BUSITEMA UNIVERSITY
Pursuing Excellence

FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL AND PROCESSING ENGINEERING

DESIGN AND CONSTRUCTION OF SOLAR- ELECTRICITY HYBRID ENERGY SYSTEM FOR A WATER BOILER

BY

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ABSTRACT

Water boiling is the second largest energy user at domestic level and hotels accounting for about 26% of the total energy costs. The study on electricity consumption at hotel Africana, one of the typical large hotel in Uganda revealed that about 27% of the total energy are consumed by water heaters.

The purpose of this project was to design and construct a solar-electricity hybrid energy system for powering a continuous flow water boiler for households and restaurants. This would reduce the cost spent on the grid electricity in boiling water by first preheating the water using the free solar energy and providing a clean energy for water boiling so as to reduce emissions of greenhouse gases and particulate matter into the environment.

In order to achieve the above purpose, data on solar energy and solar energy technologies for heating water were collected, the use of electrical energy for water boiling was also analysed, different construction techniques such as welding, grinding, cutting and so on were adopted, and the system's performance tested for a period of five days at a volume flow rate of $31.25 litres/\ hour$.

The objectives of the study were achieved with the efficiency of the solar and electricity energy systems being 34.1% and 70% respectively. The economic evaluation showed that the system has a cheaper operation cost (12,023,600Ushs. Over a period of 5 years) as compared to the electrical water heaters (22,071,000 Ushs. over a period of 5 years) hence, an ideal power solution for businesses that uses a lot of energy for water boiling such as restaurants and households.

The implementation of the system would therefore reduce the consumption of electric energy from the grid and reduce environmental pollution.

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Great thanks goes to my supervisors Ms.Abbo Jacqueline and Dr.Wandera Catherine for their tireless efforts rendered to me during the preparation of this piece of work, may the good Lord bless u so much.

Lastly, I would like to thank my friend Twambaze Emmanuel for all kinds of help, may God bless u abundantly.

DEDICATION

I dedicate this report to all my family members for the love and efforts they rendered to me. They nurtured me in the best way so that I become the person I am today. So may the almighty God bless and reward them abundantly. **AMEN.**

DECLARATION

I ***OBONGE JIMMY***, declare that the work in this report is my own except where indicated with reference within the text and that it has never been submitted before to any university or institution of higher learning for the award of Degree in Agro Processing Engineering, APE. I therefore take full responsibility over it.

Student's signature: .....

Date: 30/05/2017.....

APPROVAL

This final year project report has been submitted for examination with approval from the following supervisors:

Dr. Catherine Wandera

Signature .....

Date..... 15/6/2017

Ms Jacqueline Abbo

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LIST OF ACRONYMS

REPU- Renewable energy policy for Uganda

CHS - Convention Heat Storage

CO_2 - Carbon dioxide

HCF - Heat Circulation Fluid

HEP - Hydroelectric power

ICS - Integrated Collector System

IDP – Internally displaced people

Kgs - Kilograms

LDP – Low density polyethene

SWH - Solar Water Heater

NPV- Net present value

UBOS- Uganda bureau of standards

MW- mega watts

CSP- Concentrating solar power

FPC- Flat plate collector

CHAPTER ONE: INTRODUCTION

This chapter presents the general information about the research project giving its background, problem statement, purpose of the study, its justification, objectives, and study scope.

1.1 Background

Energy utilisation at domestic levels, restaurants and hotels are majorly for air conditioning, lighting and production of hot water (**Investni.com**). Typical energy types being utilised are grid electricity, natural gas, liquid petroleum gas, oil, diesel, petrol and biomass. Hot water is utilised for various purposes at domestics and commercial levels and this include preparing food, washing dishes, washing clothes, bathing/showering and many others.

Water heating is the second largest energy user at domestic level and hotels accounting for about 26% of the total energy costs, therefore for families with electric water heaters, the monthly energy consumption is usually between 300 and 500 kWh per month (**Burzynski et.al, 2010**). The electricity consumption by water heaters at hotel Africana, one of the typical large hotels in Uganda constitutes about 27% of the total energy consumed by all the loads in the hotel (**Mugisha et. al, 2003**).

It is known that Uganda has only 827.5 MW of installed electric power capacity (**UBOS, 2014**), this power is insufficient and therefore other energy-saving schemes have to be considered. Among the energy saving schemes being implemented in the commercial sector to avoid or reduce load shedding and to reduce the use of costly generators is the use of Solar Water Heaters given the fact that the mean solar radiation is 5.1kwh/m^2 which is favourable for solar water heating (**REPU, 2007**). Flat plate solar water heater have been used for water heating However, the major drawbacks of these solar water heaters is that the Collector requires more space and involves the limitation of dilution of solar energy (**Ogle et. Al, 2013**). Thus, in this research, a solar- electricity hybrid energy system was studied as an eventual energy option for water boiling with the aim of reducing the cost spent on the grid electricity and providing a clean energy for water heating so as to reduce emissions of gases and particulate matter into the environment.

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