often left in situ to naturally decompose [2]; but they are a potential feedstock for the generation of biogas from anaerobic digestion (AD). AD is the breakdown of organic material by microorganisms to produce biogas (methane and CO_2) and digestate. Previous work has shown that verge grass is not contaminated with chemicals and can be harvested at a competitive cost. If verge grass is to be used successfully for AD the grass must generate biomethane at levels competitive with current feedstock crops, a reliable supply of grass must be available and the harvesting and processing process must be profitable.

Evaluating Biomethane Potential:

- Experimental biomethane potential (BMP_{ex}) of road-verge grass and maize was undertaken using an automated BMP assay (Bioprocess™).
- Digestion conditions mimicked those used by the pilot-scale AD Digester at Scrivelsby Farm.
- Road-verge grass generated a higher BMP_{ex} at a faster rate than maize.



Findings:

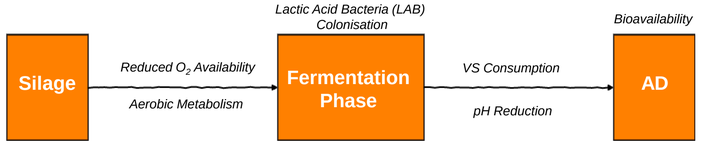
- Theoretical BMP (BMP_{th}) was determined via the Boyle Equation [3] and elemental composition of verge grass and maize feedstock.
- Biodegradability (BI) can be calculated from experimental and theoretical BMP.
- Verge grass sample had a BI of 45%; applied to prediction of BMP_{th} for ensiled verge grass samples.

Sample	BMP_{ex} (ml CH_4/ g VS)	BMP_{th} (ml CH_4/ g VS)	Calculated BI (%)
Verge Grass	222	490	45
Maize	202	467	43

$$BI = \frac{BMP_{ex}}{BMP_{th}} \times 100$$

Biochemical Change under Ensiled Conditions:

- Ensilage is the process of silage production and applied as a method for the prolonged storage of biomass. Silage development is applied as a method of maintaining a sufficient volume of homogenous feedstock for the operation of an anaerobic digestion plant.
- Ensilage allows for the reduction of oxygen through metabolism of aerobic bacteria. Anaerobic conditions encourage the development of LAB communities and lactic acid. A reduction in pH inhibits microbial development as a method of improved storage. Organic acid and alcohol accumulation enhances consumption during biogas generation [6;7].

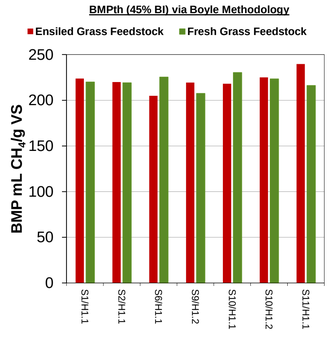


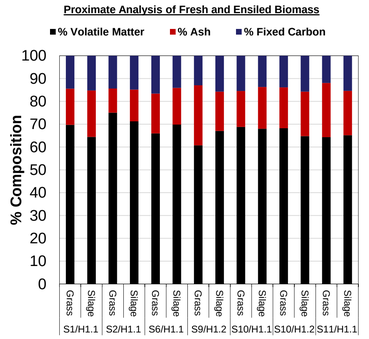
Reasons for ensiling:

- Storage allows for improved feedstock availability thereby mitigating seasonal supply variability.
- Ensilage of feedstock is undertaken as a method of mitigating potential loss of BMP over time.
- Silage development is identified as a possible pre-treatment enhancing BMP over time.

Findings:

- Road-verge biomass was stored under ensiled conditions for a six month period.
- BMP_{th} analysis presents similar biogas potential for both fresh and ensiled verge-grass feedstock.
- Material and biochemical characteristics remain similar for both feedstocks.
- Addition experimental analysis is required to validate BMP_{ex} and potential effects of LAB operation, under ensiled conditions, upon digestibility and substrate accessibility.

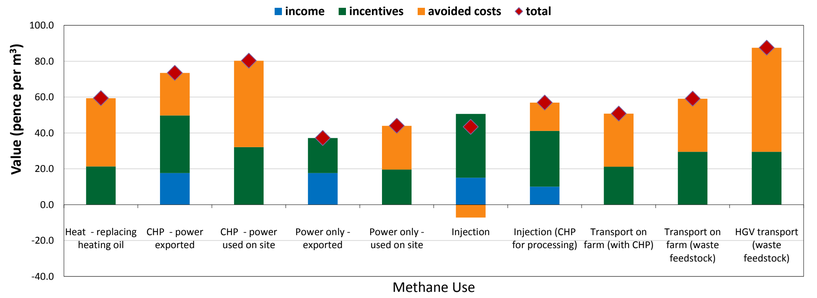




Income from Biogas:

The biogas produced from anaerobic digestion can be used to generate heat, or to generate combined heat and power (CHP) and the electrical power can be sold or used on site. The gas could be cleaned up and biomethane injected into the national or local gas grid, or could be cleaned up and compressed to be used on the farm as a tractor fuel or used by heavy goods vehicles. This chart shows the potential value of using a cubic meter of methane sales, avoided fuel costs and income from government incentives (such as the renewable heat incentive, feed in tariff and renewable transport fuel certificates).

Value of 1m³ of biomethane (pence) for each type of use



Conclusion and Future Work:

- The verge grass sample produces competitive levels of biomethane compared to maize (energy crop) [3,4]
- Limited variation in material and biochemical characteristics are identified following ensilage. BMP_{th} analysis suggests a similar biomethane potential with parent material with limited elemental loss. Additional BMP_{ex} analysis is required to evaluate the true potential of ensiled material and potential losses derived from prolonged storage.
- The income from the processes biogas varies depending on how it is used.

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