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Bio Gas Plant Green Energy From Poultry Wastes In Singapore

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Abstract

Singapore is a land scarce nation where farming space is very limited competing with other critical uses for a growing population. Farms taking up large tract of land and generate wastes face many unsurmountable difficulties and regulatory compliances on sustainability issues. Poultry farm is not the best type of industry due to polluted wastes generated and foul smell emissions. Yet an 800,000 chicken egg-producing farm in the last bastion of farming land in Singapore called Lim Chu Kang has evolved to overcome the space constraints, environmental regulatory, sustainability demands, production efficiencies and green energy push in lowering the carbon footprint. This company has been the first successful farm in Singapore to convert chicken wastes into biogas as fuel to generate electricity. In doing so, it has reduced the polluted wastes and transform it into energy toward self-sufficiency, recovering waste heat from the turbine exhaust for drying of chicken feed. The power generated is up to 1 MW while the waste water in the aerobic digester is treated and extracted the sludge into dried cake for agricultural fertilizers. Excess energy could also be sold to the Singapore Power Grid as income. This company in its CSR efforts has invested this waste-to-green energy technology as a creative first mover while increasing food security, fighting food scarcity promoting safe eggs for the people of Singapore. Further initiatives on achieving international green energy recognition and improving on green energy efficiencies would be the steps forward for the benefits of Singapore. Green energy production is an essential way of meeting energy needs as the inevitable depletion of non-renewable energy sources coupled with climate change are now global challenges. It adopted a zero-waste policy to reduce its waste stream and air pollution with an anaerobic digester and a biogas power plant fuelled by 50 tonnes of chicken manure per day. The biogas is used to generate heat and electricity power the farm's infrastructure, including its new co-generation feed dryer. The digester liquor is treated and treated water is recycled for the initial dilution of manure to enhance the digestion process. Sludge undergoes a belt press to separate solids and liquid resulting in bio solid cake used for making fertilisers. This integrated system ensures that by-products can be reused, minimizing waste and reducing emission of greenhouse gases by adapting biogas for green electricity production.

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1. Introduction

Renewable sources of energy have been the point of interest in the world due to climate changes and the inevitable depletion of finite resources such as coal and oil. This is one of Singapore's main interests as there is a limited amount of natural resources to work with. Due to its geographical location and features, there is a lack of tidal and wind energy that can be used for producing electricity. On the other hand, it sits on an area that has very good geothermal activity underground but it has not been tapped on because it is unfeasible from an economical point of view [1, 2]. Biogas is a relatively new area in the energy industry in Singapore and will be the focus of this paper.

Although solar energy is currently considered to be the most viable option for renewable energy in Singapore [2], biogas was not taken into consideration in the assessment as biomass is not extensively available in the highly urbanized city. However, this can be different depending on its application; places like farms creates waste products that are mostly biomass which will be able to be fuel the production of biogas. In Singapore, there has not been an integrated facility that has achieved a zero-waste policy through the utilisation of biomass yet. A project that aims to achieve this with its facilities is one co-planned between the National Environment Agency's (NEA's) Integrated Waste Management Facility (IWMF) and Public Utilities Board's (PUB's) Tuas Water Reclamation Plant (TWRP) [3]. This paper will provide information of the first poultry farm in Singapore to implement a biogas cogeneration plant for its energy needs in a sustainable manner, as well as the positive impact on the environment.

1.1. Background Information

The poultry farm operated in Lim Chu Kang is home to 800,000 chickens producing 350,000 eggs per day and is a major supplier of the industry in Singapore. Consequently, this produces more than 50 tonnes of chicken manure daily. These wastes were earlier made into compost using traditional methods which put a strain on the company's manpower and posed an occupational health and safety risk for its employees. Mixed wastes to be stored for 3 months prior to usage for this method also spread unpleasant odour to residential areas in the vicinity which resulted in fines by the National Environment Agency (NEA) due to complains by residents. Land use is also inefficient as the process also requires storage space for the mixed wastes, sawdust and woodchips needed to be mixed with chicken manure to produce the compost, and excess compost inventory due to low demand. The space is taken up and hinders the potential expansion of its core business operations. Thus, the company decided to implement an alternative measure to its waste management, keeping in line with CSR and aim for sustainable agriculture through the reduction of its waste stream.

2. Anaerobic Digester (AD)

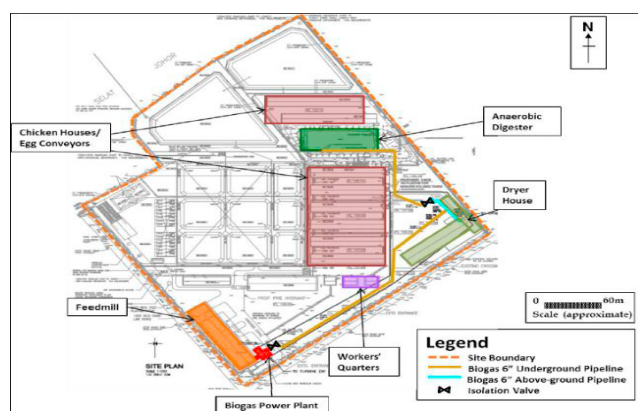


Fig. 1. Farm Site Layout [4]; Fig. 2. Anaerobic Digester

The AD constructed is a lagoon-type liquid digester covered by a high-density polyethylene (HDPE) flexible membrane. It is used to produce biogas, digester liquor and activated sludge. The production of biogas in the AD has

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