

Methane emissions from biogas plants

Methods for measurement, results and effect on greenhouse gas balance of electricity produced

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1 Introduction

Methane is a potent greenhouse gas with a global warming potential much higher than carbon dioxide. Excessive fugitive methane emissions from a biogas system are not conducive with the ambition of reducing greenhouse gas (GHG) emissions. The report addresses methods used for evaluation; presents selected results of measurements; proposes mitigation measures; and puts methane emissions in a context of a standard greenhouse gas assessment.

2 Methods for quantification and results of measurements

Currently several methods for emission quantification are in use and a variety of data sets have been provided from different international teams. The methods used can be distinguished into two major approaches. The single source method aims at an identification, quantification and summation of every emission source. The overall plant measurement aims at the quantification of the plant emissions in total. The approaches have different advantages and limitations. An important task for the future is method harmonization including for documentation and reporting of the results. Factors influencing the results involve: the limitations of the methods used; the duration of measurement (in order to cover time variability of specific emission sources); the completeness of plant components measured and potential sources included but not belonging to the biogas facility (such as barns); and the operational mode of the plant.

The parameters with major influence on the quantity of methane emissions can be distinguished by structural (the technologies deployed) and operational (plant management) means. **The most relevant sources include: open storage or composting of the digestate; the combined heat and power (CHP) engine; leaks; and the pressure release valve (PRV).** Large quantities of methane emissions have been reported caused by single large leaks or long lasting pressure relief events. The results available show a large variability in the amount of emissions. It is very difficult to give general, average numbers for emissions from components or complete biogas plants. Firstly, the results given in literature have large differences due to the variations within the methodologies applied. Secondly, the plants are individualized and generalisation needs to include a classification considering the plant design and plant operation in order to obtain a general emission factor for the sector. Thirdly, methane emissions need to be seen in context with other factors influencing GHG emissions. There is insufficient data for a general assessment of the sector, but trends indicate which components should be monitored and which measures are useful to minimize the amount of released methane.

3 Reduction measures

The application of specific monitoring and maintenance and/or the application of specific technologies can reduce emissions. **A crucial part of any operation should be a monitoring plan** and in particular frequent monitoring of any potential emission sources on site. Some of the potentially larger sources (CHP, PRV and large leaks) are dependent on operation and time variation and therefore need to be routinely monitored. In case of increasing emissions, they can be substantially reduced by operational measures. Reduction measures can include the following:

- Handling of process output: gas tight cover of digestate tank; optimization of the degradation of the substrate; and aerobic post-treatment with an adequate oxygen supply.
- Gas engine: Frequent control and documentation of motor settings; frequent maintenance; monitoring of methane concentrations in the exhaust: and post combustion of the exhaust gas.
- Biogas upgrading technology: post treatment of off gas; monitoring of functioning and performance.
- Biogas containing components: frequently monitoring for leakage identification.
- Gas management: avoidance of pressure relief valve openings and flaring events; automatic operation of the flare linked to the filling level of the gas storage; gas storage filling level around 50 %; gas transportation and adjustable pressure conditions in connected gas storage systems; adequate dimensions for all components.

4 Emissions in context of GHG balance and outlook

When putting the methane emissions into a context of a GHG balance and assessing the overall sustainability of the bioenergy system, it becomes apparent that beside the fugitive methane emissions other important factors (in decreasing order) include: the substrate used; the heat utilization; and the parasitic energy demand. In case of a clear GHG reduction target the plant design needs to be chosen carefully, since some components (such as CHP unit, open digestate storage) inevitably cause some emissions once in operation. By using the data and methodology adopted by the European Commission, and assuming 30% of the Fossil Fuel Comparator (FFC) for electricity as a targeted limit for the operation, it was shown that energy crop based plants will experience difficulties in reaching this reduction target without specific measures (such as heat utilization or exhaust treatment at the CHP) since the energy crops come with a GHG burden associated with the production of the crop. Manure based plants come with a large credit due to avoided emissions from raw manure storage. Consequently, manure digestion systems with limited fugitive methane emissions can lead to carbon negative renewable electricity produced from biogas. This carbon negativity can also be seen in crop manure co-digestion systems.

The major task for the future is an improvement of precision, reproducibility and representativeness of the methods used for emission quantification. A method harmonization will be necessary to compare results from different measurements. Only comparable results in combination with a sufficient number of plants analysed will lead to a better understanding of the emissions from the whole sector and a reliable data base for emission inventory. A general task for the future is to raise awareness within plant operators and plant manufactures of this issue. Only if the industry is sensitive to the subject, can emissions be further reduced.