An integrated approach for a dynamic energy and environmental system analysis of biogas production pathways

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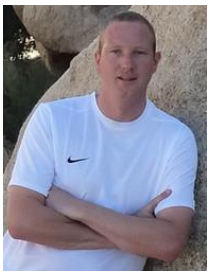

Currently, Frank is a PhD researcher at the Hanze University of Groningen. He graduated from the Hanze University with a B Eng. and holds a MSc. in energy and environmental sciences from the University of Groningen. He previously worked at Philips as a process engineer focused on sustainability.

Abstract

Developing decentralized smart energy systems is a promising method of integrating local renewable energy production and maintaining grid stability. Within this context, biogas can play an important load balancing role as a flexible energy carrier. Biogas can be transformed into electricity, and / or heat, green gas, or it can be stored for longer periods of time.

However, the environmental impact and energy efficiency of biogas production within dynamic and geographical energy systems are not fully understood, due to the large number of factors and dynamics influencing the complex process. The main source for the production of biogas is not very abundant with only a small amount of renewable biomass available for digestion. Biogas production requires energy inputs partially still supplied by fossils, hidden away in for instance, cultivation, transport, processing, conversion of energy and construction of the various systems. There are also multiple uses for biogas that upgrade biogas to green gas, produce electricity and heat or use the biogas directly in a heat boiler. Furthermore, biogas systems operating within a decentralized smart energy system can encounter amongst other things; intermittent energy production and demand; geographically dispersed sources of biomass and locations of energy demand; and intermittent availability of biomass. Hence, determining the environmental impact and energy efficiency of biogas production within decentralized smart energy systems will require an integrated system analysis, which addresses temporal dynamics, geographic diversity, energy efficiency, and environmental impacts.

Therefore, this issue is researched as part of the Flexigas project, wherein a new integrated approach and simulation tool are proposed, which can help to identify the most efficient and sustainable use of biogas in specific geographic locations. The approach combines energy and environmental system analysis, geographic modeling, and temporal dynamic load modeling, in order to gain more insight into biogas production pathways, which can operate as a load balancer in decentralized smart energy systems. The new approach is based on the industrial metabolism concept, and is expanded with three known methods; the Material Flow Analysis (MFA) method is used to simulate the decentralized energy system; the Material and Energy Flow Analysis (MEFA) method is used to determine the direct energy and material requirements; and the Life Cycle Analysis (LCA) is used to calculate the indirect material and energy requirements, including the embodied energy of the components and required maintenance. The efficiency and sustainability of biogas production will be expressed in, Energy Returned on Energy Invested, carbon footprint, and EcoPoints. The proposed methodology and simulation tool may expand current knowledge on the efficiency and sustainability of biogas production pathways operating within a decentralized smart energy system. This knowledge can help in designing a tailor-made biogas production chain for a specific geographic location, increasing the efficiency and sustainability of biogas as a renewable resource. Hopefully this article will also provoke further discussion on the subject of modeling complex energy systems, as society is asking for an integrated and understandable overview in the decision making and planning process towards a more sustainable energy system.

Rules for submitting poster

Abstract: maximum 500 words (not for publication)

Timing
Poster submission closes: March 14, 2014

After submission your abstract will be sent to members of the scientific committee for review. Selected papers may also be published in a peer-reviewed journal to commemorate and document the conference. Additionally, a book on biogas science and technology will be published as part of “Advances in Biochemical Engineering/Biotechnology”.