Renewable Energy Solution using Solar-DG Hybrid Power Generation for Telecommunication Base Station (BTS)

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Abstract - Energy is a dominant cost component for telecom companies. The energy consumption is mainly for operating the Base Transceiver Station(BTS) or simply mobile towers. The sector now requires 14 billion units of electricity annually. This is projected to grow to over 26 billion units in 2012.The gap between the demand of the customers connected to the grid and the available electricity is 10% of most of the mobile towers are in the rural sector, where continuous supply of grid connected electricity is not available. Moving further 25 % of these towers are located in areas with no grid connectivity. Electricity availability in a day ranges from about 7 to 21 hrs. across the major telecom circles in India. To curb this menace, the telecom companies keep a backup power source. The backup power source will be a 15-25kva 40kva diesel generator. Energy expenses constitute one third of total OPEX costs for telecom towers. Each tower consumes an average of 4000 liters of diesel every year. A telecom operator should have to spend Rs 3 billion every month for running this generator. By using the diesel generator, the telecom sector is responsible for over 6 million tons of CO2 emissions annually. In this paper we present how, we can use solar-DG hybrid system to generate power to supply telecom network to overcome Diesel uses in rural areas.

Keywords - power; energy; base station; measurement; modelling; traffic; consumption; network; wireless; mobile.

1. INTRODUCTION

In the last decade, the attention for environment-friendly solutions has drastically increased. Especially due to the debate concerning climate change every emerging technology scurrilously evaluated on its carbon footprint. This is also the case for information and communication technologies (ICT). It is estimated that ICT is accountable for 2 –4% of the worldwide carbon emissions. The power consumption during the use phase of the equipment accounts for roughly 40 –60% of the carbon emissions. By 2020 these emissions are expected to double if no initiatives are taken to reduce this footprint.

A significant part of these emissions, about one sixth, is attributed to telecommunication networks [1]. Worldwide, the growth rate of internet users is about 20% per year. In developing countries this growth rate is closer to 40 – 50%. Thus, the share of greenfield deployments in telecommunication networks will be significant. Therefore, emerging technologies need to be evaluated on their environmental impact. Also, ICT is being regarded as a solution with the potential to eliminate about 15% of the global carbon footprint [2]. If the sector wishes to realize its ambitions, it will also need to demonstrate it can reduce its own footprint.

India is a land of opportunity with vast investments in telecom sector but the challenges faced in this sector with respect to power supplies are quite unique and unavoidable.

What energy challenges are we dealing with

- High energy related OPEX due to long DG running hours (8-10 hrs in rural)
- Higher Fuel Costs also due to increasing fuel transportation costs, pilferage, theft
- Indoor BTS require cooling that consumes 50% of power at tower
- While operator goes rural, the grid power availability remains very poor64%
- Difficulties in measuring actual power consumption
- Most of direct/indirect sources of power are carbon emitting
- Considerable CAPEX required to invest in alternate energy solutions

Most of the power supplies in the existing mobile tower sites are equipped with the Alternating Current (AC) mains based Switch Mode Power Supply (SMPS) and Diesel Generator (DG) set to charge the battery bank and cater to the telecom load. This results in a higher capital expenses (CAPEX) investments. The Operational Expenditure (OPEX) which includes the monthly costs of running and maintaining the telecom equipment including power supplies is primarily high because of dependency on grid electricity and diesel cost., Presently in urban areas, 40% power requirements are met by grid electricity and 60% by diesel generators [2], however, the situation is even worst in rural areas, where around 87% is met by DG. On an average, 70 percent of the approximately 400,000 mobile towers in India (mostly in rural areas) face electrical grid outages more than 8 hours a day [1]. The subsequent rise in the price of diesel in India has increased from INR 32.87/liter in 2009 to INR 60/liter in 2016 [1] resulting in

increased OPEX cost year after year. Solar energy is the most common and affordable renewable energy. India has clear sunny weather about 250 days to 300 days in year. The average solar insolation incident over India is about 5.5 kWh/m2 per day [3]. There has been many Hence, a hybrid solar power supply system is being proposed in this paper, where the benefits and drawbacks of a standalone grid as well as a solar charger system are combined to provide an optimum power generation solution. To reduce the down time of such a hybrid power supply, it should be remotely monitored and managed.

The need for a Hybrid System

As during grid or mains unavailability, we need to shift to these sources of alternative power generation to keep our businesses moving

Diesel generators are the handiest and readily available option till now but present problems with

- High operating expenses
- Rising diesel costs
- High maintenance costs and turning completely to Solar PV system cannot ensure reliability on rainy or cloudy days

Proposed Solution- Hybrid System

With benefits of cheaper PV electricity and reliable DG set generated electricity We integrate both the Solar PV and existing diesel set with the help of a PROGRAMMABLE LOGIC CIRCUIT to ensure the most economic, reliable and uninterrupted power supply. So that your business does not lose.

Solar PV – DG set HYBRID SYSTEM

- Pure diesel generator system consumes too much fuel and price of diesel is subject to increments
- DG needs frequent replacement and maintenance
- Pure solar system requires much larger initial investment
- Pure solar system lack reliability when facing long periods of rainy days

DEMERITS of DG based power solution.

- Pollution, Smoke, noise, Heat.
- Dependence on fuel world-wide increase of oil prices; limited resources in future
- Transportation to the sites long distances and cost intensive transports
- Storage of the fuel at site safety problems - explosions, vandalism
- No unattended operation is possible high personnel cost
- High maintenance cost and limited life-time of DG

Hybrid Renewable Energy Systems

On the other hand, the proposed renewable energy based system helps in:

- Decrease environmental pollution Reduction of air emission
- Energy saving Reduces production and purchase of fossil fuels
- Abatement of global warming CO2 and other greenhouse gases are not produced
- Socioeconomic development Develops employment opportunities in rural areas
- Fuel supply diversity of energy carriers and suppliers
- Distributed power generation Reduces requirement for transmission lines within the electricity grid

2. SYSTEM MODEL

A Hybrid energy system combine Solar PV and Diesel power generation systems that when integrated, overcome limitation in either of the systems. The main reason integrating renewable energy sources in a hybrid system is primarily to save expenditure on diesel. Hybrid system can be configured in three different ways:

- Grid connected off-grid with distribution system and for direct supply. The first configuration is able to rely on grid if the hybrid system has problems. Similarly feeding the power to the grid, thereby, boosting the voltage and minimizing power cuts strengthens the grid.
- For off-grid configurations, the hybrid can either be connected to many load centers or can act as a source of supply for one or two loads, thus avoiding the need of a distribution system.
- An isolated off-grid system is usually used to charge batteries or supply power to small rural industry/households.

3. PREVIOUS WORK

[5] P. S. Tiwari,

Any power system, however complex, may be modeled by means of analogue theory as an interconnected network of

active and passive nodes with communication links in a manner to engender desired performance objectives. A Network Management System could be envisaged for monitoring and control of such a power system network. To predict the performance, quality and reliability for such an interconnected power engineering system, it is possible to generate a simulation model and have a detailed study of the outcome. The present paper indicates the steps required to carry out the above process for ascertaining the quality and performance of the system.

[6] D. Kumar and A. S. Patil,

Author(s) have studied hybrid system having Genest, Grid and Battery Bank, for a typical Indian Telecom industry scenario. It has been found that such a system has very attractive payback period under certain optimized conditions. The paper also explains various challenges and opportunities for solar PV based hybrid systems in Indian Telecom sector.

[7] I.Nedyalkov, D. Arnaudov, N. Hinov and H. Kanchev

In this paper photovoltaic power supplying system for telecommunication equipment has been modelled. The power supplied equipment can be radio communication equipment, active equipment for optic networks and other. The model is developed in LabView. The chosen capacities of the energy storage elements (ESE) can be determined by using the developed model. The proposed model can be used to determine if the capacity of the ESE is enough or not.

[8] M. Mraovic, N. Gospic and V. Milosevic [4],

this paper presents a short survey of general principles and approaches in telecommunication networks management from viewpoint of application on telecommunication system used by Electric Power Transmission Company (EPS). EPS's optical telecommunication network, represents complex, branched, ring structured network, realized by high capacity OPGW technology, with total lenght around 3.000 km, which critical services require exceptional availability of links. Also, this complex network demands efficient management and monitoring system. Regarding special aspects that need to be considered when management system is projected, the paper treats analysis of available management organization options and discusses possibility for appropriate applications on concrete situation.

[9] Yoshihiro Goto, Tadao Ishiguro, Masaki Kiya [5],

An integrated system that manages and remotely monitors telecommunications power plants has been developed and has started operations. The system is used to operate and maintain more than 200,000 telecommunication power plants, including devices such as rectifiers, inverters, and UPSs, and air-conditioning plants installed in about 8,000 telecommunication buildings. Features of the system are the integration of management and remote monitoring functions into one system and improved user interfaces, which use information and communication technology such as Web technology. Adapting the entire center system to a DC power supply and introducing mutual substituting function have made the system even more reliable.

[10] E. Ribeiro, A. J. M. Cardoso and C. Boccaletti [11],

Telecommunications networks optimization (in order to minimize the number of network units) and possibilities of energy sources for such systems using renewable energy generators complying with environmental concerns is thoroughly studied. Drawbacks related to their intermittence and unpredictable nature and the subsequent need for oversizing, leading to a high initial cost is analyzed. Energy storage system and the energy management strategy for system sizing and cost is presented in the paper.

4. PROPOSED METHODOLOGY

This paper presentation I did a case study and assumes an outdoor site with 3 kW load and with 8 hours of grid power outage per day on average.

Table-1: Case scenario

Case scenario		
Site Type		Outdoor
Site Load	kW	3
Grid Power Availability	hrs/day	16
Output Power Requirement	kWhr/day	24
Battery Output Voltage	volt	48

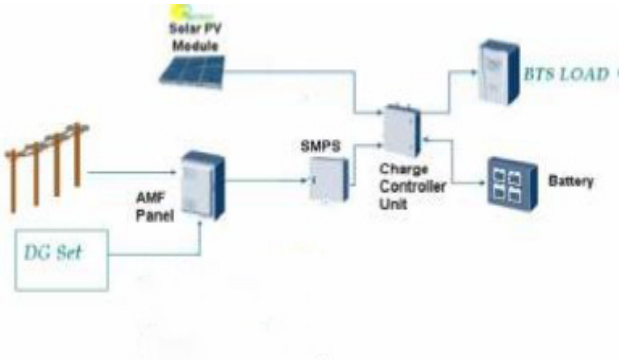

Fig.1 Solar Present, Grid available Battery Charged through MPPT charge + main Load supplied through Grid

The site requires 8 hours or 24 kWh/day equivalent of back-up power.

To meet the site off grid energy requirement of 24kWhr/day, the solar photovoltaic solution should can provide 33kWhr/day.

Assuming average of 4 hours of sunshine per day, an 8kW solar photovoltaic system will need to be installed. It is assumed that, the 8 hours of outage can occur during sunshine availability hours or during non-availability hours.

Considering average standard sunshine of 4 hours and 30% depth of battery discharge per day, a battery capacity of 1720 Ah @ 48 volt will be required. As per energy

Table-1: SPV solution

SPV solution		
Avg. Sunshine availability	hrs/per day	4
1 Kwp SPV Panel generates	KWh/day	4
Efficiency Loss Charge		
controller efficiency	%	90
Loss due to Dust	%	95
Battery Effiency	%	85

It is to be noted here that the system life of a solar photovoltaic system is estimated to be 20 years and that of the battery is 3 years.

Table-4: Various power availability scenarios and corresponding Genset run hours

Solar	EB (Hrs)	DG (hrs)	Diesel (Consumption /day)	Payback (Period)
NO	NO	12 hrs	40.13 ltr	---
NO	4 hrs	8 hrs	29.27 ltr	---
YES	NO	7.5 hrs	27.59 ltr	< 3yrs
YES	4 hrs	4 hrs	13.96 ltr	<3yrs
YES	6 hrs	1.5 hrs	6.3 ltr	---
YES	8 hrs	0	0 ltr	---

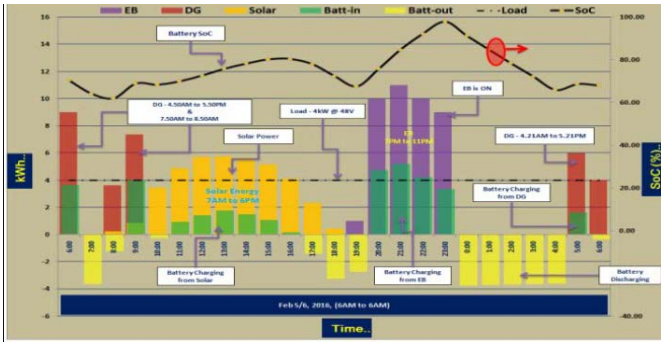

Fig 2 System profiling for single day with 4 hrs of grid availability

5. CONCLUSION

After analyzing all the system models, PV and Grid connected system is found to be more economical with lowest cost of energy of Rs 8.84/kWh. At present time the cost of energy for the grid connected system is Rs 8.84/kWh, which is expected to increase with time. At the same time the CO2 emissions are maximum for the grid connected system which can be reduced by adding the PV with the grid connected system without much influence in the cost of energy. By adding the alternative sources, we can overcome the scheduled power cut too.

6. FUTURE SCOPES

Instead issues like improvement of life of people living in rural areas, the future situation regarding fossil fuel sources, development of clean energy, role of a standalone hybrid system in protecting the environment from degradation, and its contribution to the reduction of pollutant emissions into the environment should be taken into account.

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The site requires 8 hours o

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