ABSTRACT
Energy demand in the world today is increasing rapidly and energy generation and resources in the world are incapable of catering for this increase in demand. In third world countries such as Nigeria, energy generation is epileptic; this is evident in the electric power sector of Nigeria. Issues such as Environmental degradation and energy shortages in countries have therefore rekindled interest in alternative and renewable sources of energy. Biomass gasification is one of such sources of energy.This project is aimed at studying biomass gasification, various types of gasifier technologies and their application in the generation of sufficient amount of biogas useful for small scale activities or operations.
The methodology focuses on the design of a gasifier, stating design specifications, developing conceptual designs, design calculations and details of design of the selected concept. The chosen concept is then analyzed to ascertain the viability of the design in carrying out gasification of biomass.
Results show that reasonable amount of biogas (0.167 kmol gas/kg feed)can be generated by biomass gasification and that high temperature materials such as mild steel used in construction of the gasifier can support the thermal requirements of gasifier operations.

CHAPTER ONE
INTRODUCTION

1.1 Background to study

The world today is in a state of increasing energy demand, rising energy prices with more emphasis placed on reinforcing countermeasures to defend against the ever present problem of global warming .The result of this situation being the development of alternative sources of energy. In 2006 the U.S. Energy Information Administration (EIA) projected that the world's energy consumption would increase by 2% per year until 2030. The EIA and other organizations project that resources will be adequate to meet the world's growing energy needs, but many critics disagree. Issues such as climate change also undermine the credibility of such forecast .Also according to the IEA world energy outlook, the world's primary energy supply has increased by 58% in 25 years.

The energy crisis in the world today is a major concern that the world's demands on the limited natural resources are diminishing as the demand rises. The glaring issue being that these natural resources are in limited supply. While they do occur naturally, it can take hundreds of thousands of years to replenish the reserves. Governments and concerned organizations are working to make the use of renewable resources a priority, and to lessen the irresponsible use of natural supplies through increased conservation.

The world relies on coal, oil and gas (fossil fuels) for over 80% of our current energy needs, this being a situation which shows little sign change apparent over the medium-term without drastic policy and philosophical changes (EIA, 2006). On top of this energy demand is expected to grow by almost half over the next two decades. Understandably this may instill the fear that our energy resources are starting to run out, thus of course posing devastating consequences for the global economy and quality of life. The potential for crisis if we run out of energy is very real but seeing the occurrence of such situation isn't in the nearest future, coupled with the ever growing size of fossil fuel reserves in the world, the importance for alternative sources of energy is being overlooked. In the past two decades proven gas reserves have increased by 70% and proven oil reserves by 40% (EIA, 2006). At expected rates of demand growth we have enough for thirty years supply. Moreover, better technology means that new oil and gas fields are being discovered while enhanced recovery techniques are opening up a potentially huge and profitable

array of unconventional sources, including tar sands, shale gas and ultra-deepwater. Ultimately, the near-unlimited supply potential of renewable energy sources would ensure that the world does not fall short of its energy needs. (EIA, 2006)

The EIA further asserts that closely related to the overdependence of the world on fossil fuels is the ever growing destructive effect of such fuels on the environment and climate. Over the past century, human activities have produced and released large amounts of carbon dioxide and other greenhouse gases into the atmosphere. The majority of greenhouse gases come from burning fossil fuels to produce energy amongst deforestation, industrial processes, and some agricultural practices .Clean air is essential to life and good health but in contrast several important pollutants are produced by fossil fuel combustion: carbon monoxide, nitrogen oxides, sulfur oxides, and hydrocarbons.

The EIA further expressed thus; impacts of the emission of these pollutants include global warming, air quality deterioration, oil spills, and acid rain.Fossil fuels for all its benefits pose a severe threat to the future of the world with regards to energy generation and climatic and environmental issues whose solution will be the development and employment of alternative, renewable and clean sources of energy. Renewable energy still remains unused is most of the countries, most especially developing countries. Most of the energy comes from non-renewable sources like coal. It still remains the top choice to produce energy. Unless we give renewable energy a serious thought, the problem of energy crisis cannot be solved. Renewable energy sources can reduce our dependence on fossil fuels and also helps to reduce greenhouse gas emissions.The world's population has now exceeded 6 billion people, and growth projections (FAO, 2000) indicate that the total population will be over 8 billion by 2030. More than half the world's population lives in rural areas, and the vast majority of these, some 2.8 billion people, live in rural areas in developing countries. There are 2 billion people without access to adequate, affordable and convenient sources of energy. At least two-thirds of them are dependent on the traditional fuels: wood, dung and crop residues for cooking and space heating. These traditional fuels have low energy conversion efficiencies. Their use, especially in arid and semi-arid areas, can lead to environmental damage through excess stripping of forests and woodlands, and to adverse health effects due to smoke inhalation causing respiratory diseases.

Time spent by rural people in gathering and cooking with these fuels involves hard work and drudgery, and is a diversion from other economically useful activities. In 2009, about 1.4 billion people in the world lived without electricity, and 2.7 billion relied on wood, charcoal, and dung for home energy requirements (IEA, 2006). This lack of access to modern energy technology limits income generation, blunts efforts to escape poverty, affects people's health, and contributes to global deforestation and climate change. Small-scale renewable energy technologies and distributed energy options, such as onsite solar power and improved cook-stoves, offer rural households modern energy services.

The emergence of biomass as a credible source of alternative energy is fast gaining global recognition and acknowledgement in the world today. Attributing factors to its growth owe to the fact that its availability is of no shortage as its supply is renewable coupled with the fact that its application/utilization has minimal or significant detrimental effects compared to the utilization of fossil fuel. Biomass is one of the most plentiful and well utilized sources of renewable energy in the world. According to the IEA, (2006) Biomass refers to organic matter that has stored energy through the process of photosynthesis. It exists in one form as plants and may be transferred through the food chain to animal bodies and their wastes, all of which can be converted for everyday human use through processes such as combustion, gasification and pyrolysis which

releases the carbon dioxide stored in the plant material. Biomass is a renewable energy source not only because the energy in it comes from the sun, but also because biomass can re-grow or replenish over a relatively short period of time in comparison to the hundreds of millions of years that it would take fossil fuels to form through the process of photosynthesis.

Many of the biomass fuels used today come in the form of wood products, dried vegetation, crop residues, and aquatic plants. Biomass has become one of the most commonly developed renewable sources of energy in the last two decades, second only to hydropower in the generation of electricity. It is such a widely utilized source of energy, probably due to its low cost and indigenous nature, that it accounts for almost 15% of the world's total energy supply and as much as 35% in developing countries, mostly for cooking and heating (IEA, 2006).

Biomass power is carbon neutral electricity generated from renewable organic waste that would otherwise be dumped in landfills, openly burned, or left as fodder for forest fires. When burned, the energy in biomass is released as heat. In biomass power plants, wood waste or other waste are burned to produce steam that runs a turbine to produce electrical energy, or that provides heat to industries and homes. Fortunately, new technologies including pollution controls and combustion engineering have advanced to the point that any emissions from burning biomass in industrial facilities are generally less than emissions produced when using fossil fuels (coal, natural gas, oil) (IEA, 2006).

Gasification is a process that converts organic or fossil fuel based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide. This is achieved by reacting the material at high temperatures (>700 °C), without combustion, with a controlled amount of oxygen and/or steam. Gasification is not a new technology, it was originally developed in the 1800s and is the processes used to make town gas for lighting and cooking. Small scale gasifier were also used to power internal combustion engine vehicles during fuel shortages during the Second World War. It is a manufacturing process that converts any material containing carbon such as coal, petroleum coke, biomass or waste into synthesis gas (syngas). The syngas can be burned in a turbine to produce electricity or further processed to manufacture chemicals, fertilizers, liquid fuels, substitute natural gas, or hydrogen. The percentage of biomass and waste used as feedstock for gasification has been increasing in recent years. Gasification is a flexible, reliable and clean energy technology that can turn a variety of low-value feedstock into high value products, help a country reduce its dependence on imported oil and natural gas, and can provide a source of base-load electricity, substitute natural gas, fuels, fertilizers, and chemicals needed for economic growth. These amongst others are benefits biomass gasification. (IEA, 2006)

1.2 Statement of the problem

The world is in a state of increasing energy demand accompanied by decreasing availability of conventional energy sources, the bulk of these energy sources being fossil fuel. The cost of fossil fuel, inclusive of cost of procurement, processing and utilization when considered alongside the deficient power generation from this energy source especially in developing countries is of exorbitant nature . Fossil fuel is in a state of decreasing availability. This unfavorable situation when considered with the detrimental effects of fossil fuel consumption on the environment poses a long overdue problem for confrontation.Need hitherto has arisen for the discovery and development of a cheap, alternative and environmental friendly source of energy such as biomass gasification.

ANALYTICAL STUDY OF A SMALL SCALE BIOMASS GASIFIER