	INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI SHORT ABSTRACT OF THESIS
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SHORT ABSTRACT

Fossil fuel energy sources have been the primary source of energy and has a major share in meeting the energy demands of the day-to-day activities. However due to constant depletion of fossil fuel sources and low replenishment rate, it has forced mankind to shift its approach towards more renewable and sustainable energy sources. In recent years, all nations have shifted their approach from a fossil reliant nation to a more sustainable and greener approach nations. India being an agriculturally rich country with abundant biomass resources and ample solar radiation for maximum time of the year has invested majorly in biomass and solar. Anaerobic digestion of organic and lignocellulosic biomass has been a major area of research in many parts of this region. Though large-scale anaerobic digestion of organic biomass has already been implemented in some cities, use of lignocellulosic biomass has not been extensively done. The lignocellulosic biomass resources are either dumped in fields or are burned down releasing more carbon dioxide in the atmosphere. Keeping in view the constant depletion of fossil fuel sources and ever rising energy demand, it is essential that application and feasibility of renewable energy sources at community level is emphasized. The study was thus sub divided into three parts focusing on energy generation from anaerobic digestion, solar photovoltaic and hybrid systems.

The anaerobic mono- and co-digestion of three lignocellulosic biomasses viz. duckweed, switchgrass and rice straw were performed in 1 litre laboratory-scale batch reactors. The initial biochemical methane potential test was performed at three different total solids concentrations (10%, 15%, 20%) and cattle dung to feedstock ratios (1:1, 1:1.5, 1:2) under mesophilic conditions (28–32 °C) for 36 days. Co-digestion of feedstocks at 1:1 ratio yielded better results than other cattle dung to feedstock ratios. Optimized physical parameters were further implemented for a scale-up co-digestion study of biogas potential from 4 m3 community-size biogas digesters. The investigation was performed for 60 days maintaining a hydraulic retention time of 40 days, and a comparative analysis with mono digestion of cattle dung was also analyzed. Average daily biogas production for digester containing rice straw and cattle dung was 0.36 m3/kg-VS, whereas it was 0.34 m3/kg-VS and 0.32 m3/kg-VS for switchgrass and duckweed, respectively. An overall comparative analysis of the biogas production and its composition for both biochemical methane potential tests and continuous processes are discussed in this work.

The decentralized energy generation from solar photovoltaic systems both in standalone and grid-connected mode at community level was also investigated. A pilot-scale 1 kW photovoltaic system was installed at Auniati Satra near IIT Guwahati for studying the effects of its operating parameters at different load conditions corresponding to the

environmental conditions prevalent in Guwahati, Assam (India). The photovoltaic system was subjected to constant electrical load both in standalone mode and grid-connected mode during the daytime at eight different load conditions viz. 20%, 30%, 40%, 45%, 50%, 60%, 70% and 80% and half-hourly data of different parameters like solar insolation, photovoltaic energy, photovoltaic charge, temperature, and battery capacity were analyzed. Optimum load condition in standalone mode was found to be at 45% – 50% load under normal solar insolation without much burden on the battery bank and can be extended to a maximum load of 70% during the daytime at high solar insolation. In grid-connected mode, load application up to 45% was economically beneficial as less power was utilized from local grid. Though it can be subjected to almost its full rated capacity with input from the ac supply.

The study was further extended to investigate the techno-economic and environmental assessment of a hybrid 1 kW solar photovoltaic plant (having battery backup) and a 3.5 kVA biogas fueled generator. The hybrid system was subjected to constant load conditions from 20% to 80% of the rated power conditioning unit, and energy shared by the combined systems was investigated. At lower loads, the photovoltaic system was sufficient to meet the demand. Whereas at higher loads, energy share from the biogas system was required for meeting the load demand. Economic analysis over a project lifetime of 25 years revealed a high positive net present value of $1562.15 with a levelized cost of the energy value of $0.21/kWh for the hybrid system. A comparative financial analysis for the standalone solar photovoltaic system was also performed using the system advisor model. System advisor model analysis resulted in a positive net present value of $306.45 and a Levelized cost of the energy value of $0.15/kWh. The environmental analysis revealed a net CO2 mitigation of 104.59 Tons, equivalent to an earned carbon credit of $2090.31 from the hybrid system.

This study thus presents a holistic approach for utilization of locally available lignocellulosic biomass for biogas production and integration of bioenergy with solar photovoltaic systems for electricity production.