DESIGN OF 5th GENERATION POWER OPTIMIZATION MODEL USING GREEN COMMUNICATION FOR A SMART CITY

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APPROVAL

This Project titled "DESIGN OF 5th GENERATION POWER OPTIMIZATION MODEL USING GREEN COMMUNICATION FOR A SMART CITY", submitted by TasnimTamanna, Shahadul Islam Raju and Sidratul Sadia Dina to the Department of Electronics and Telecommunication Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Electronics and Telecommunication Engineering and approved as to its style and contents. The presentation was held on January,2020.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md. Taslim Arefin, Associate Professor & Head Department of ETE, Daffodil International University**. We also declare that neither this project nor any part of this project has been submitted elsewhere for any award. Where other sources of information have been used, they have been acknowledged.

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ABSTRACT

Power optimization has become an important issue in wireless networks in the present scenario. Power optimization infrastructure is necessary in order to meet demands for increased capacity, better data speeds and better service quality of the next-generation networks. It is also our social responsibility to reduce the carbon footprint by reduction in electricity usage in a wireless network, together with these criteria. There is therefore an immediate need for a safe contact. The study shows some power optimization techniques and a hybrid power generation system for the delivery of power in the base station. The power optimization part is divided by two part mainly, one is energy efficiency and the other one is energy consumption. In this study the power optimization part is simulated by MATLAB software where the terminologies are coverage area, beamforming, return loss, impedance of massive mimo antenna and also the sleeping mode of the mimo antenna during low transmission time. The hybrid power generation system is based on Biomass, Solar and grid. The hybrid system will produce sufficient power to support the whole base station direct combustion technology and using solar panels and also grid. This project also summarized the architecture of the integrated energy system using the renewable energy sources and monthly load measurement for an entire base station is simulated by Homer pro software. This study also presents a 5G power optimization architecture for smart city using green communication.

TABLE OF CONTENT

CONTENT

PAGE

LIST OF FIGRUES

LIST OF TABLES

ABBREVIATION

MIMO	Multiple input multiple output
D2D	Device to device
MM WAVES	Millimetre waves
SC	Small Cell
DCG	Digital converter generator

CHAPTER 1
Introduction

1.1 Introduction

The information and communications technology grow rapidly and expands, energy consumption is also rapidly rising. Mobile operators have also been identified to be among the top energy users. The use of 4 G services globally raises the energy consumption even more. The energy efficiency of 5G networks is expected to be increased 100x times. It is estimated that wireless traffic will rise over 1000 times over the next 10 years. Many new technologies have been developed to enable the high-speed wireless networking in the upcoming fifth generation mobile communications networks. This involves large multi-input and multi-output antennas, millimetre waves, sleeping modes and small cell systems. There has been a growing need for green connectivity. The emphasis is on the integrated energy optimisation approach. And a smart city idea demand high speed data transformation. So, this implementation of 5g in a developing country like Bangladesh is quite expensive [1].

Current worldwide electricity generation models are not environmentally friendly, as systems rely primarily on fossil fuels that generate greenhouse gas (GHG) and contribute to global warming. Bangladesh has a new perception of the hybrid power station. This electricity generation technology, is being used for a long time by developed countries [27]. Substantial advantages over other renewable energy sources are provided by biomass coal. Because Bangladesh is an agricultural land, there are also many agricultural residues, urban solid waste and animal manures which are the major source of biomass energy and unlimited solar power from the sun. There will therefore be a huge prospect that both biomass and solar will be used as a potential renewable energy source in Bangladesh [26]**.**

1.2 Aim and Objectives

1.2.1 Aim

Aim of this thesis is to establish a power optimization model for 5g network as well as to propose a Hybrid power generation system for efficient and smart supply of power for that network system.

1.2.2 Objectives

- To determine about different energy problems as well as the multiple power optimization trends over the past decade.
- To Illustrate about the evolution of wireless communication.
- To determine about some new energy efficient techniques such as MASSIVE MIMO, Small cell, Sleeping mode.
- To proposing an architecture design on optimizing the next-generation network and promoting the green communication idea and an idea about Hybrid power generation in Bangladesh.
- To proposing an architecture design on proper use of biomass, solar system and grid.

1.3 Report formation

Report formation section represent, what actually discuss and analysis in. In this paper try to establish a model architecture about 5g implementation in smart city using green communication

Chapter 1: Introduction-Contains some fundamental knowledge about power optimization, green communication, smart city and hybrid power generation system, aims and objective of this thesis.

Chapter 2: Background theory- Contains the background theory about communication technology, power optimization, green communication, smart city and hybrid power generation system.

Chapter 3: Literature Review-Contains the literature review about power optimization, hybrid power generation system, green communication and smart city.

Chapter 4: Proposed Model-Contains the proposed architecture about 5th generation power optimization model using green communication for a smart city.

Chapter 5: Methodology

Chapter 6: Data analysis and results.

Chapter 7: Conclusion.

Chapter 2

Background Theory

2.1 Communications technology

Technology of communication includes the planning, development and networking practices. Communication technology allows to convey more information to more users in less time with greater precision and less incomprehension, speed and overall volume that can be managed at any given time. Wireless communication is the biggest part of the communication technology [14].

2.1.1 Wireless communication

Wireless communication is one form of wireless data transmission. This is a broad word that encompasses all methods, wireless communications systems and technologies for linking and communicating with two or more devices via a wireless signal. The way people share information with each other has theoretically improved with wireless communication technologies. Throughout recent history, the ability to communicate by text transfer and reception has been simpler. Day by day the demand of sharing information like voice and data are rapidly increase. The term wireless communication came into being in the 19th century and over the following years wireless communication technology has developed vastly [15].

2.1.2 The evolution of wireless communication

Over recent decades, after the first wave of mobile networks in the early 1980s, the modern wireless communication infrastructure has undergone many phases. Mobile communications technologies have increasingly evolved to accommodate more consumers, due to the huge need for more worldwide connectivity. The first electrical communication device, i.e. the telegraph, has been invented by S. In 1838, Morse. It can also be used for the transmission of human speech. In the 1850's Maxwell predicted the idea of electricity being transmitted wirelessly, as Hertz demonstrated in 1888. In 1876 A. G. Bell invented the handset already. Additional wireless telegraphs were used to account for trajectory failure over distance using the transmitter with an extremely high power via the wireless link. This lack of direction was substituted by the electron tube amplified by de Forest in 1915. It allowed radio transmission and TV transmission later. Then a low power transistor was substituted for the electric cable. Shortly afterwards, wireless contact developed to live mobile phones, which changed the way our society operates [1].

- 1G

  Analog cellular networks (1 G), such as Scandinavian mobile telephones and the advance mobile telephone service, were created in the early 1980s. It had up to 2.4kbps of data rate but had many inconveniences. Since it was originally a framework which was primarily designed to ensure wireless connectivity and availability, there was no emphasis on network capacity optimisation.

- 2G

  After approximately a decade, early digital cellular systems followed, known as 2 G systems. The 2 G systems are designed primarily for voice and power control approaches with a data rate of approximately 64kbps to provide a certain level of service quality. Services such as Short Messages and E-Mail are also offered. The Global Mobile Communications System (GSM), IS-95andIS-136 were the main 2 G standards. Due to low power radio signals, 2 G mobile phones have a longer battery life. Instead came 2.5 G, the 2 G network structure used, but with the circuit flipping the packet shifted. The

data rate was up to 144kbps. Generic Radio Packages, the Improved GSM Evolution Data Rate, and the Multiple Access Code System, 2000, were the key 2.5 G software innovations. Levels were similar to 2G.

- 3G

  By late 2000, there emerged 3 G networks that offered up to 2Mbps transmission rate with increased QoS. 3 G is based in accordance with the broadband CDMA standard, International Mobile Telecommunications 2000. One of the 3 G standards is the Unified Wireless Telecommunication Network, a GSM counterpart and developed by 3GP. 3 G also provided international roaming services and improved quality of the voice. The big downside for 3 G mobile devices was the need for more electricity than most 2 G systems.

- 4G

  The IMT Advisory Guidelines for 4 G requirements revised after another 10 years from the ITU Radio Communications Committee (ITU-R). 4 G is generally known as the 3 G and 2 G standard descendant. The Long-Term Evolution Advanced (LTE-A) is now developed as the upcoming 4 G protocol for the third-generation collaboration (3GPP). By contrast to older generations customers, utilities such as audio, video and digital are delivered any time and everywhere and at high data speeds. Users will have access to apps like Multimedia Messaging System, Video Chat, High Definition TV content and mobile TV. The concept of multi-hop in-and outside-band relays, which can contribute to increasing the area of coverage and making the Network more energy-efficient, was introduced in the newly emerging markets such as the 3GPP LTE-A and the IEEE 802.16j standards. The major disadvantage of 4 G networks is the use of cell-specious c reference signals (CRSs) that minimize the network's energy efficiency due to excessive overhead.

- 5G

The 4 G network will soon be replaced by the next 5 G network to satisfy the increasing demand for high data rates. The energy efficiency of the next-generation networks is necessary in order to meet the demand of their subscribers. A key role will be played in this by Green contact. 5 G incorporates technologies such as the massive mimo, multi-access beam separation, D2D networking and multi-radio domain processing. With the frequency used, the power demand for the network decreases. According to the ICNIRP regulations for power density (watt per square meter), the prescribed safe RF exposure limit is f/200 when F is the frequency for MHz.

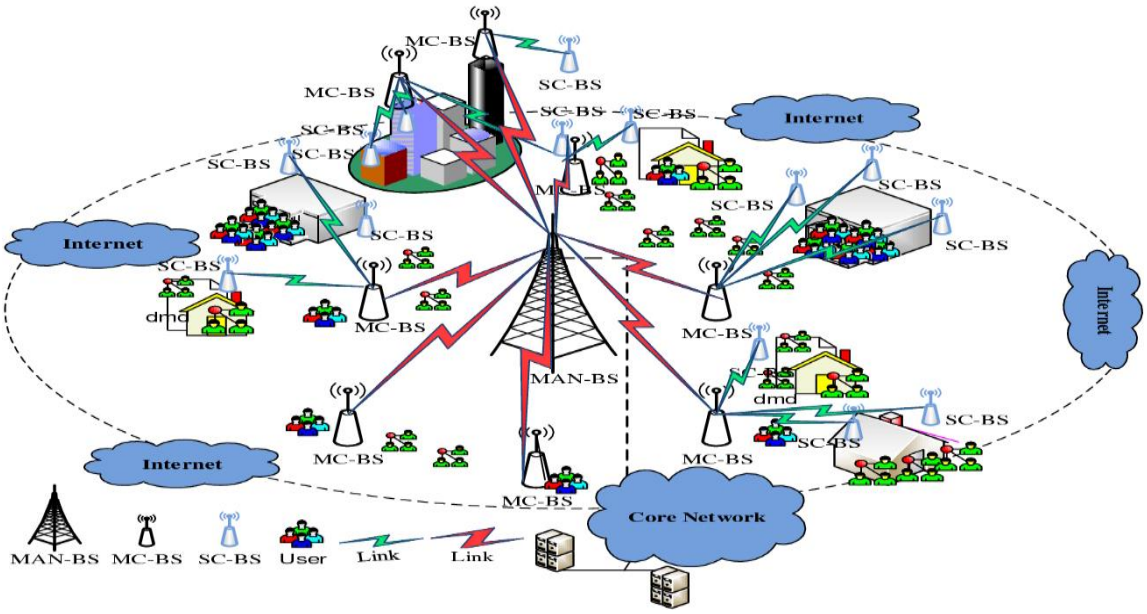

Figure 2.1 General Layout of the Proposed 5G ultra-Dense Heterogeneous Network

Table 2.1 Evolution of wireless mobile communication.

GENERATION	SPEED	KEY FEATURES
1G	14.4Kbps	Voice service only.
2G	9.6/14.4Kbps	Voice and data service.

2.5G to 2.75G	171.2Kbps 20-40Kbps	Voice, data, web mobile internet and email service.
3G	3.1Mbps 500-700Kbps	Voice, data, multimedia, support for, smart phone applications, video streaming.
3.5G	14.4Mbps	As same as 3G and more speed and mobility.
4G	20-100 Mbps 3-5Mbps 100Mbps(wifi)	High speed, high quality voice, hd multimedia streaming, 3d gamming, hd video conferencing and world-wide roaming.
5G	Up to 1gbps	All kind data transformation.

2.2 Power Optimization

- Energy Efficiency:

Energy efficiency appears to mean that use less energy to do the same job, namely eliminating the waste of time and energy. The criteria of energy supply are also growing as communication technology is developing. According to a survey, mobile operators are among the leading energy consumers and their use increases very rapidly, especially with the use of 5 G technology. A large part of the power generated at the base station is absorbed by a huge amount of power. So, the acquiring of energy efficiency has signed the cant economic benefits, from the point of view not only of the producer but also of the customer. It is also very environmentally and socially responsible in terms of climate change. For this purpose, energy efficiency, optimum efficiency and spectral efficiency are desperately important for the design of a wireless network.

The energy efficiency of wireless communications is also important from the point of view of the customer. Energy efficient communication demands come from power-restricted networks such as ad-hoc networks in which battery-powered wireless systems are used to reduce energy usage. Cellular systems must therefore be energy-effective, particularly with the recent increase in demand in mobile multimedia communication that made the battery restriction an important problem. This has encouraged energy optimisation for mobile devices [6].

Table 2.2 List of terminologies used in efficient the energy in 5g network.

MASSIVE MIMO	Massive MIMO is a multi-user MIMO technology, which allows the wireless terminal to receive consistently good service in a high-mobility environment. The key concept is to provide the base stations in the same time-frequency network with a variety of antennas used to support many terminals at the same time.
MASSIVE	Massive means the number of antennas is used.
BEAMFORMING	Beamforming is a processing technique for signal transmission or acceptance used in sensor arrays.
COVERAGE AREA	Coverage area means the area can be cover by the antenna.
THROUGHPUT	Throughput is actually the data rate of antenna which actually used for characterising the antenna.
RETURN LOSS	Loss of return is the power loss of the signal returned/ expressed in a transmission line discontinuity

IMPEDENCE	The antenna impedance refers to the voltage at the antenna entrance.

- Power Consumption:

Power consumption means saving the power. Power consumption and the resulting energy pollution are becoming major operational and economic concerns in the communications space. The exponential increase in network traffic and the number of connected devices is increasingly important for energy efficiency. This will help to reduce capital and operating expenses, increasing energy consumption of mobile networks [21].

Table 2. 3 List of terminologies used in power consumption in 5g network.

SLLEEPING MODE	The base station will reduce energy consumption by entering sleep mode during network operation gaps.

2.3 Hybrid Energy based power generation system

Hybrid technology is a combination of different power generating systems. Bangladesh has a new understanding of renewable energy. Bangladesh is an agriculture region, residues of vegetables, city waste and livestock manures, which are also abundantly responsible here for the major source of the biomass energy system and limitless solar energy from the sun. There are also tremendous hopes of these technologies mitigating the country's energy shortage and biomass and solar will act as both future renewables in Bangladesh. The program involves the production of renewable energy. Synchronized link of biomass, solar and grid electricity [26].

Table 2. 4 List of terminologies used in power consumption in 5g network

Biomass	Biomass is plant or animal waste used as a raw material for a wide variety of products for the production of energy (electricity or heat) or in various industrial processes. These may include deliberately planted energy plants, woodland or wood reside, food waste, horticulture, food processing, animal agriculture or human waste from sewage plants.
Solar power	Photovoltaics (PV), implicitly use concentrated solar power, or a mixture of solar power are the transfer of energy from sunlight into electricity is the solar power.
Grid	An electricity grid is a distributed energy network for consumers

2.4 Green communication

Green communications are a way of choosing energy-efficient computing and networking systems and goods and of maximizing the use of capital for all communications industries where possible. In the recent past, there has been huge success and competition in the telecommunications industry. There are more than half of the world's smartphone subscribers today. The ICT industry is currently becoming a major global energy market. Researchers were urged to explore various ways of reducing energy consumption. There is a double incentive. Secondly, the cost of energy is the key element in pro t equations for the telecommunications network operators. Furthermore, social responsibility for protecting the environment arises by rising the carbon footprint through IT [18].

2.5 Smart city

A smart city is a city that integrates ICT to improve the quality and output of public infrastructure like electricity, transport and amenities, in order to reduce consumption of resources, pollution and overall costs. The overall objective of a clever city is to improve its citizens ' quality of life through clever technology [28].

Chapter 3
Literature Review

3.1 Overview

The way people share information with each other has potentially changed with communications technologies. It has been made more readily available in the last few years to connect by sending and receiving text information. Like the Pony Express, the telegrapher, and the telephone, modern technological methods have reinvented the communication means available once more.5g is the upcoming wireless communication technology. 5g lift the mobile networks to include not just humans in contact but also computers, objects and appliances in the inter-connection and power. It will provide new levels of efficiency and success to support new user experiences and integrate new industries. 5g delivers multi-Gbps peak rates, extremely low latency, huge capacity and a more consistent user experience.5g mainly deliver data not voice information. For delivery the data it needs high rate of frequency. Because of this power optimization is the main target to implement the 5g. The 5g base station require number of small cells under one base station. Because of this 5g base station need huge power for running. To achieve improvements energy efficiency, power consumption and power delivery has several techniques. And this are the main criteria of green communication and smart city.

3.2 Power optimization

Wireless communication is the biggest part in the communication field. At the very early age in 1960s research efforts in the sector have increased over the past decade. David Tse (University of California, Berkeley) and Pramod Viswanath (University of Illinois, Urbana-Champaign) write a book about the fundamentals of Wireless Communication. 5g is the upcoming technology of wireless technology. Jeffrey G. Andrews, Fellow, IEEE, Stefano Buzzi, Senior Member, IEEE, Wan Choi, Senior Member, IEEE, Stephen V. Hanly, Member, IEEE, Angel Lozano, Fellow, IEEE, Anthony C. K. Soong, Fellow, IEEE, and Jianzhong Charlie Zhang, Senior Member, IEEE are discussed about the what 5g will be. There they discuss about just the last

year, the early enthusiasm of developers and engineers all around the world grew into a full-fledged debate about a potential 5 G standard. With the long-term transition (LTE) program that covers 4 G, only modest enhancements and low levels of new spectrum can be predicted. Power optimization is the prime factor in wireless communication as well as in 5g. Energy efficient technologies must be implemented to meet the demands of expanded capacity, better data speeds and improved service efficiency in the next-generation networks. To relation to this obligation, our social responsibility also rests to reducing the carbon footprint of a wireless network, by reducing energy usage. There is therefore an immediate need for a green contact. AKSHITA ABROL, (Student Member, IEEE), AND RAKESH KUMAR JHA, (Senior Member, IEEE) discuss several technologies about the power optimization in smart city using green communication. And they also proposed an energy efficient architecture for the smart city. The energy efficient techniques are massive mimo and small cell. K. N. R. Surya Vara Prasad, Ekram Hossain, and Vijay K. Bhargava are discussed about the Energy Efficiency in Massive MIMO-Based 5G Networks: Opportunities and Challenges. Imran Ashraf, Federico Boccardi, and Lester Ho, Alcatel-Lucent are discussed about the sleeping mode for the base station. Abdelrahman Arbi and Timothy O'Farrell, Member IEEE, Department of Electronic and Electrical Engineering,

The University of Sheffield, Mappin Street, Sheffield, S1 3JD, United Kingdom they discuss about the small cell deployment for 5g base station.

3.3 Hybrid Power Generation System

Waste-to-energy is now a kind of energy use that will offer environmental and economic gains in the world. Maw Maw Tun, Dagmar Juchelková , Helena Raclavská and Veronika Sassmanová they did a case study about utilization of biodegradable wastes as a clean energy source in the developing countries. MD. Hafezur Rahman Chowdhury proposed a Hybrid Energy Based Power Generation System for A Residential Building in his paper.

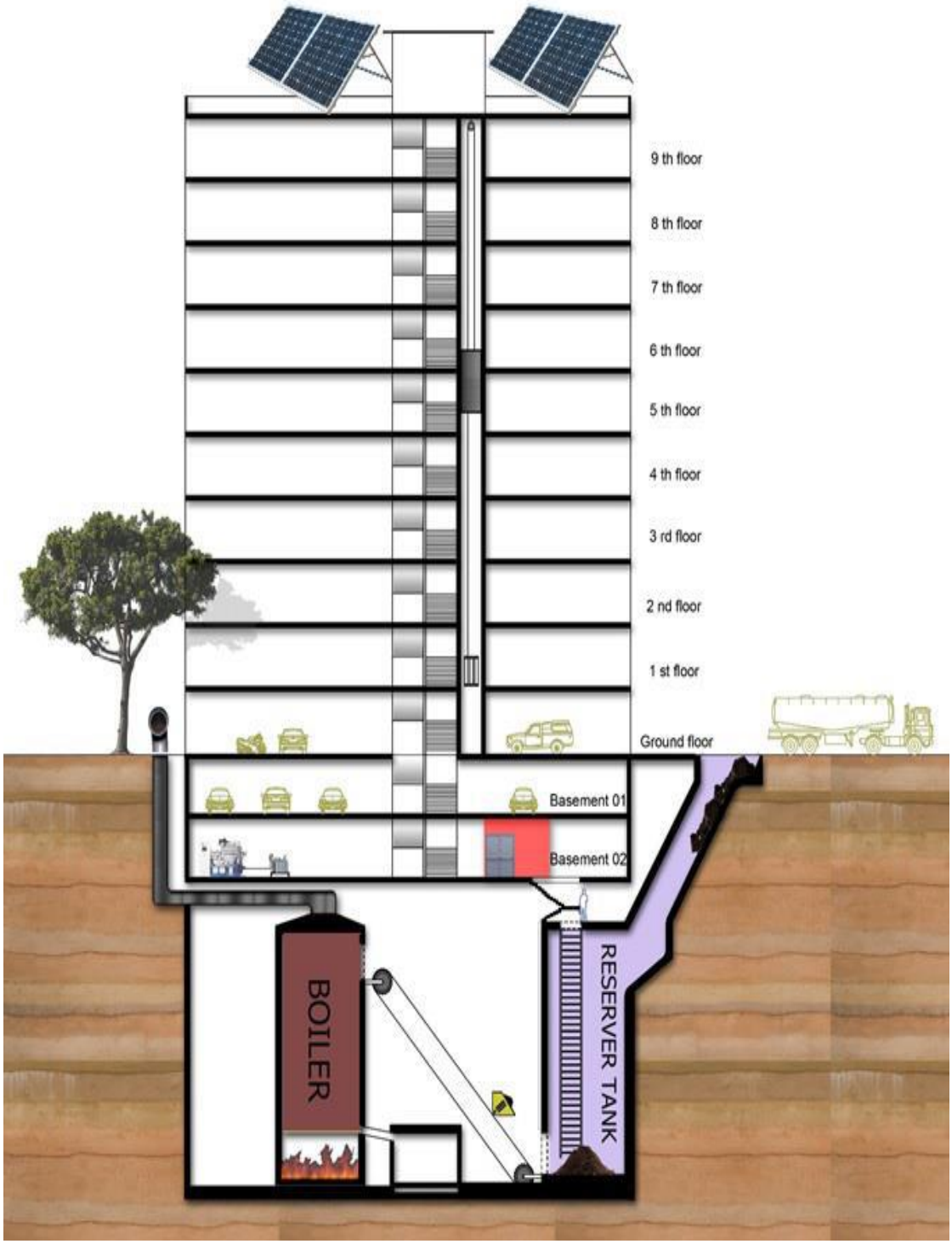

Figure 3. 1 Hybrid Power Generation System For A Residential Building.

Chapter 4
Methodology

4.1 Methodology

The methodology of 5th generation power optimization model using green communication for smart city is a step by step process.5g mainly transmit data not voice. There are so many techniques for optimizing the power at 5g base station. In telecoms for several reasons, such as high data rate demands, rising energy prices, global pollution effects, stresses and social responsibility for climate change. Massive mimo antenna is the key technology for the energy efficiency and sleeping mode is the power consumption technique. Also, Bangladesh has a huge electricity problem for which reason hybrid power generation system can reduce the pressure on the grid.

4.2 Preparation

The power optimization part in 5g is consist of two part mainly. And for power delivery hybrid power generation system is the combine of Biomass, solar PV and grid.

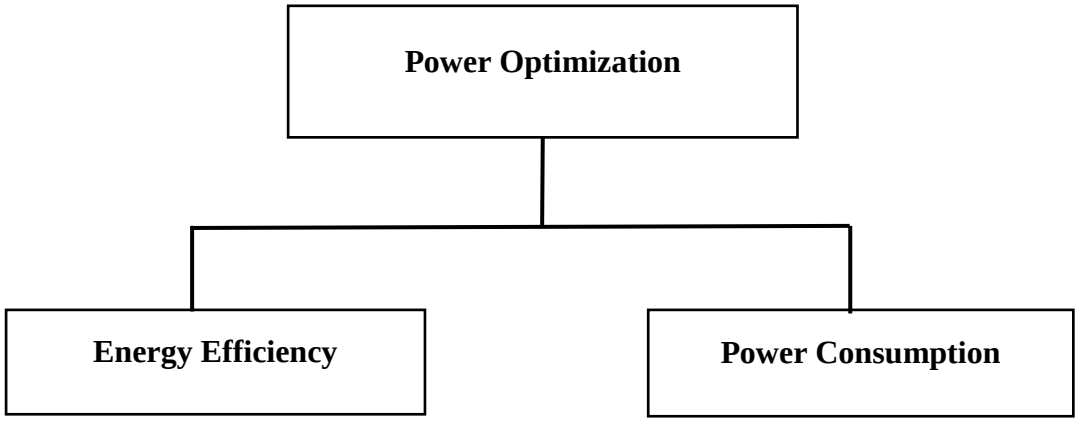

Figure 4. 1 Power optimization components for 5G network.

4.3 Energy efficiency techniques

Energy efficiency also means that use less energy –namely to remove waste energy. Energy efficiency has several advantages: a reduction in greenhouse gas emissions, a reduction in fuel supply demand and a decrease in consumer prices and economic costs. Although renewable energy solutions help meet these targets, the cheapest–and generally the imminent–way to reduce the use of fossil fuels is for the increase in energy efficiency. In every sector of the economy, whether in housing, infrastructure, manufacturing or energy generation, tremendous prospects for improvements in efficiency are present. There are some energy efficiency techniques for 5g base station [1].

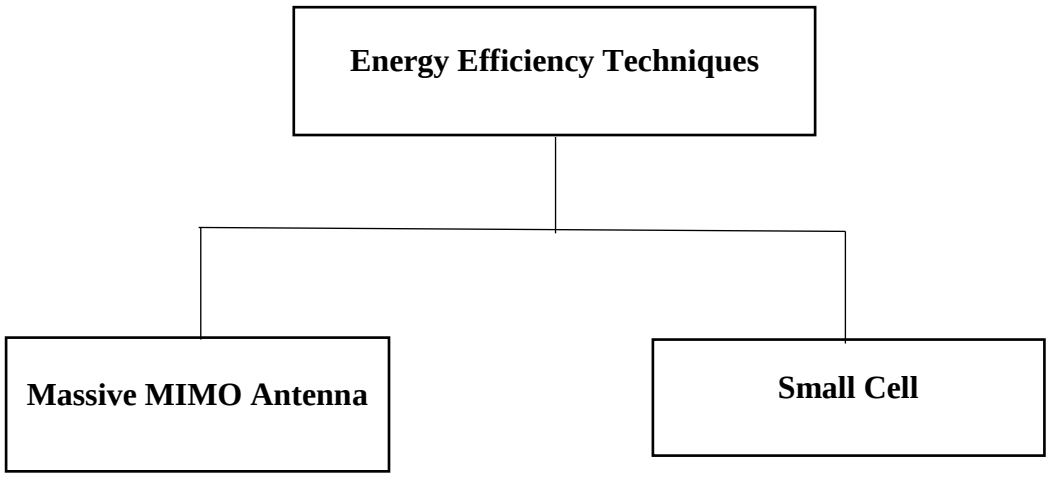

Figure 4. 2 Energy Efficiency Techniques used in 5G

4.3.1 Massive MIMO Antenna:

Massive MIMO is an extension of MIMO where it has multiple input and multiple output, which primarily brings antennas at the transmitter and the receiver together to provide a better performance and spectrum capacity. There are some term for analysis the MIMO antenna [7], which are-

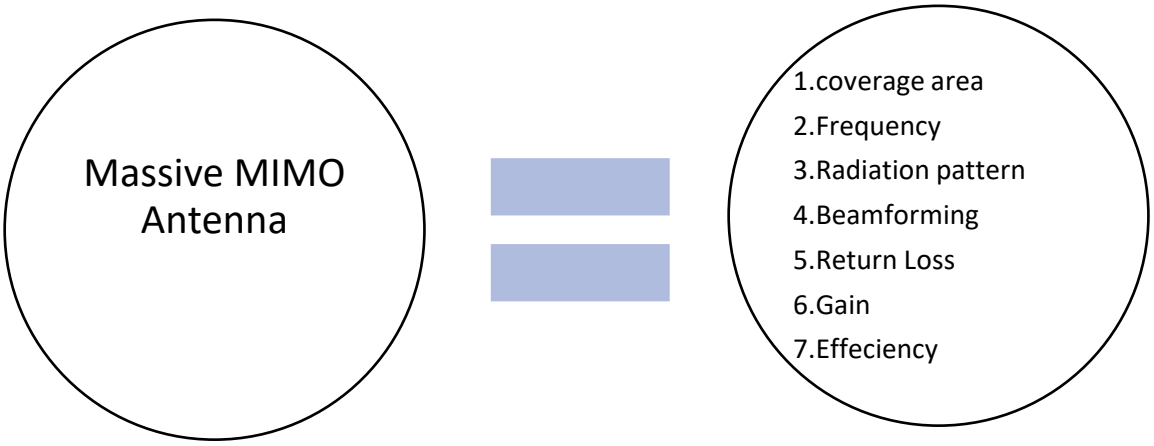

Figure 4. 3 The Massive MIMO antenna system.

4.3.2 Small cell Base station

A small cell is actually a compact base station that separates a cell site into smaller parts and is a term that includes indoor and outside structures. There is one tube into the network with a macro base station and breaking the tube into several tubes with small cells. The main aim of small cells is to increase the capacity, speed and total network output of the macro cell's edge data. Small cells usually are used in highly populated urban areas, such as shopping malls, sports venues, airports and trains-basically wherever you have multiple people who use data at a certain time. Most smaller deployments for cell infrastructure are now outdoor [11].

Table 4. 1 Lists of small cells used in network base station.

Cell type	Outdoor Power	Cell Radius	Users
Femto cell	0.001 to 0.25	0.010 to 0.1	1 to 30
Pico cell	0.25 to 1	0.1 to 0.2	30 to 100
Micro Cell	1 to 10	0.2 to 2.0	100 to 2000
Macro Cell	10 to >50	8 to 30	>2000

4.4 Power consumption

The energy consumption means the power supplied for the base station per unit of time, supplied for service. Power consumption in watts (W) or kilowatts (kW), usually is estimated. Equipment usage efficiency often exceeds the energy needed in practical. Because the 100% of power is not used in base station all time. For consuming the power base station can turn into sleeping mode when the data traffic is low.

4.5 Hybrid Energy Based Power Generation System

The hybrid power generation system is the combine of biomass, solar and grid technology. The ultimate goal is to use the renewable energy for supply the power which is able to defend the necessity of the power. And the main motivation of hybrid energy-based power generation system is the electricity problem of Bangladesh. There is huge difference between the peak load demand and the actual produced electricity. Bangladesh presently contains nearly 160 million inhabitants and has a surface area of 147,570 km2. Electricity production per capita is an assessment of the

actual amount of life and is small in Bangladesh. The current electricity generation per household is roughly 292 kWh / year. Electricity demand is present in all economic sectors, including agriculture, manufacturing and utilities. The residential and industrial sectors use about 43% and 44% of the electrical energy in these two countries, that is, about 87% of electricity consumption. The rising demand for electricity in recent years could not meet due to a lack of maximum capacity. Because of 5g base station use a great amount of power so hybrid energy-based power generation system is the way to reduce the pressure of power supply on the grid [26].

- **Biomass**

Biomass is used for the processing of plants or animals (electricity or heat) or in various industrial processes. The trees, timber or biomass, food crop waste (wheat straw), gardening (yard waste) and food processing (corn cobs), agricultural animal (manure, nitrogen rich and phosphorous), and human waste from sewage plants will deliberately be made. It can be a food waste from plants. The energy from the biomass can be produced by two kind of waste.

- Biodegradable waste.
- Non-biodegradable waste.

Biodegradable waste

Biodegradable waste is a form of waste that can be destroyed by other living organisms from plant or animal sources. A biodegrading material may be defined as a material that can be decomposed and not added to pollution by bacteria or other natural organisms. Food and kitchen waste from the home, comparable wastes from food processing plants, restaurants, caterer and retail premises, and organic waste is identified as biodegradable garden and park waste. It does not bring in waste materials such as cardboard or recycled timber and natural textiles. It does not manufacture sewage, water sludge, forestry or agricultural waste [27]. The list of biodegradable wastes is:

- Leaves.
- Flowers.

- Kitchen waste.
- Animal or Human excreta.
- Seedless food.
- Handmade bags.
- Dead animals or human beings.
- Wood.
- Natural textiles.
- Wires.
- Vegetable Scraps.
- Papers.

Non-Biodegradable waste:

Waste not decomposed by nature is known as "non-biodegradable waste." Non-biodegradable material can be described as a category of surface that is not disassembled by natural organisms and pollutes. Non-biodegradable waste cannot be treated effectively unlike biodegradable waste. The product which cannot be decomposed or dissolved by natural agents is non-biodegradable. They live on Earth without decay for thousands of years. The threat they pose is therefore more important as well. The plastics that are commonly used in almost every field are a remarkable case [27]. The list of non-biodegradable wastes is:

- Plastics products.
- Nylon products.
- Synthetic products.
- Silk products.
- Clothes.
- Rubber tires.
- Metals products.
- Construction waste.

- **Solar Power**

Solar power is a conversion of energy from sunlight to power by means of either photovoltaic energy directly or indirectly, or by means of a combination of concentrated solar power. Concentrated Solar power systems are used to concentrate a large area of solar light on a small beam with lenses or mirrors and tracking systems. Originally photovoltaic cells were used primarily as a means of electrical energy for small and medium-size purposes, from a solar-powered calculator into rural homes powered by an off-ride photovoltaic network. (2) Photovoltaics are only a device resource for small and medium-sized applications. In the 1980s, commercial solar concentrates were first produced [27].

- **Grid**

An electricity grid is an interconnected electricity supply network for producers to consumers. It consists of generating stations supplying electrical substations for the step-up or downward transfer of electrical power for high voltage distribution lines and bringing electricity from distant sources to the distribution lines linking individual customers with the demand centres [27].

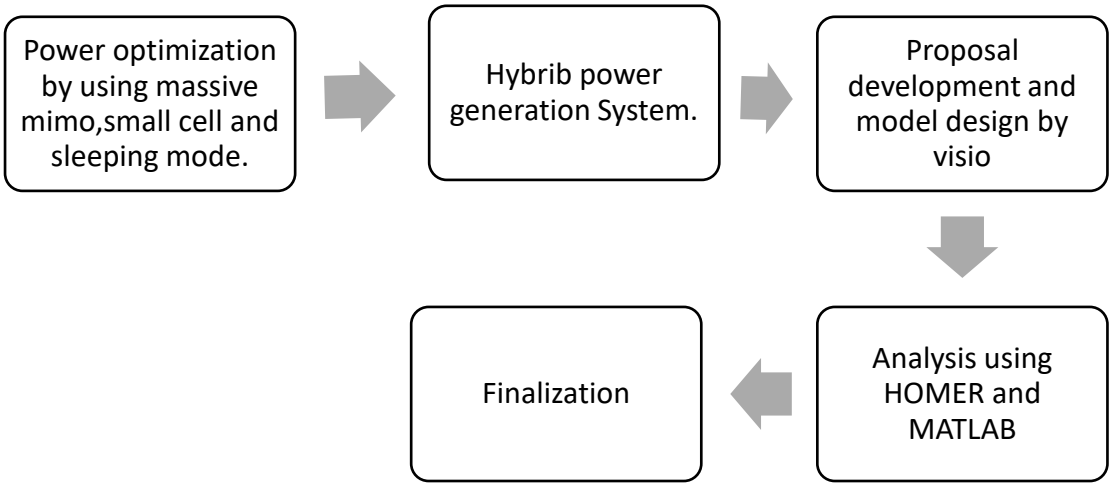

Figure 4. 4 Process sequence of 5G implementation in Smart city using Green Communication.

Chapter 5
Proposed Model

5.1 5G Network Model

The model is proposed for a 200$\mathbf{m^2}$ area. Here the base station is established with Massive MIMO antenna and sleeping mode. For covering 200 $\mathbf{m^2}$ there are two small cells. And all base station is connected with the cloud storage. The power of the base station is delivery from the hybrid power generation system.

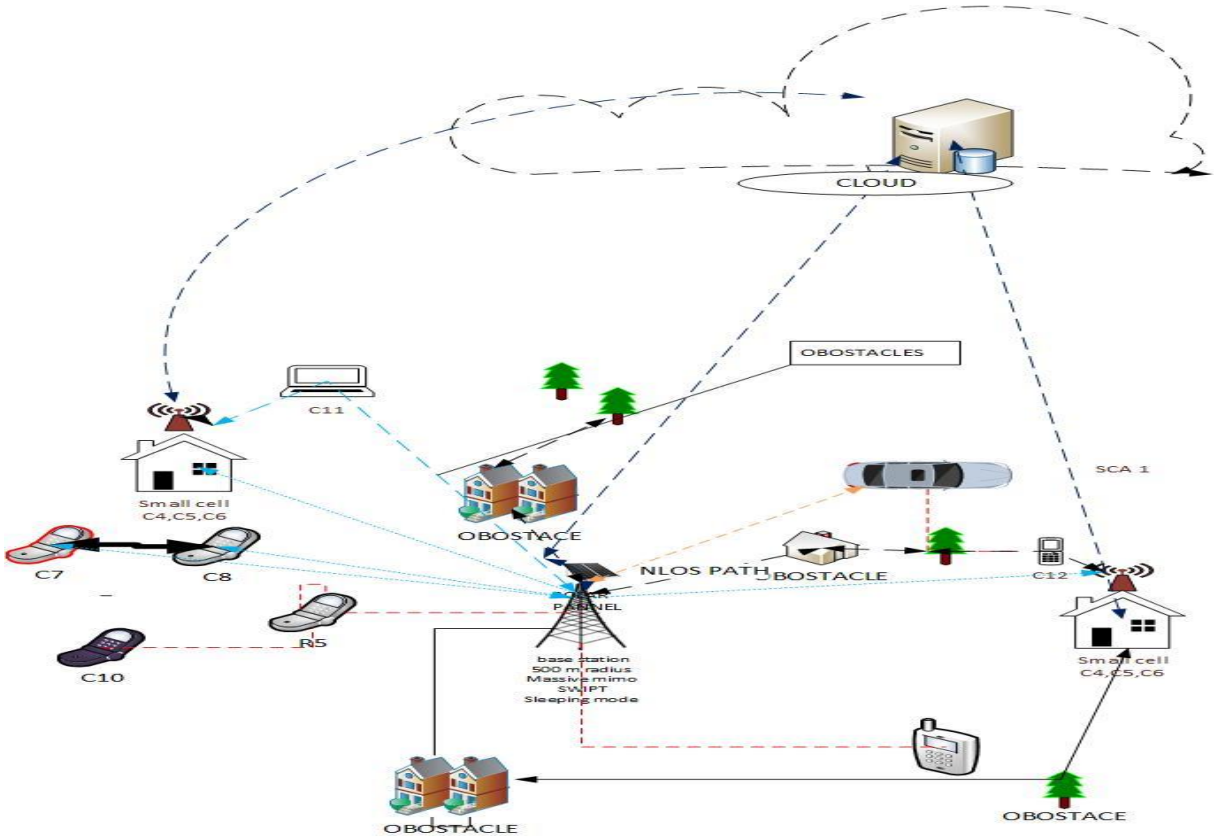

Figure 5.1 Proposed 5G model for smart city using Green Communication.

5.2 Hybrid power generation model

The power generation model is consisting of biomass, solar and grid. All power from these three sectors are convert by a 220v converter and then supply to the base station**.**

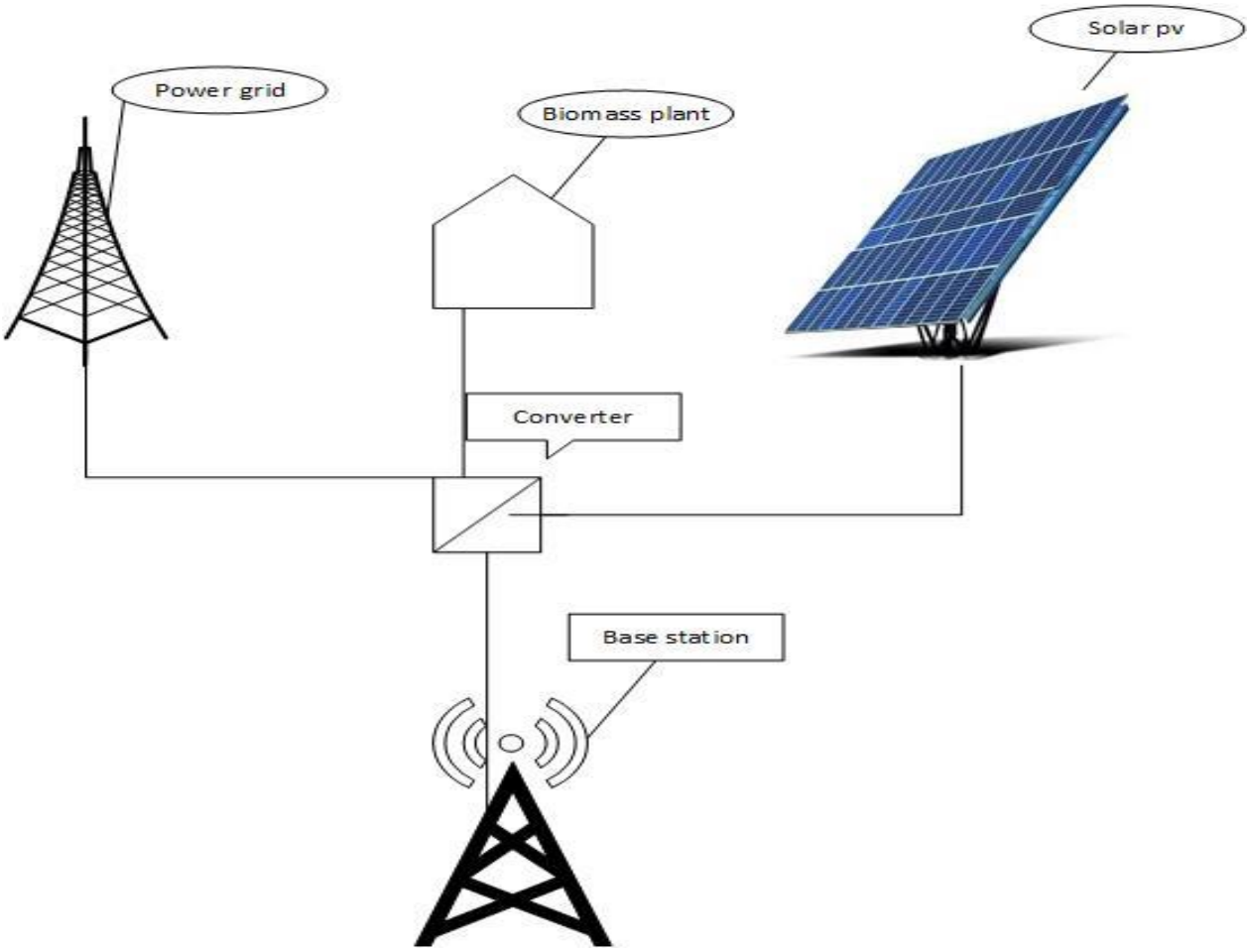

Figure 5. 2 Hybrid Power generation model

Chapter 6

DATA ANALYSIS & RESULTS

6.1 Data Analysis

6.1.1 Massive MIMO antenna

There are some parts which need to be analysis in massive mimo antenna. Multiple-input and multiple-output (MIMO) is a multi-path networking method of network connectivity capability increase.[1] MIMO has become an essential element in the wireless communications protocols including IEEE 802.11n (Wi-Fi), IEEE 802.11ac, HSPA+ (3 G), WiMAX (4 G) and Long Term Evolution (4 G LTE) standards and the multi-path multi-input and multi-output (Wi-Fi) system. MIMO has become a key element of Wireless communications standards

6.1.1.1 Coverage analysis of MIMO antenna

It is spread through land areas, known as "cells," often supported by three cell sites or base transceiver stations, but more commonly. Such base stations maintain the network coverage of the cell which can be used to relay voices, data and other service types. A cell typically uses a different range of cell frequencies to prevent interference and to guarantee quality of service inside each cell. Here is the flow chart of the simulation for the coverage area-

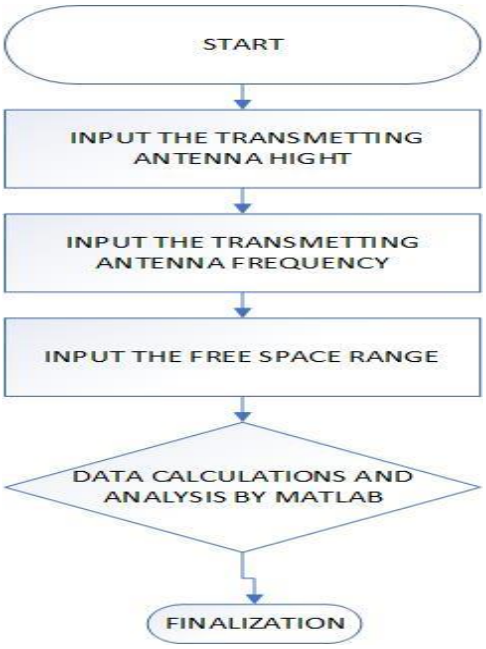

Figure 6. 1 Flow chart for simulating the coverage area.

The antenna downlinks in degree, outer radius of the antenna, inner radius of the antenna can be found from the coverage area of the antenna.

Downlink Angle $\mathbf{A_{DT}} = \mathbf{tan^{-1}}\left(\frac{\mathbf{h_T - h_R}}{\mathbf{D}}\right)$

Coverage radius $\mathbf{R_{outer}} = \frac{\mathbf{h_T - h_R}}{\mathbf{tan}\left(\mathbf{A_{DT}} - \frac{\mathbf{Q_{BW}}}{\mathbf{2}}\right)}$

Inner coverage $\mathbf{R_{inner}} = \frac{\mathbf{h_T - h_R}}{\mathbf{tan}(\mathbf{A_{DT}} + \frac{\mathbf{Q_{BW}}}{\mathbf{2}})}$

Table 6. 1 Symbol And notation For Calculating Coverage Area.

$\mathbf{A_{DT}}$	Antenna downlink in degrees
$\mathbf{h_T}$	Height of the transmitting antenna
$\mathbf{h_R}$	Height of the receiving antenna
D	Distance between antenna
$\mathbf{R_{outer}}$	Outer radius of coverage
$\mathbf{R_{inner}}$	Inner radius of coverage
$\mathbf{Q_{BW}}$	Beamwidth of antenna in degree

6.1.1.2 Beamforming

Signal shaping or spatial filtration is a technique for signal manipulation in sensor arrays used to transmit or receive directed signal. The combination of antenna array element to signify positive interference from a particular angle when disruptive interference happens to others. Transmission and receipt for spatial selectivity can be used for transmission and receiving purposes. Beamforming is essentially the linear combination of the product outputs, which can be measured using a beam.

$$\boldsymbol{\zeta(\theta)} = \sum_{\mathbf{K=0}}^{\mathbf{k=N}} \mathbf{a_k(\theta).X_k}$$

Table 6. 2 Symbol And Notation For Calculating Beamforming.

N	Number of elements
K	An index Variable

$\mathbf{a_k}$	Complex coefficient of the $\mathbf{k^{th}}$ element
$\mathbf{X_k}$	Voltage response from the $\mathbf{k^{th}}$ element
ζ	The beam response
θ	The angle of the beam.

- The flow chart of the beamforming:

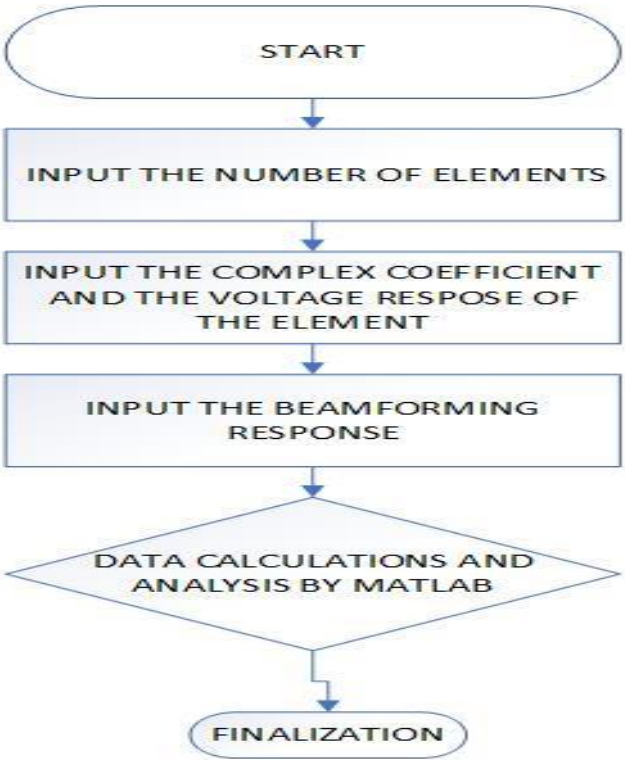

Figure 6. 2 Process flow of beam-forming simulation

6.1.1.3 Return loss

Return loss is the power loss in the signal reported / reflected in the transmission line or optical fibre in telecommunications Return loss is related to both the SWR and the reflection coefficient. Return losses are due to the lower SWR corresponds to increased return loss. The return loss is a function of the matching between equipment or lines. If the return loss is small, a match is fine. The high cost of return is beneficial and the loss of incorporation is that. This disruption may be unacceptable to the terminating load or to a

system inserted into the track. The ratio in decibels (dB) is generally indicated. The formula of measuring the return loss is:

$$\mathbf{R_L = 10\log(\frac{P_{in}}{P_r})}$$

Table 6. 3 Symbol And Notation For Calculating Return Loss

$\mathbf{R_L}$	Return Loss
$\mathbf{P_{in}}$	Input Power
$\mathbf{P_r}$	Return Power

- The flow chart of the return loss:

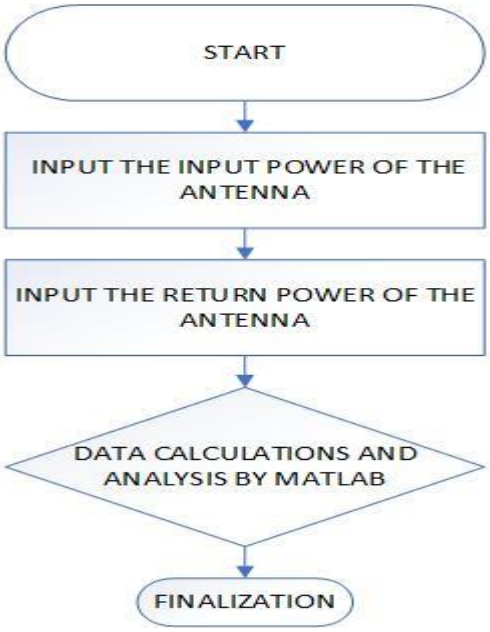

Figure 6. 3 Process flow of simulating the return loss.

6.1.1.4 Impedance of mimo antenna

Antenna impedance applies to the voltage at the antenna origin. The voltage is in line with the current, as the impedance is a real number. The impedance has a magnitude.

The phase of the antenna=$\mathbf{\tan^{-1}\left(\frac{Im(Z)}{Re(Z)}\right)}$

That is, in contrast to the voltage waveform the current waveform is overdue. To define it, if the voltage (with frequency f) is given in the antenna terminals, $\mathbf{V(t) = \cos(2\pi ft)}$

The electric current is, $\mathbf{I(t)} = \frac{\mathbf{1}}{\mathbf{magnitude}} \mathbf{cos}\left(\mathbf{2\pi ft} - \frac{\boldsymbol{\pi}}{\mathbf{180}}.\mathbf{45}\right)$

- Flow chart of impedance for the antenna:

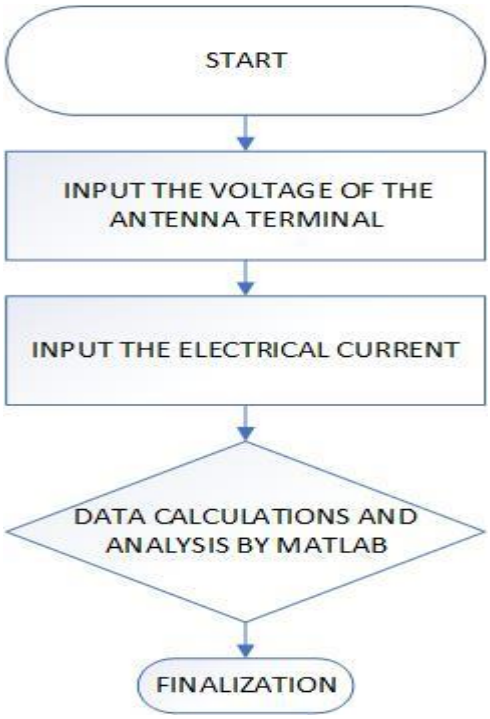

Figure 6. 4 Process flow identifying the impedance for the antenna

6.1.1.5 Gain of the MIMO antenna & SISO antenna

Power gains or simply gains from an antenna are a key performance figure, matching the orientation of the antenna with electric efficiency. Mimo antenna require 8kw power and require 7.5 Kw power. To finding the gain of an antenna then the equation is

$$\mathbf{G} = \frac{\mathbf{4\pi u_m}}{\mathbf{p_{in}}}$$

6.1.1.6 Efficiency of massive MIMO antenna & SISO antenna

The antenna output is a measure of the energy provided to the antenna compared to the antenna power. The bulk of the energy at the origin of the antenna is radiated by a high

efficiency antenna. A low-efficiency antenna loses most of its power as defects in the antenna or as a result of a defect in its impedance.

$$\varepsilon_r = \frac{P_{rad}}{P_{in}}$$

6.1.2 Power consumption by sleeping mode

The higher load in base station the higher power is need. When the load is high which means in the office time the necessary of the power is high but rest of the time except the office time the necessity of the power is less. But the base station remains active all time. For which reason the base station need power for running all time.

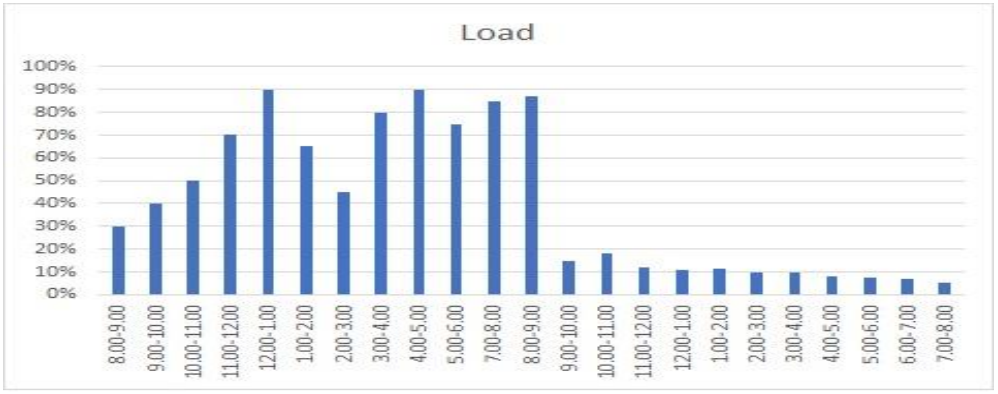

Figure 6. 5 Data traffic Statistics on hourly basis.

6.1.3 Power Delivery from Hybrid Model

In 5g for running one single base station need 192kw power for covering 200 $\mathbf{m^2}$.But there are so many small base stations also need for implement the 5g. And the all small base stations are also connected with the main base station. This is because 5g required high frequency data rate. And the frequency is related with the wavelength. Higher frequency demand short wavelength. The more often the duration becomes shorter. According to the vacuum movement of all light waves at the same time, the number of wave crests that reach a point in one second depends on the length of the wave. This figure, often called the

frequency, is bigger in the case of a short wave than for a long wave.Beacouse 5g only transmit data ,when the data traffic is high which means at the office hour the base station need huge power for running the base station but when the data traffic is low the power also needed for running the base station and data transmission. When data traffic is high can be on active mode but when the office hours end and the ratio of data traffic is low then it can go into sleeping mode respectively. From which base station can save the power.

6.1.3.1 The analysis of Hybrid power system

To analysis the hybrid power generation some data from the MSW collection and energy efficiency research or investigations in Bangladesh have subsequently been collected. A new model designed as a proposal for Bangladesh's new work. For calculating and simulating this paper, homer software had been used.

- Flow chart of hybrid power generation system

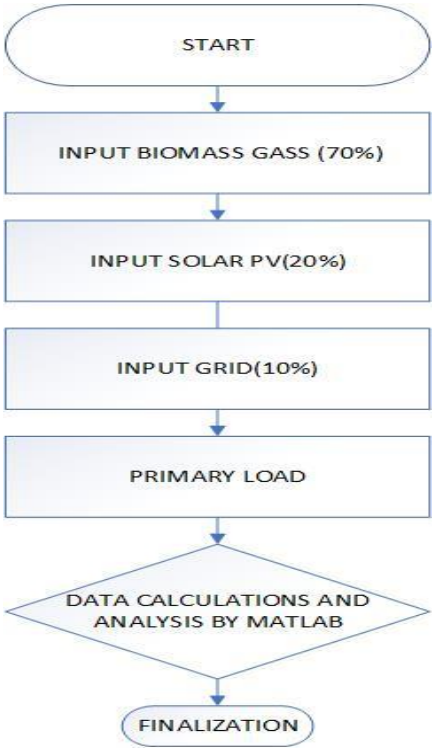

Figure 6.6 Flow diagram of the hybrid power generation system simulation.

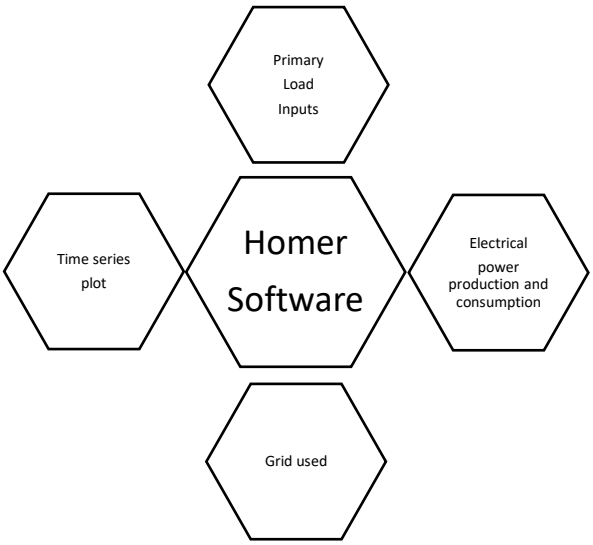

Figure 6. 7 Designing of hybrid power generation system

The power generation system is established for a small area where a base station can cover 200 $\mathbf{m^2}$.Where running one base station per day need 8kw power per hour. The HOMER representation of the11kw/h system of Hybrid System is given below:

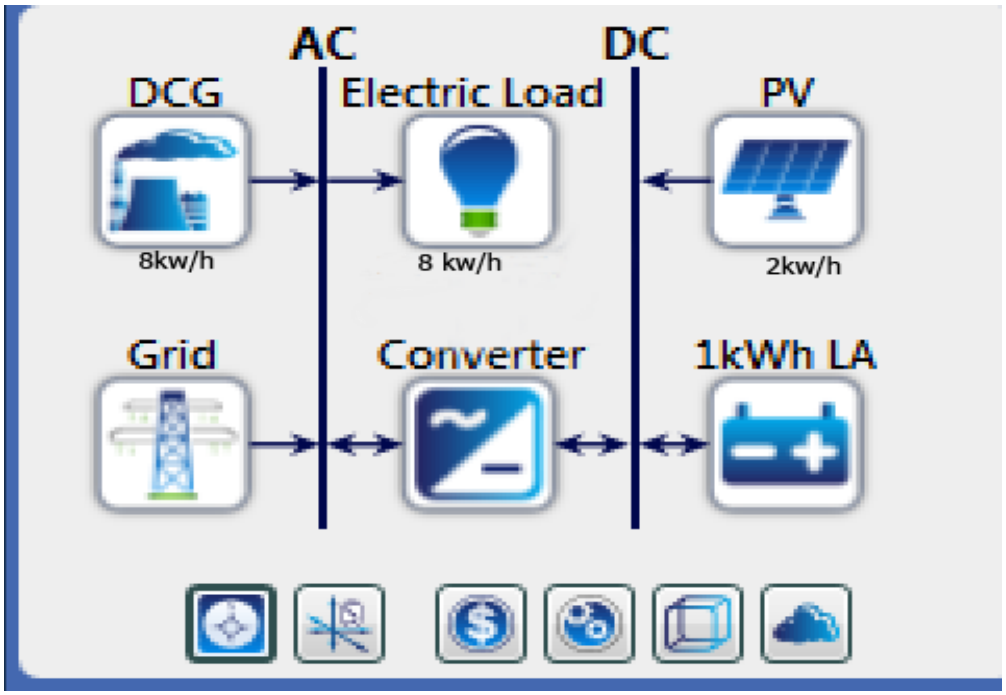

Figure 6. 8 HOMER Representation of Hybrid Power Generation System.

Table 6. 4 Perimeter of Hybrid Power Generation System**.**

Source	power
Biomass	8kw/h
Solar	2kw/h
Grid	1kw/h (for backup)

6.2 Results

6.2.1 Massive MIMO Antenna

The analysis result of several part of massive mimo antenna and the efficiency and gain of massive mimo antenna with the comparison with siso antenna are given this section**.**

6.2.1.1 Coverage of MIMO antenna

Here the height of the antenna is 30m and it can cover 200$\mathbf{m^2}$ minimum. From this coverage the downlink angle 0.8594-degree, coverage radius router 5.88 feet and inner coverage radius 5.487 feet can be found.

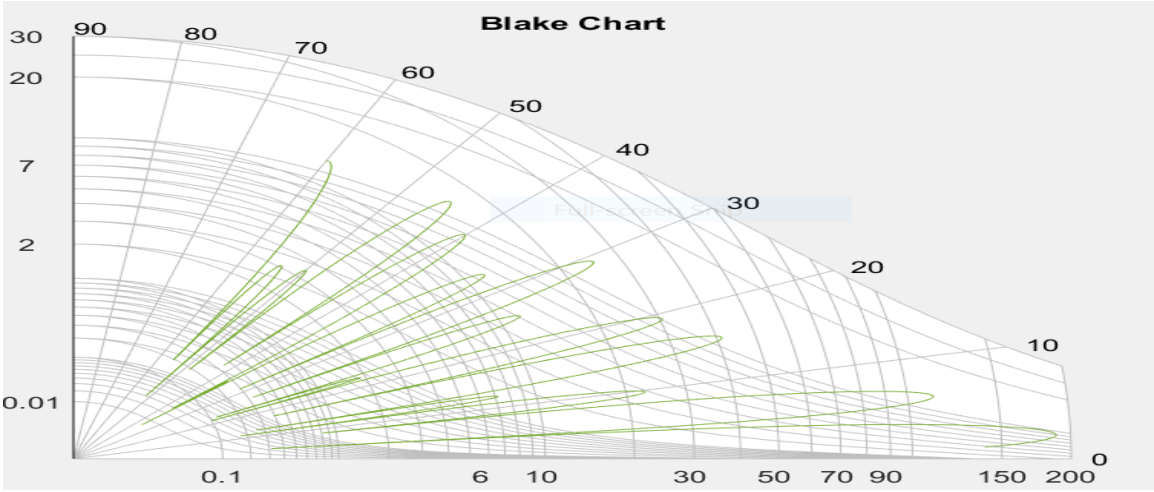

Figure 6. 9 Coverage area for MIMO antenna.

6.2.1.2 Beam-forming

The beamforming graph shows the point to point mimo ofdm system.

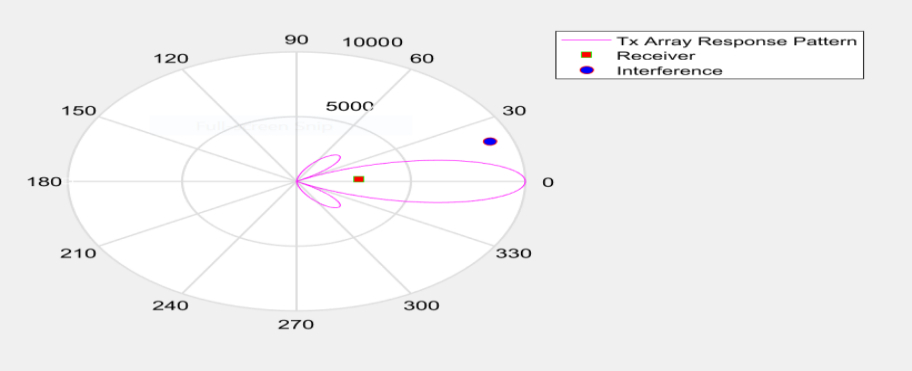

Figure 6. 10 Beamforming for MIMO antenna

6.2.1.3 Return loss

From the return loss analysis, we found the return loss in mimo antenna for 200 $\mathbf{m^2}$ is 6.02 db. Which means 25% refection and 75% power in antenna.

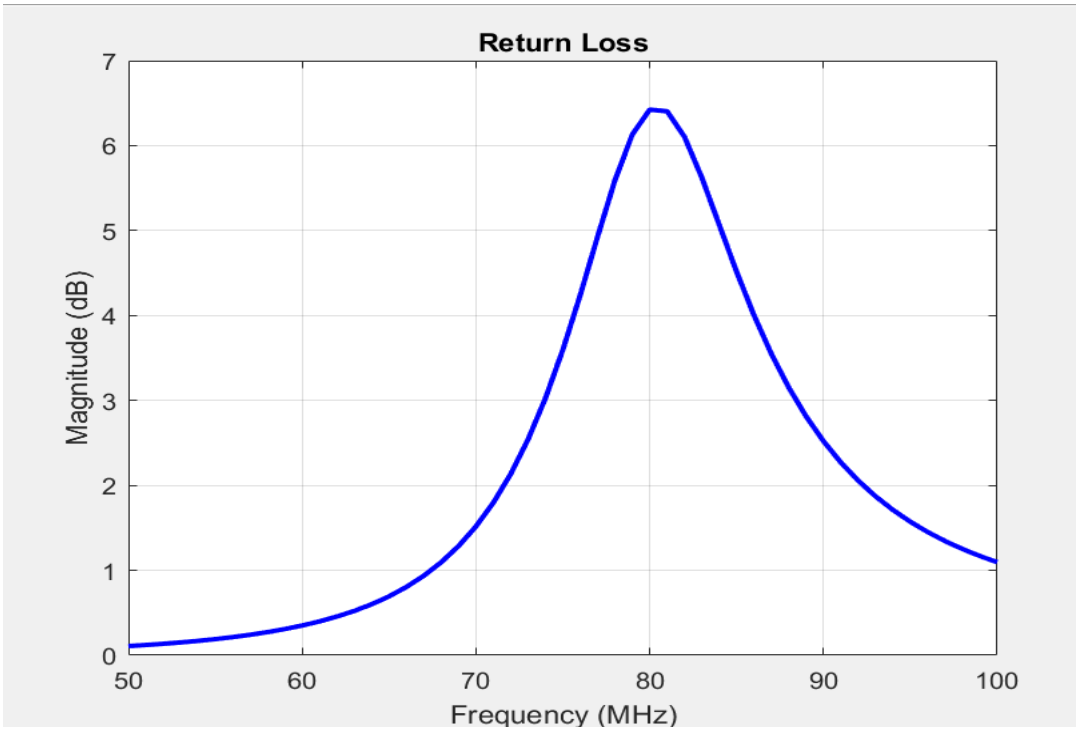

Figure 6. 11 Return Loss For Massive MIMO Antenna

The return loss of SISO antenna is approximate 15 dB and the MIMO antenna is 6.02 dB So, the return loss of MIMO antenna is less than the SISO antenna.

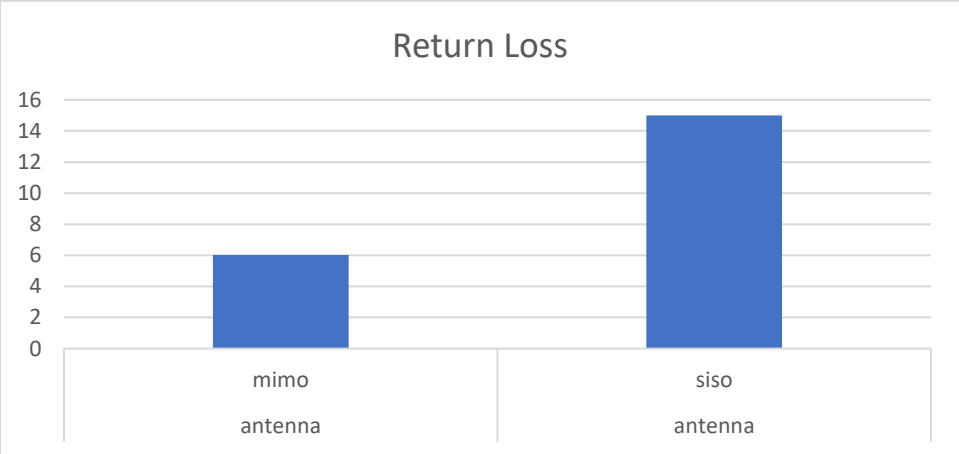

Figure 6. 12 Return loss of the mimo antenna vs siso antenna

6.2.1.4. Impedance

With distance from the antenna the impedance changes and shows contrary comportments for the dipole and the circuit. The dipole, the electric field's primary radiation source, shows a small distance from the radial ring, α/2μ while the magnetic dipoles that can be called a circle shows a limit in the impedance. The field underneath the radius sphere displays the first crossing over 377 meters. This crossover takes place very close to the system and the strong separation means that we are in receptive vicinity. The wave impedance for the dipole and the layer decreases and increases respectively beyond the radius sphere distance (β/2α). The impedance continues to converge towards the value of free space of μ=37 pounds. The wave impedance has not even converged at a distance from the antennas of 5 μ/2τ-1μ which means that it is still not far enough. The values of wave impedance are almost equal to 377 regulars at a distance of kα/2α=1 and higher. Beyond 10 λ, the wave impedance stabilizes and the region of space can be termed as the far-field for these antennas at the frequency of 1GHz.

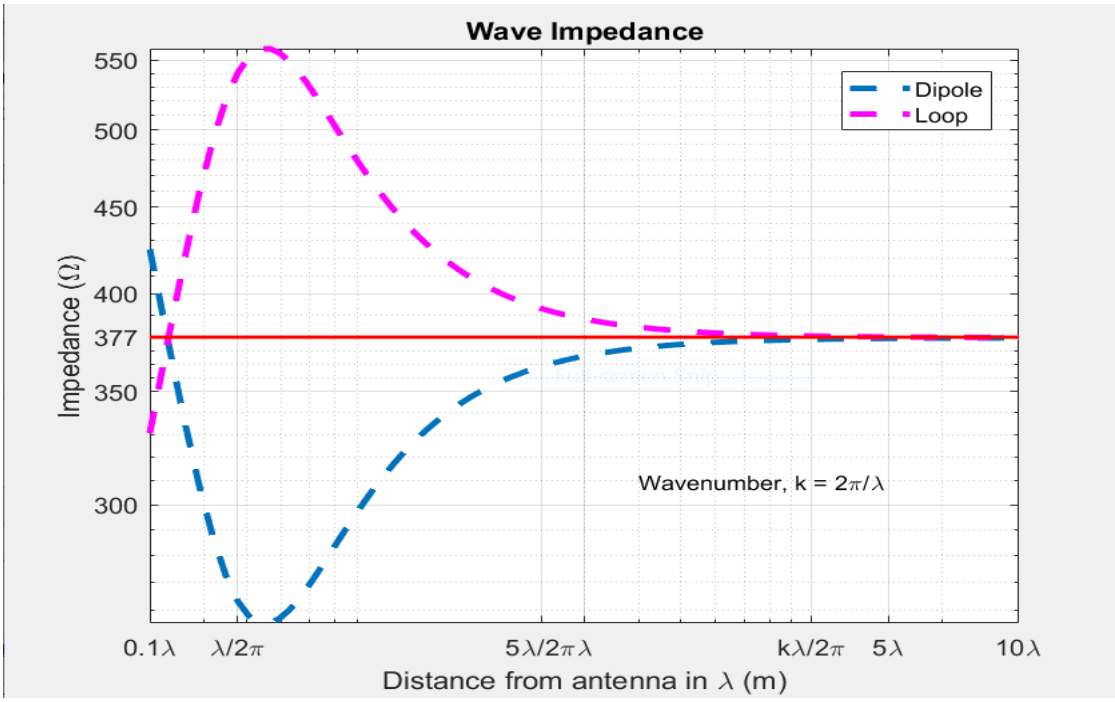

Figure 6. 13 Impedance For Massive MIMO Antenna

6.2.1.5 Gain of the massive mimo vs siso antenna

The gain of the massive mimo is 10.85 and the siso antenna is 9.25. And A more directional antenna than a low-gain one is a higher gain. So, mimo antenna is better than the siso antenna.

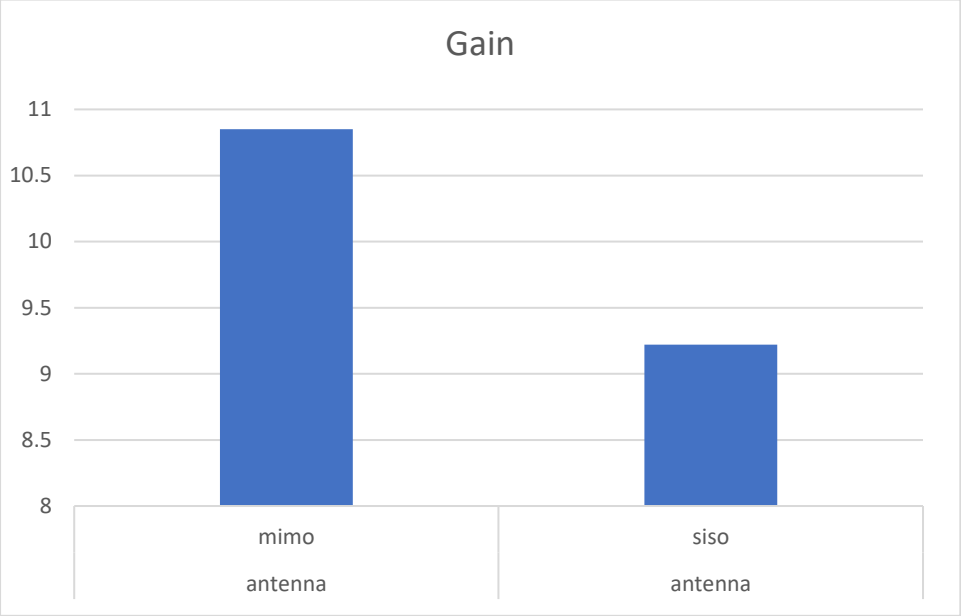

Figure 6. 14 Gain of the massive mimo vs siso antenna

6.2.1.6 Energy efficiency in massive mimo Vs siso antenna

The efficiency of massive mimo is 93.75% and the siso antenna is 75%. So, mimo antenna is more efficient than the siso antenna.

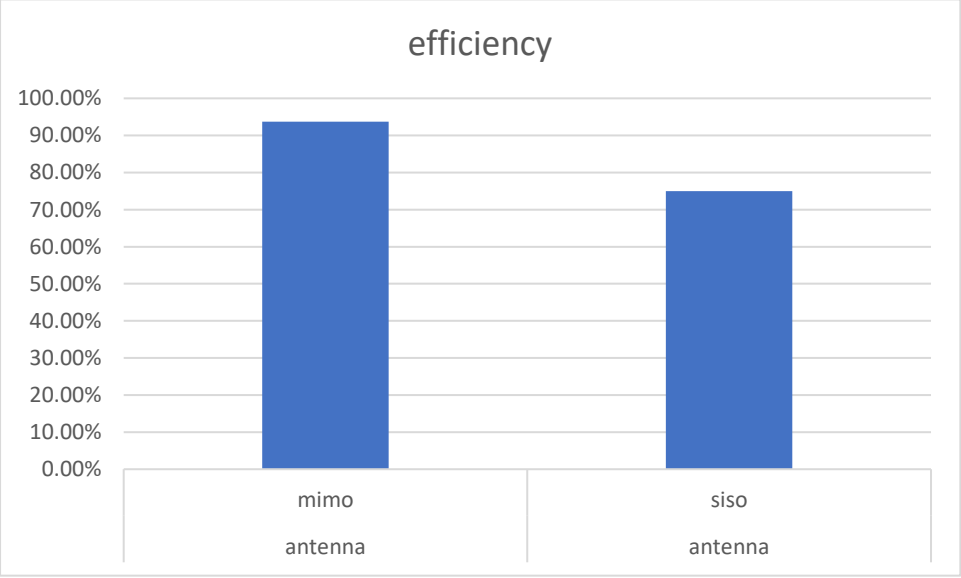

Figure 6. 15 Energy efficiency in massive mimo Vs siso antenna

6.2.2 Power consumption

When the base station goes into the sleep mode during the low power transmission time it used 60% of the power. If it remains active during the low power transmission time it need 100% of the delivery power. So, during sleeping time it can consume 40% of the power.

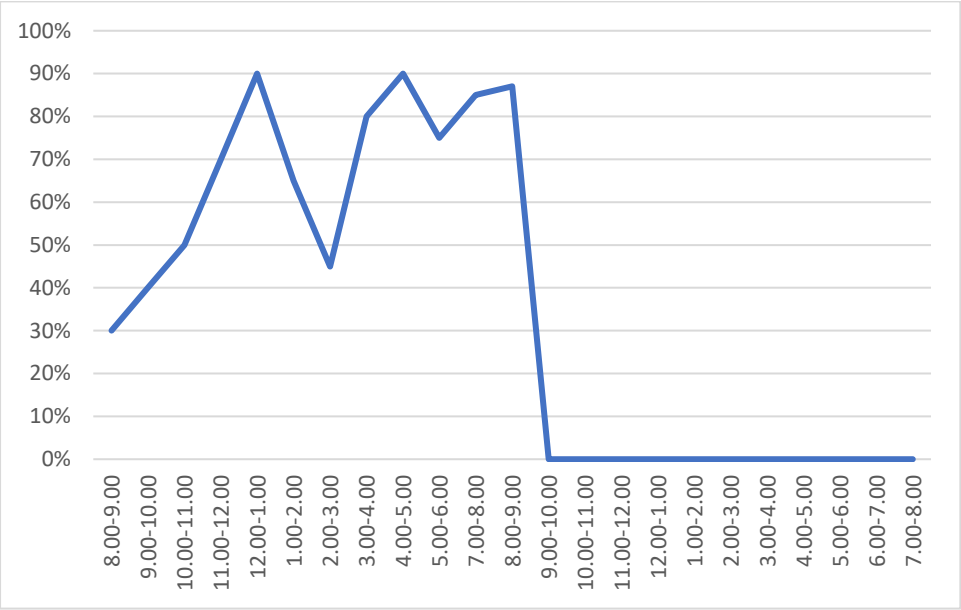

Figure 6. 16 Power Using When Sleeping Mode On

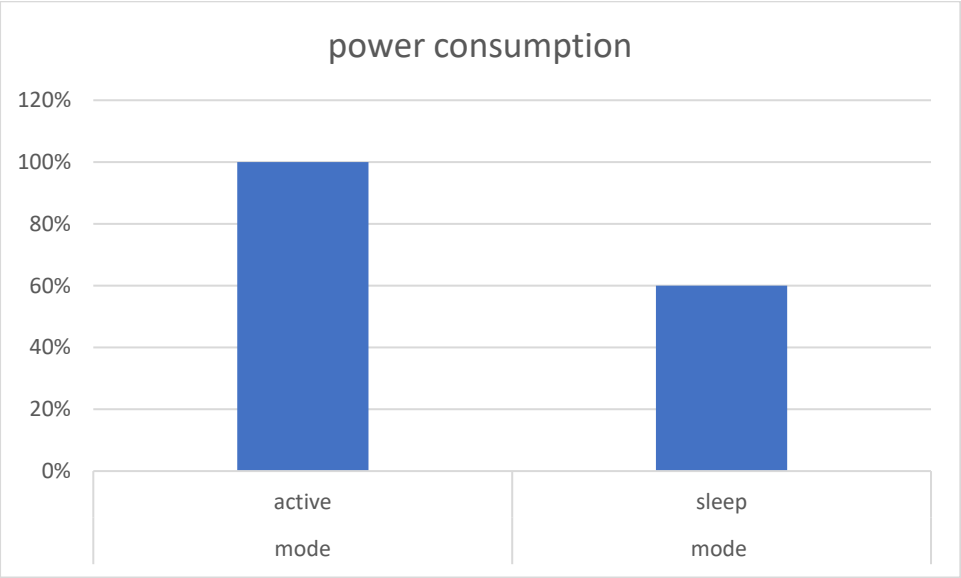

Figure 6. 17 Power consumption By Sleeping mode

6.2.3 Power delivery by hybrid power generation system

The variation of the hybrid power generation system per month has been shown in Figure 6.18 Per day for a base station which cover 200 $\boldsymbol{m^2}$ area need 11 kw power. So, monthly it needs 330 kw and yearly it need 3960 kw. But the necessity of the power is varied hourly. This is simulated by Humor software for 12-months power generation**.**

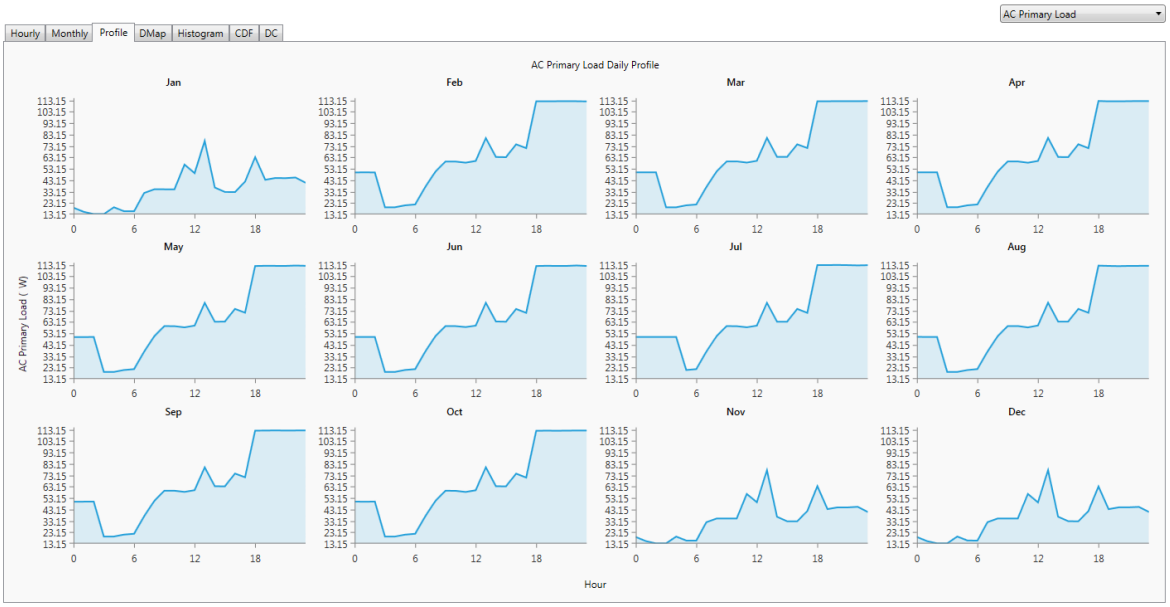

Figure 6. 18 Hourly Power Variation for 12 Months

Chapter 7

CONCLUSION

7.1 Conclusion

In the next generation networks, in this study we talked about the increasing need for power optimization. Showing the last decade old wireless networking and the necessity of greener connectivity for next generation mobile network. It has also been addressed the importance of choosing the correct EE metric. We developed a model about power optimization and power delivery system for 5g in smart city for developing country like Bangladesh.

The power optimization sector is mainly two part. One is about energy efficiency and the other one is about power consumption. For energy efficiency here we discuss about the massive mimo antenna for base station. And for power consumption we discuss about the sleeping mode technology. Because 5g transmit data only and it need high frequency for transmit the data so there is no need to implement 5g for covering the whole country. It will implement for the industrial area where the data traffic is high. And the data traffic is high at office hour mainly. When the office hour end if the base station goes to sleep mode, it can consume the power and then our old LTE mode will be active.

The power delivery system is based on hybrid power generation system which is include biomass, solar and the grid. This is because Bangladesh has a huge electricity problem. By developing the power generation model the pressure on the grid can reduce.

7.2 Limitation

Like most of the researchers this research also has limitations. One of the major limitations is the implementation of small cell technology under one base station. And the area measurement for the establishment of hybrid power generation system.

7.3 Scope of future researches:

1)The process of small cell implementation,

2)Area measurement for establishment of hybrid power generation system.

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