KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI.

COLLEGE OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

REPORT TITLE: AN IMPROVEMENT IN THE IMPROPER DISPOSAL OF BATTERIES IN NEW GBAWE COMMUNITY.

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INDEX NUMBER: 4020615

DATE: AUGUST, 2016.

ACKNOWLEDGEMENT

First and foremost, I'd like to thank the Almighty God for bringing this fruitful project to a successful completion. As well, this project couldn't have reached this milestone without the aid of the likes of my diligent project coordinator, Mrs. Ella Kwao Boateng, Mrs. Mizpah Rockson and the chemical Engineering department as a whole. My special gratitude goes to the above people. Also, I extend my sincere appreciation to Mr. Daniel Babalola of Apotica Electricals for examining the content of my report and offering useful suggestions.

Finally, to the inhabitants of New Gbawe, I say a big 'Ayekoo' for offering their time to fill my questionnaires and for the necessary information they provided me with to pursue this project. God bless us all.

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CHAPTER ONE

INTRODUCTION

1.1 COURSE BACKGROUND

Engineering in society is a course introduced in the curriculum of the college of engineering in KNUST. The course, Engineering in society was introduced as a result of the inability of most engineering students to apply the knowledge gained from their various fields of study to help their society. A gathering of engineers from across Africa met and they expressed their concern towards the inability of African engineering students to apply their knowledge in their various fields of study to help curb the problems they encounter in their society. A lot of concerns were raised about the credibility of students graduating from the university as engineers. This resulted in the introduction of this course to help inculcate the habit of problem solving in engineers in Africa.

The course is geared at inculcating into students the fact that engineering is a problem solving field. The course also tends to encourage students to appreciate their programme of study and broadens the scope of students in their chosen field.
The course also tends to create a link between the chosen field of study of the students and solving societal problems using the field in question.

1.2 COURSE OBJECTIVES

The objective of the course is to inculcate in students an appreciation of the fact that the purpose of engineering is to solve societal problems. The objectives of this assignment are to identify a developmental challenge in a selected community and indicate how one's chosen field of engineering (i.e. Chemical engineering) can address the challenge. This course is aimed at encouraging students early in their programmes of study to draw a link between their chosen field of Engineering and the application of this field to the issues that confront their day to day lives.

1.3 ABSTRACT OF THE REPORT

The report contains an overview of how the entire project was carried out. It contains how the problem was identified, which is categorized into methodology and again sub divided into; the process adopted in the identification of the problem, process involved in making the map, how data was collected about the problem, report discussion which also contains; a description of my study community and a map of the area, nature and characteristics of the problem at hand and a description of my area of engineering. Last is the conclusion, recommended solution to the problem and an appendix which contains a questionnaire that helped me to analyze the problem and a copy of an introduction letter.

CHAPTER TWO

METHODOLOGY

2.1 PROBLEM STATEMENT

In many ways, we live in a battery-driven society. From our cell phones, laptops and other electronic devices to children's toys and cars, modern life runs on batteries. But they're not just used in consumer goods. When storms knock out the power grid, batteries keep hospital equipment working and trains running. If you have a landline, you can still make and receive calls because batteries power the phone lines. ***But batteries can seriously damage the environment—and human health—if not disposed of properly.***

2.2 DATA COLLECTION

I made several visit to different homes, industries and the Environmental Protection Agency to formally interrogate them and also with the help of some senior course mates, I prepared a questionnaire. So, data was mainly obtained from the people through questionnaire and personal interrogation. I had to carry out thorough surfing of the internet to get information that was vital to this project.

I also communicated with a company called 'Battery Solutions' and they provided me with the ways of recycling the different types of batteries, their response and cooperation turned out to be very helpful in the carrying out of this project.

2.3 CHALLENGES

A few people were not cooperative in the process and illiteracy too was a problem thus they could not fill the questionnaires.

CHAPTER THREE

DESCRIPTION OF RESULTS

3.1 BRIEF OVERVIEW OF THE GBAWE COMMUNITY

Gbawe is a suburb of the Greater Accra Region of southeastern Ghana. Gbawe is the twenty-third largest settlement in Ghana, in terms of population, with a population of 74,403 people. Gbawe is located a few kilometers west of Accra in the Ga West District. At the Ghana census of 26th March 2000, the population was 28,989 inhabitants living in the Town. Projections of 1st January 2007 estimated the population to be 52,910 inhabitants. In the census of 1984, only 837 residents were listed, and in 1970 it was the 608th largest settlement in Ghana. The Town was founded more than 100 years ago. Today the Town has a more rural structure in the large-scale marked suburban development areas.

Figure 1. Map representation of the Gbawe community

<u>3.2</u> ABOUT CHEMICAL ENGINEERING

Chemical engineering is a discipline influencing numerous areas of technology. In broad terms, chemical engineers conceive and design processes to produce, transform and transport materials — beginning with experimentation in the laboratory followed by implementation of the technology in full-scale production.

Chemical engineers are in great demand because of the large number of industries that depend on the synthesis and processing of chemicals and materials. In addition to traditional careers in the chemical, energy and oil industries, chemical engineers enjoy increasing opportunities in biotechnology, pharmaceuticals, electronic device fabrication and environmental engineering. The unique training of the chemical engineer becomes essential in these areas when processes involve the chemical or physical transformation of matter.

For example, chemical engineers working in the chemical industry investigate the creation of new polymeric materials with important electrical, optical or mechanical properties. This requires attention not only to the synthesis of the polymer, but also to the flow and forming processes necessary to create a final product. In biotechnology, chemical engineers help design production facilities that use microorganisms and enzymes to synthesize new drugs. ***Problems in environmental engineering that engage chemical engineers include the development of processes (catalytic converters, effluent treatment facilities) to minimize the release of or deactivate products harmful to the environment.***

<u>3.3</u> IDENTIFICATION OF THE PROBLEM

Batteries in the modern day world have become ubiquitous, in the sense that they provide energy for a wide range of products that are used across all segments, spanning from households to large industrial enterprises. They are also a major source of backup power for activities that require an uninterruptible supply of power.

According to the feedback from the questionnaires that were distributed, I could conclude that an average person residing in the Gbawe community owns about two button batteries, eight disposable alkaline batteries (A, AA, AAA, 9V, etc.) and throws away about five to six household batteries per year. This might seem a very negligible amount of goods discarded, but imagine the entire population of the Gbawe community (approximately seventy-four thousand people, 2015 estimates) throwing away used batteries, or even better, the amount of batteries disposed by the world population (approximately seven billion according to the 2015 World Population Data Sheet). This would be an insurmountable heap of solid waste with grave environmental effects.

Batteries are mainly categorized as primary (one time use batteries) and secondary (can be recharged and used again). Most of them contain cadmium, lead, mercury, copper, zinc, manganese, lithium, or potassium, which are all hazardous to the environment and also to human health.

Thus, disposal of batteries has come to occupy an extremely significant position in the eyes of battery manufacturers and recycling organizations. Unfortunately, one widely used method is to send them to landfills, although this is definitely not an environment friendly option.

3.4 WHAT ARE THE HARMFUL EFFECTS OF BATTERIES?

For humans, both lead and cadmium can be taken only by ingestion or inhalation. Mercury another harmful metal can even be absorbed through the skin.

These harmful substances permeate into the soil, groundwater and surface water through landfills and also release toxins into the air when they are burnt in municipal waste combustors. Moreover, cadmium is easily taken up by plant roots and accumulates in fruits, vegetables and grass. The impure water and plants in turn are consumed by animals and human beings, who then fall prey to a host of ill-effects. Studies indicate that nausea, excessive salivation, abdominal pain, liver and kidney damage, skin irritation, headaches, asthma, nervousness, decreased IQ in children and sometimes even cancer can result from exposure to such metals for a sufficient period of time.

In addition, potassium, if it leaks, can cause severe chemical burns thereby affecting the eyes and skin. Landfills also generate methane gas leading to the 'greenhouse effect' and global climatic changes.

3.5 DISPOSAL OF BATTERIES

There are currently two traditional ways of disposing batteries of which recycling is one but unfortunately, one widely used method is to send them to landfills, although this is definitely not an environment friendly option. We are left with the question **Recycling - A Good Option?** The answer is **YES**! Recycling batteries is a much better option than dumping them in landfills. Some advantages that recycling offers include:

- Saves natural resources
- Saves energy
- Reduces pollution
- Reduces the need for a landfill
- Generates income
- Lessens the amount of regulations as it no more falls under the category of hazardous waste
- Reduces imports

Figure 2. Collection of batteries for recycling

Figure 3. Battery recycling plant

3.5.1 RECYCLING OF BATTERIES.

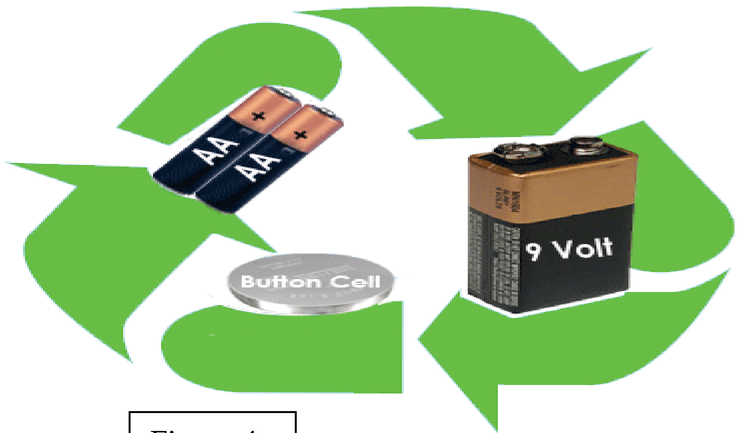
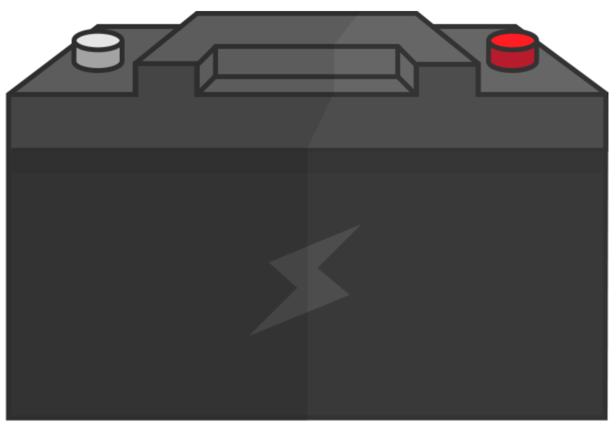


Figure 4

Recycling of batteries vary from battery to battery depending on the chemical they are made of. Below are the processes of recycling the various types of batteries.

LEAD-ACID BATTERY

Figure 5



The battery is broken apart in a hammer mill, a machine that hammers the battery into pieces. The broken battery pieces are then placed into a vat, where the lead and heavy materials fall to the bottom and the plastic floats. At this point, the polypropylene pieces are scooped away and the liquids are drawn off, leaving the lead and heavy metals. Each of the materials goes into a different recycling "stream"

Plastic

Polypropylene pieces are washed, blown dry and sent to a plastic recycler where the pieces are melted together into an almost liquid state. The molten plastic is put through an extruder that produces small plastic pellets of a uniform size. The pellets are put back into manufacturing battery cases and the process begins again.

Lead

Lead grids, lead oxide and other lead parts are cleaned and heated within smelting furnaces. The molten melted lead is then poured into ingot molds. After a few minutes, the impurities float to the top of the still molten lead in the ingot molds. These impurities are scraped away and the ingots are left to cool. When the ingots are cool, they're removed from the molds and sent to battery manufacturers, where they're re-melted and used in the production of new batteries.

Sulfuric Acid

Old battery acid can be handled in two ways:

1. The acid is neutralized with an industrial compound similar to household baking soda. Neutralization turns the acid into water. The water is then treated, cleaned, tested in a waste water treatment plant to be sure it meets clean water standards.

2. The acid is processed and converted to sodium sulfate, an odorless white powder that's used in laundry detergent, glass and textile manufacturing.

Lead acid batteries are closed-loop recycled, meaning each part the the old batteries is recycled into a new battery. It is estimated that 98% of all lead acid batteries are recycled.

ALKALINE BATTERIES

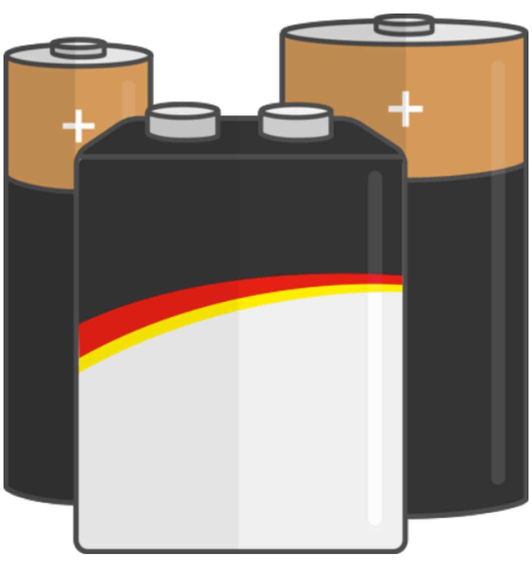


Figure 6

Alkaline batteries (AAA, AA, C, D, 9V, etc.) are recycled in a specialized "room temperature," mechanical separation process where the battery components are separated into three end products. These items are a zinc and manganese concentrate, steel, and paper, plastic and brass fractions. All of these products are put back into the market place for re-use in new products to offset the cost of the recycling process. These batteries are 100% recycled.

NICKEL-CADMIUM

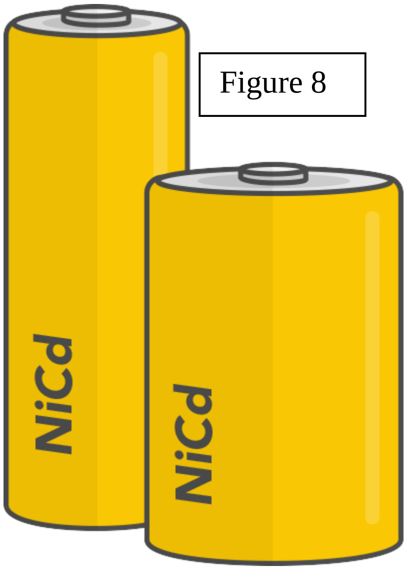


Figure 8

Prior to the recycling process, plastics are separated from the metal components. The metals are then recycled via a high temperature metal reclamation (HTMR) process during which all of the high temperature metals contained within the battery feedstock (i.e. nickel, iron, manganese, and chromium) report to the molten-metal bath within the furnace, amalgamate, then solidify during the casting operation. The low-melt metals (i.e. zinc and cadmium) separate during the melting. The metals and plastic are then returned to be reused in new products. These batteries are 100% recycled.

NICKEL METAL HYDRIDE

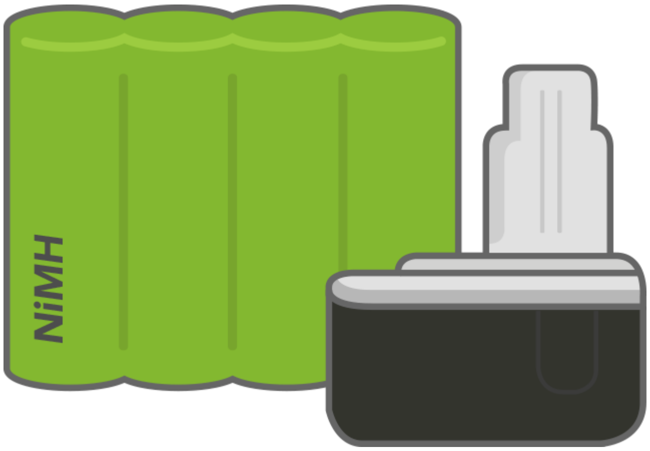
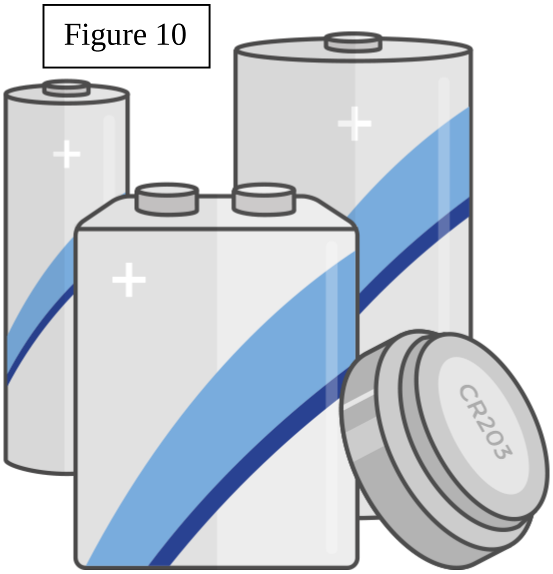


Figure 9

Prior to the recycling process, the plastics are removed from the cell portion. The cells go through a drying process to remove moisture (potassium hydroxide (KOH) electrolyte and H_2O) from the cells. The drying process heats the cells in a time and temperature controlled manner via a proprietary and proven formula. Once these cells are dried they become a valuable feedstock for the stainless steel and or alloy manufacturing industries. The metals and plastic are then returned to be reused in new products. These batteries are 100% recycled.

LITHIUM BATTERY

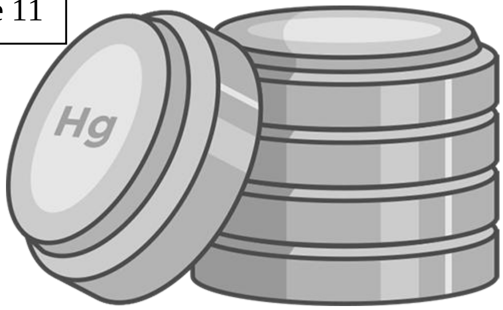
Figure 10



The contents of the batteries are exposed using a shredder or a high-speed hammer depending on battery size. The contents are then submerged in caustic (basic not acidic) water. This caustic solution neutralizes the electrolytes, and ferrous and non-ferrous metals are recovered. The clean scrap metal is then sold to metal recyclers to offset the cost of recycling these batteries. The solution is then filtered. The carbon is recovered and pressed into moist sheets of carbon cake. Some of the carbon is recycled with cobalt. The lithium in the solution (lithium hydroxide) is converted to lithium carbonate, a fine white powder. What results is technical grade lithium carbonate, which is used to make lithium ingot metal and foil for batteries. It also provides lithium metal for resale and for the manufacture of sulfur dioxide batteries.

MERCURY BATTERY

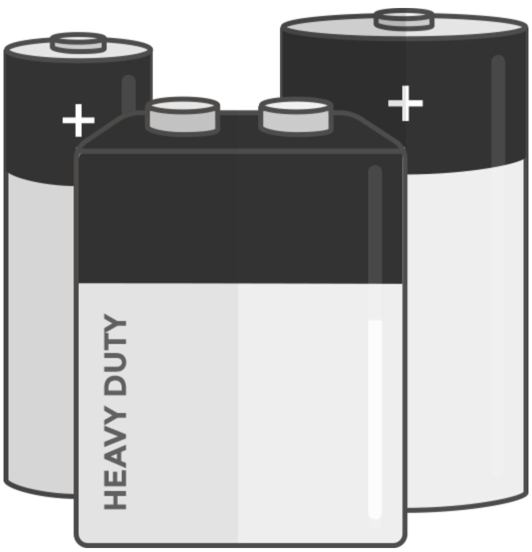
Figure 11



The batteries and heavy metals are recovered through a controlled-temperature process. It’s important to note: the percentage of mercuric oxide batteries is decreasing since the passage of the Mercury-Containing Rechargeable Battery Management Act (The Battery Act) of 1996. This act prohibits, or otherwise conditions, the sale of certain types of mercury-containing batteries (i.e., alkaline manganese, zinc carbon, button cell mercuric-oxide and other mercuric-oxide batteries) in the United States.

#

ZINC-CARBON



Zinc-carbon (AAA, AA, C, D, 9V, etc.) and zinc-air batteries are recycled in the same way as alkaline batteries or by using high temperature metal reclamation (HTMR) method to melt the metals. These metals are then reused in new products. These batteries are 100% recycled.

Figure 12

ZINC-AIR

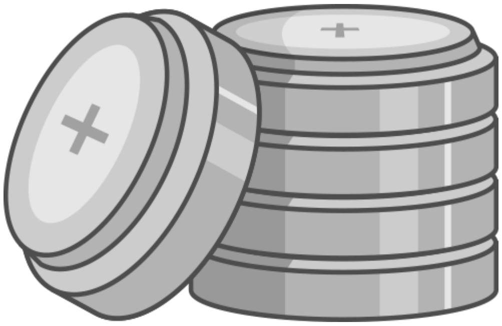


Figure 13

Zinc-carbon (AAA, AA, C, D, 9V, etc.) and zinc-air batteries are recycled in the same way as alkaline batteries or by using high temperature metal reclamation (HTMR) method to melt the metals. These metals are then reused in new products. These batteries are 100% recycled.

3.5.2 MORE SOLUTIONS TO THE PROBLEM

Some steps that can be taken to reduce or minimize the damage caused to the environment due to improper battery disposal include the following:

- Recycling of used batteries: and the steps to be followed when getting rid of batteries.
- Using rechargeable batteries more than primary batteries
- Making collection of batteries from the source easier and cost effective
- Providing appropriate remuneration to consumers for selling the used batteries
- Formulation and implementation of more stringent laws regarding battery disposal
- Buying batteries containing less mercury, lead and cadmium
- Providing complete information to customers at the time of purchase about the battery suitability, safety and ways of disposal.
- More R&D in alternative energy storage devices like fuel cells, which are also less hazardous to the environment.
- Looking at renewable sources of energy like solar, wind, water.

CHAPTER FOUR

CONCLUSION & RECOMMENDATION

This course has given many the opportunity to look indepthly into the problems that face our society daily and that are as well very much overlooked. Most often than not, a higher office isn't needed to solve these day to day problems. Through this project, it was observed that most people are oblivious of the dangers around them most often arising from their own indiscriminate actions. Scientific education must thus be intensified. This would pave the way for people to express their concerns, get answers to their questions and do their bit to curb harmful occurrences that come about due to their ignorance.

CHAPTER FIVE

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CHAPTER SIX

APPENDIX

6.1 CENG 291 QUESTIONNAIRE

1. Age

- Under 18
- 18-25
- 25-40
- Above 40

2. How long have you stayed in New Gbawe?

- All my life
- Greater portion of my life
- Not too long ago
- A very short time

3. How often do you use battery powered objects?

- All the time
- Most of the time
- When the lights go out
- Few times

4. Since when did you switch to using battery powered objects?

- Since the situation of power cuts became worse
- Not long ago
- A long time now
- Never

5. What do you do to your batteries when they die out?

- Put them in the sun
- Dump them
- Burn them

6. How many battery powered objects do you have?

- One
- Two
- Three
- More than three

7. How do you see battery powered objects?

- Satisfactory
- Good
- Very good

OBJECT	How many batteries in the object?	Rechargeable or not? (Y/N)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
	Total number =	Rechargeable = Not rechargeable =

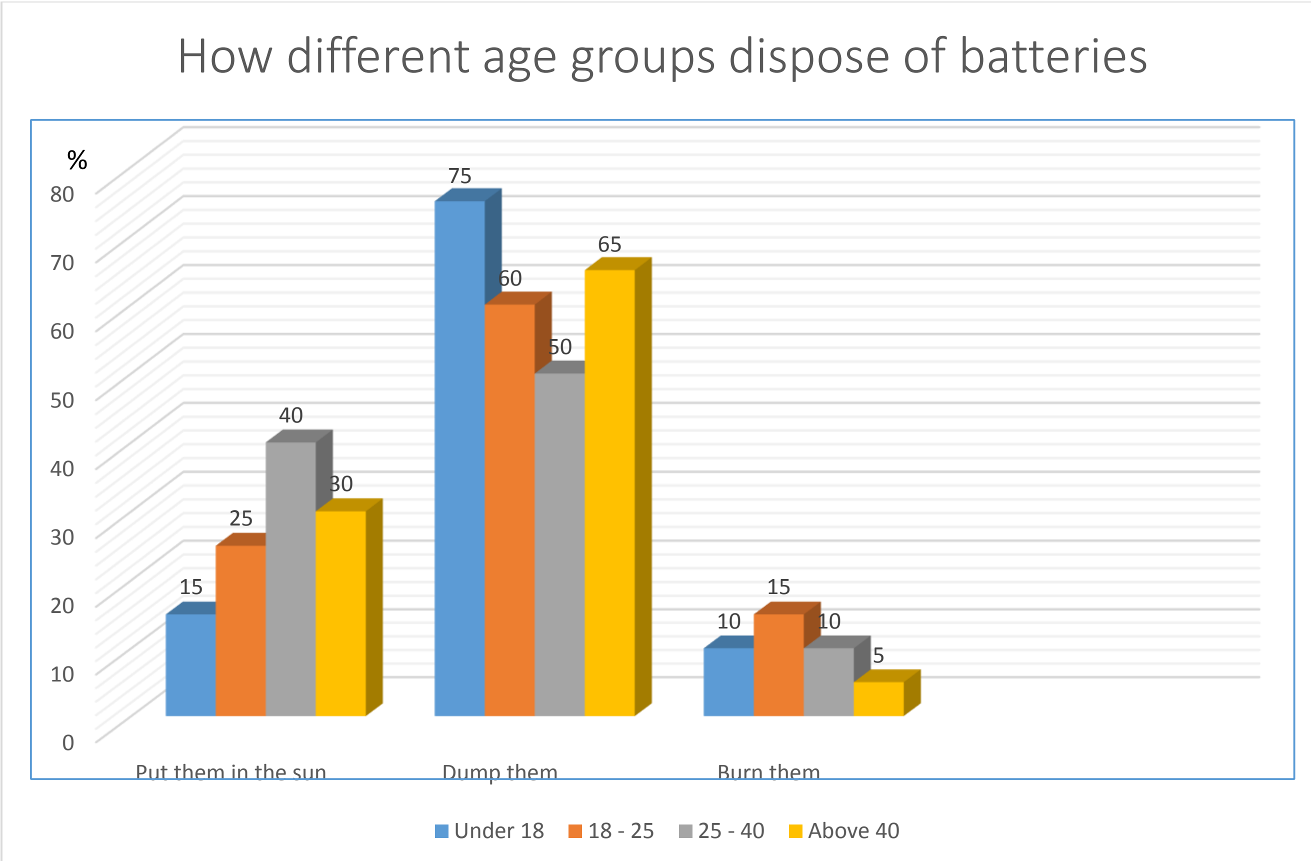
How different age groups dispose of batteries
%
80
70
60
50
40
30
20
10
0
15
25
40
30
75
60
50
65
10
15
10
5
Put them in the sun
Dump them
Burn them
Under 18
18 - 25
25 - 40
Above 40

Figure 14

6.2 Letter of Introduction

COLLEGE OF ENGINEERING

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Our Ref: Coe-PO/CENG 291/ Date: May 17, 2016

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION

The bearer of this note is a first year engineering student of the College of Engineering conducting a project in a course titled "Engineering in Society".

The overall aim of the course is to inculcate in students an appreciation of the fact that the purpose of engineering is to solve societal problems. This course is aimed at encouraging students early in their programmes of study to draw a link between their chosen field of engineering and the application of this field to the issues that confront the day to day lives of people.

We should therefore be most grateful if you could facilitate his data collection and provide any other assistance that he may need.

Counting on your usual cooperation in such matters.

Yours sincerely,

Samluupadu

ING. PROF. S.I.K. AMPADU, *FGHIE*

Provost, CoE

PROGRAMMES: Agricultural Engineering ■ BSc. Chemical Engineering ■ BSc. Petrochemical Engineering ■ BSc. Materials Engineering BSc Metallurgical Engineering ■ BSc. Mechanical Engineering ■ BSc Aerospace Engineering ■ BSc. Geological Engineering ■ BSc. Geomatic Engineering ■ BSc. Petroleum Engineering ■ BSc. Civil Engineering ■ BSc Computer Engineering ■ BSc. Biomedical Engineering ■ BSc. Electrical/Electronic Engineering ■ BSc. Telecommunication Engineering

RESEARCH CENTRES: The Energy Centre Technology Consultancy Centre