Life Cycle Energy Assessment for Domestic Biogas Systems

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With the rapid economic development and urbanization, Sri Lanka is facing a huge challenge in terms of energy security and environmental pollution due to the drastic increase in burning fossil fuels. Therefore, it is important to explore the potential of renewable energy sources for domestic and industrial consumption. Biogas is one of the best solutions for these issues as it provides triple benefits namely sustainable environmental protection, energy generation, and agricultural & farming support. However, to further development of biogas energy technologies in Sri Lanka, it is important to do a detailed energy analysis of this technology by considering the initial energy requirements and energy generation at the end. The life cycle energy assessment (LCEA) can be used for this analysis and can be used as a basis for the calculation of energy pay-back time (EPBT). This analysis includes the energy requirements during the collection and transportation of waste, construction, and operation of the plant, upgrading the biogas produced and final energy generation from the biogas. In this study, different sizes such as 8, 10, 12, 15, 22, 35, and 65 m^3 of Chinese fixed dome type biogas plants were analysed using LCEA to determine the EPBT. Embedded Energy Values (EEVs) were evaluated from the quantity of materials used for the construction of different sizes of biogas plants and EPBT of the plants were calculated using EEVs and final biogas energy production. As per the analysis, the relationship of EPBT and the volume (in m^3) of the biogas plant (X) was EPBT= $0.0006 X^2 - 0.008 X + 0.590$. Accordingly, the construction of the higher capacity plant has lower EPBT and therefore it is more energy-efficient than a smaller capacity plant. However, a detailed economic analysis is required to carry out when selecting the optimum size of the biogas plants.

Keywords: Biogas plant, Life cycle energy assessment, Embedded energy values, Energy pay-back time