RP1.2-04: Integrated model for bio-methane injection in gas networks

This project undertook the co-development (i.e. working with industry) of an integrated assessment model for assessing the techno-economic viability of projects injecting bio-methane into existing gas networks in the Australian context. Two metrics of techno-economic viability were identified as the core focus for this assessment framework: levelised cost of energy (LCOE), and net carbon mitigated. The project level biomethane viability tool was released as part of a webinar in June 2024.

The project also developed a proto-type spatial assessment tool, applying the techno-economic modelling at a 5 x 5km scale across Australia. This tool and related assessments built on the Australian Biomass for Bioenergy Assessmenet (ABBA) project to understand where feedstock was located. As such there is a focus on opportunities from agricultural feedstocks. This assessment was released as part of a webinar in June 2022.

These tools enable assessments into important questions such as:

- Where are the most viable sites located in Australia?
- How can you more optimally run a project given certain feedstock types?
- What are the factors that have the largest effect on project viability?

The project had four stages:

1. Development of a prototype for both assessment tools;
2. Development of a data set of biogas yields for different feedstock types, under a range of anaerobic digestion conditions (temperature ranges, wet/dry reactions);
3. Working iteratively with project end users to further improve the functionality and interface design of both tools, and applying the tools to address industry relevant questions.
4. A closely aligned PhD developing additional end user support for the project level planning of renewable energy systems.

The following four reports and additional project outputs were completed and made available to CRC participants:

- **Report 1 – viable case studies,** which uses the spatial assessment tool to identify the most viable sites for biomethane projects in Australia;
- A **data set** that contains biogas yields for different feedstock types, and an interface that allows users to explore different anaerobic digestion conditions;
- A **Journal paper** that focusses on the project level assessment of biomethane viability, and the impact of co-digestion on biomethane yields for an Australia case study;
- **Report 2 – integrated assessment model,** which outlines the developed project level biomethane viability tool, its main functionality, the user interface and the underlying model;
- **Report 3 – factors that affect viability**, which uses the biomethane viability tool to perform a sensitivity analysis and identify the factors that affect both LCOE and net carbon emissions;
- **Report 4,** which is a summary report covering both the assessment tools, and contains user guides for each.

The first report presented the findings of a spatial assessment of most viable sites in Australia. The results of this assessment indicate that the most suitable large-scale plants are in South Australia (Adelaide) and NSW (Griffith), and the most suitable small-scale plants are on the border of Victoria and NSW (Yarrawonga). Here, suitability was defined by the locations with the largest quantities of different types of feedstock, with proximity to transmission and distribution gas lines.

The results also demonstrate how the LCOE of bio-methane projects can increase when attempting to harvest large quantities of agricultural waste if this waste is only available for some parts of the year. This is because large plants are required to convert the available feedstock into biomethane when it is available, leaving the plant idle for the remainder of the year, thereby reducing its efficiency. Consequently, the most commercially viable locations are the major cities in each state (with constant supplies of MSW), and the belt of sugarcane along north-eastern Queensland.

Reports 2 and 3 detail the development of the project level biomethane viability tool, as well as the application of the tool to understand the factors that most affect the viability of biomethane projects, both for LCOE and net carbon emissions. The factor the LCOE metric was found to be most sensitive to was the gravimetric energy density, i.e. the GJ biogas produced from a tonne of dry feedstock. Smaller energy density values result in reduced biomethane production for a fixed transport cost of feedstock. This highlights that the energy content of the feedstock slurry is a key leverage point for projects, as relatively low-cost options such as pre-treatment and co-digestion can result in greater biomethane yields for the same fixed cost of feedstock transport. The second and third most significant factors were feedstock availability and feedstock amount, which both also affect the size of the biomethane plant.

For the net carbon emissions metric, the two most significant factors by far were the emissions avoided from feedstock and the feedstock amount. Both of these factors provide a strong motivation for biomethane projects with respect to waste re-use as part of a more circular economy, with the potential to save tens of thousands more carbon emissions depending on the feedstock type used. Emissions avoided from the decomposition of feedstock will also vary widely depending on the prior use of feedstock (for example are crop residues burned, is OMSW being sent to landfill etc).

The project level biomethane viability tool was also used to assess the impact of a Feed-in tariff based on values from the Netherlands and other countries in the EU, when combined with a 50% CAPEX grant from Government funding. Results suggest that this would provide net profits for a biomethane project when selling at the price of natural gas ($12/GJ), with a net LCOE of $8.92/GJ, meaning that if such policies were applied in Australia, this would increase the viability of large-scale agricultural projects like the one modelled in the baseline project scenario of this assessment.

Both assessment tools have been further developed and applied to new research questions in the follow-on project (**RP1.2-06**). The final report for this project summarises the major functionality of the two developed tools, including additions from the follow-on project.

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