International Conference on Science, Technology, Engineering & Management [ICON-STEM'15]
Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115

Intelligent energy management for base transceiver stations (BTS) along with hybrid renewable energy resources

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ABSTRACT

This paper deals with effective power utilization in Wireless Network using Green Radio and supplying Base Transceiver Station with a Hybrid Renewable Energy system. The Hybrid energy setup of this paper consists of Solar and Wind Energies.Green radio is the concept of decreasing the number of communication towers as per the number of users using the strong wireless sensor network by keeping the tower in idle mode.It is anticipated that the Hybrid Renewable system along with Green Radio, will contribute to global environmental protection on wireless networks. This concept along with the smart grid technology helps us to supply power to the households near the BTS when the BTS is in OFF condition. Hybrid power generation system helps network tower in rural locations without much dependence on commercial power generation systems.

Keywords: hybrid renewable energy; green radio; solar energy; wind energy; grid technology; wireless network

INTRODUCTION

Today, the major problem faced by our nation is power deficit. Numerous power plants are commissioned all over the world with huge investments. But with the increasing demand, the upcoming projects when comes into operation does not supply the need. The demand can only be met by examining the areas where abundant power is wasted and it must be saved. One such area where power can be saved is the Wireless Network Communication. Information and Communication Technology is crucial to a country's socio-economic growth. It is one of the main architect of the accelerated growth and progress of different segments of the economy. Increasing connectivity is highly instrumental in improving governance, Business Communication, Security and response to emergencies and in overall strengthening of the socio-cultural ethos of the country. India is witnessing a phenomenal growth in the telecom sector for the past many years with average monthly addition of 15-18 million subscribers. The teledensity, which was less than 3 % a decade ago, has increased to 73.11 %. As per TRAI, India has 840.28 million wireless subscribers out of a total telephone subscriber base of 874.68 million, as on 31st May, 2011. We have 12.12 million subscribers in wireless networks. Remote areas of the country that have no roads, grid-electricity, landline telephones or gas still receive network from one or more telecom companies. However, the Base Transceiver Station (BTS) that these companies used in Off-grid areas are dependent on on-sight diesel generator and the frequent maintenance refueling that this entails.

CURRENT SENARIO

The mobile towers are always found to be in active mode (24x7) which results in higher rate of energy consumption throughout its usage. (Chowdhury S.A and Aziz S, 2012) Base Transceiver Stations (BTS) consumes around 2% of the total power production in India and this 2% is consumed by only 30% of the towers which are connected to grid.

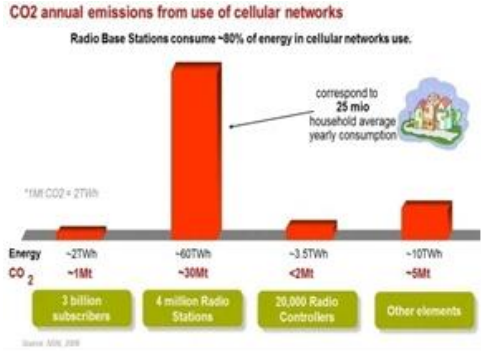


Fig.1. CO_2 emission from use of cellular networks

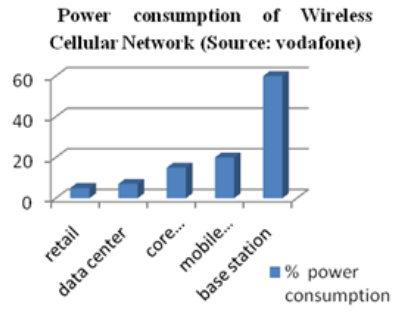


Fig.2.Example for power consumption of wireless cellular networks

Tower companies in India consume ~2 billion liters of diesel which is around 3.5% of total diesel consumption in India, next only to Railways. It is estimated that over 1.7 million tons of CO_2 are released into the atmosphere by more than3, 00,000mobile towers located across the country. 70 % of these towers are in rural areas i.e. off grid area.

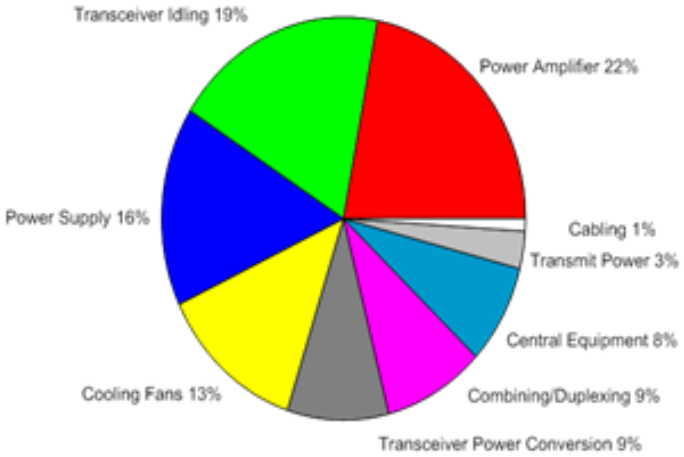


Fig.3.Depiction of 60% power consumption from Base station

Tower companies also have to incur expenses related to security of the cell site due to pilferage of diesel which is as high as 15-20% of total diesel consumption by tower companies. Apart from this, these generators entail transportation and storage of diesel which is a major problem in remote and hilly areas.

HYBRID RENEWABLE ENERGY

The capital cost of hybrid renewable powered system for a BTS is 50% more than one using diesel. However, if we use 9% cost of capital the renewable power system will recover the invested capital in less than six years. According to the reports by World's Resource institute, the benefit of using renewable energy solution can be measured in terms of cost factor and risk management. Switching to renewable energy is the way a corporation can signal to shareholders and institutional investors that it is mitigating climate related risk. Major corporations like Johnson and Johnson, FedEx, General Motors (GM) to name a few, now are obtaining their electricity from renewable sources including solar and wind.

GREEN RADIO

There are also other equipments in a BTS whose time of operation can be controlled for power consumption. They are Blowers, Fans, Air Conditioners, and Light Indicator. The parameters such as Temperature, Humidity and light intensity are sensed with the help of sensors such as Thermistors and LDR's. If the humidity in the air rises above a certain limit or if the temperature drops to a lower value then the air conditioners will be switched off and the blowers will come into operation to make use of the humid air for cooling. Similarly the light indicators which are used only at nights can be switched off at day time with the help of data obtained from a light sensor. All the inputs from the sensors will be processed by a PIC microcontroller and the output of the controller will be used to drive the switching circuits. This method of controlling the air conditioning and other devices helps in reducing the emission of greenhouse gases into the atmosphere.

EFFECTIVE ENERGY UTILIZATION

There are many existing hybrid Renewable Energy projects but this project differs in the following aspects. (K. Bumman et al 2010) In our system the BTS will be equipped with Hybrid Renewable Energy (Solar-Wind) System, a Diesel Generator, and Battery Bank, Green Radio logic circuits and other usual components found in a common BTS. The main aim of this project is 100% power utilization. Different cases arises in BTS and in each and every case we make sure that not even a single watt of power gets wasted. The cases are as follows

Case 1:

BTS State: **ON, Connected to GRID**

Sources: Solar, Wind, Battery, Grid power.

If power from the hybrid setup is sufficient then BTS will only use this power. If the Renewable sources are not sufficient (such as unavailability of solar energy during night time or at low wind speeds) then the BTS will use power from the grid and from its Battery bank for its operation.

Case 2:

BTS State: **ON, OFF GRID**

Sources: Solar, Wind, Diesel Generator, Battery.

The BTS will use the Renewable Energy sources if sufficient power is obtained else it first uses the power from its Battery and then the Diesel Generator is switched on to get the remaining power apart from the power from Renewable setup.

Fig.4. Example for power utilization using grid

Case 3:

BTS State: **IDLE Mode**

Sources: Solar, Wind, Battery.

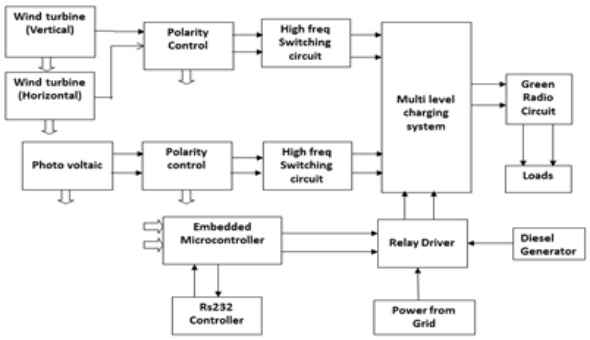
Now the BTS is in idle mode and the power from the solar-wind setup is used to recharge the battery. Once the battery is fully charged then the power will flow through the Micro Grid which is connected to the Domestic and Commercial loads nearer to the BTS. Of course, the power from the renewable setup will not be sufficient and hence grid power will be combined along with this power and it will be supplied to the nearest Domestic and Commercial loads and thus contributing to nations power production.

ARCHITECTURE

Hybrid Renewable Energy Setup: In this system photo voltaic panels and dual model wind turbines are used. The AC output of the wind turbines will be rectified to DC using a rectifier. The rectified output of the wind turbines is then combined with the output of photo voltaic and it is used to charge the battery bank through a polarity control bank and a high frequency switching circuit.

The polarity control provided at the output of the wind and solar energy setups helps to prevent the back flow of current from the battery to wind turbines to prevent motoring action and also to solar panels.

Journal of Chemical and Pharmaceutical Sciences ISSN: 0974-2115



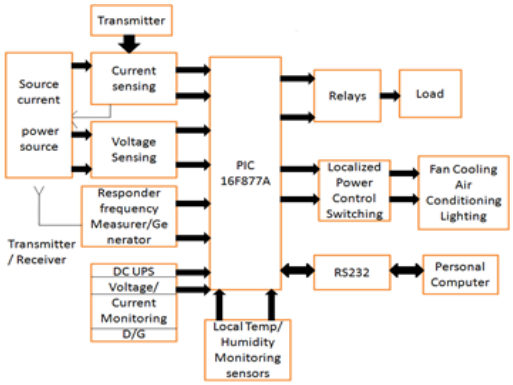


Fig.5. Block Diagram of Hybrid Renewable System

Fig.6. Block Diagram of Green Radio

EXPERIMENTAL RESULTS

Hybrid Renewable Energy: The results for the Hybrid renewable energy setup is simulated by using Matlab. Parameters such as voltage and current of the setup are depicted in the figure. The rating of the setup is taken as 3kw for simulation with a voltage of 380V and current of 7.6A.

Fig.7.Simulation of Hybrid Renewable Energy- Current

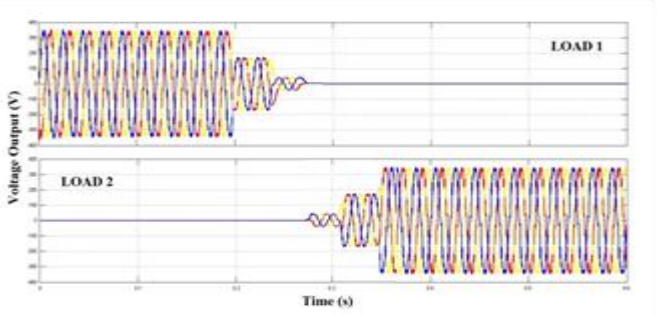


Fig.8.Simulation of Hybrid Renewable Energy- Output Voltage

The results are simulated using normal electrical relay with step signal so the output for load 1 will fall to zero in step value and the output of the load 2 will rise in step value. The load used is resistive load. The inverter is controlled using sinusoidal pwm.

Green Radio: The simulation results for the green radio are done with Microsoft Visual Basic 6.0. The switching of different BTS is based on the user frequency is shown.

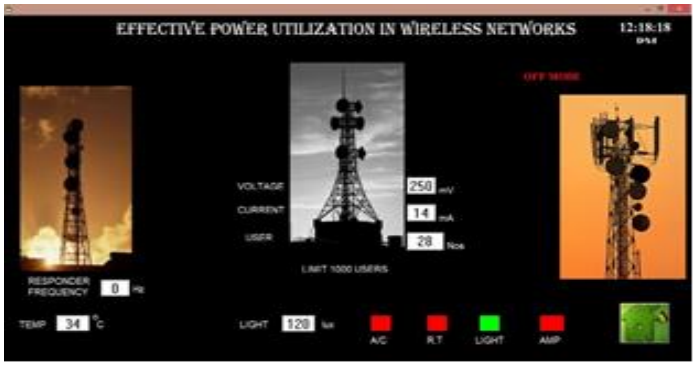


Fig.9.Simulation output for Green Radio-I

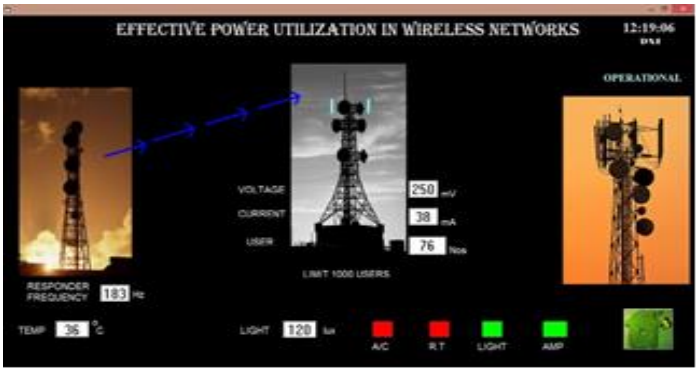


Fig. 10. .Simulation output for Green Radio-II

Let us assume that user limit for the first BTS be 100. When the no of users exceed 100 responder frequency will be sent from the first BTS to the second one which drives the BTS from IDLE to ON state.

Similarly, alternative towers will be switched ON from the IDLE mode once it receives responder frequency from the previous BTS which reaches its user frequency limit.

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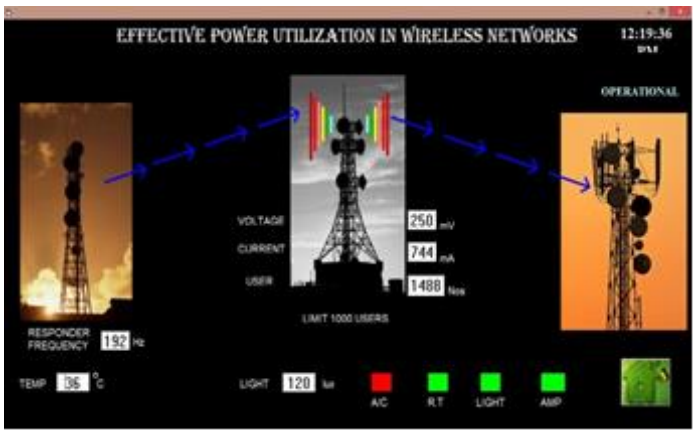

Fig.11.Simulation output for Green Radio-III

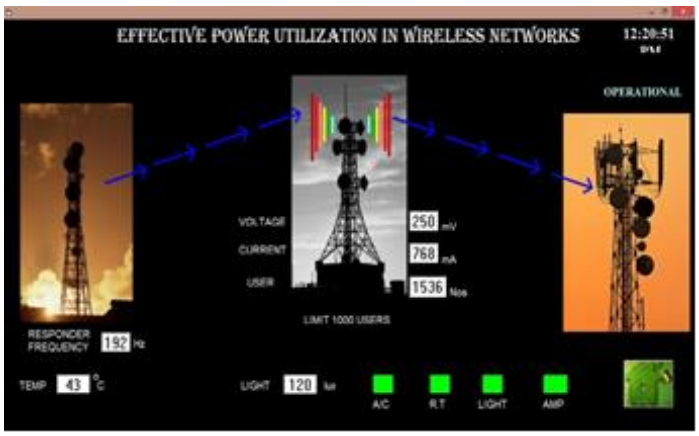

Fig 12.Simulation output for Green Radio-IV

The smart usage of Air Conditioners, Blowers and lights based ontemperature,humidity and light intensity are also simulated.

CONCLUSION

This project implementation leads to very innovative and interesting results, which contribute a lot to the environment globally. This reduction can create wonders in contributing to the world's environment. Along with this government should provide sufficient funds and pose strict act in implementation of renewable energy. On the long run the investments can be achieved by approx.5 years. So the BTS tower companies should be analyzing regarding the above concepts even though the investments are high.

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