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TECHNO ECONOMIC ANALYSIS OF ALTERNATE ENERGY OPTIONS FOR MOBILE TELECOM SITES

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Abstract: The wireless telecom network is growing at an exponential rate. Due to heavy cost of energy consumption; high carbon footprint of mobile communication infrastructure, need is being felt to use the renewable energy sources to power the mobile telecom sites. The critical component of wireless telecom network is telecom towers. Generally at telecom tower site, infrastructure is being shared by multiple operators (telecom service providers). Typically, a telecom tower site has active and passive infrastructure components. Fig. 1 shows a typical telecom tower site.

Key Words : Electromagnetic Waves, Reflection, Refraction, Transmittivity, Reflectivity.

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The critical component of wireless telecom network is telecom towers. Generally at telecom tower site, infrastructure is being shared by multiple operators (telecom service providers). Typically, a telecom tower site has active and passive infrastructure components. Fig. 1 shows a typical telecom tower site.

Active components include the antennae, base transceivers, feeder cables and microwave radio equipments. Base Transceiver Stations (BTS) are most important part of active components of mobile telecom infrastructure. They are needed to communicate with the handsets of the subscribers. Every BTS covers a geographical area or cell and connects all users who are located in the cell to the wireless network. The size of these cells depends on operating frequencies and geographical conditions. Many cells with a small size are found in cities, whereas only a few cells covering large areas are found in non-urban zones.

The passive mobile telecom infrastructure components include the underlying land, tower, shelter, air conditioning equipment (AC), diesel generator (DG), battery, electrical supply, technical premises etc. Generally, telecom operators share the passive infrastructures like tower, DG Set, Grid power etc.

The electrical energy is required for operation of the telecom towers and due to uncertainty of availability of grid electricity and long power interruptions diesel generators are used.

The power demand of a telecom tower is determined by the configuration of number of Base Transceiver Stations (BTS) in the cell tower. The telecom towers consume the largest amount of energy of the mobile telecom network.

A schematic figure of power supply arrangement at telecom tower is given in figure 2. The power from grid is supplied to a Power Interface Unit (PIU). The function of PIU is to check and select the best phase of the three phase grid to feed the Switched Mode Power Supply (SMPS).Air conditioners and other auxiliary load is fed from AC supply from grid. The function of SMPS is to covert 230 V AC to -48 V to power the BTS and other telecom equipments as well as charging the stand by batteries. In case of interruption of grid supply PIU sends a signal to the diesel generator. The diesel generator starts and supplements the power. During the transition period of change of supply from grid to DG set and in case of problem with DG set, the stand by batteries provide the power to the telecom equipment to ensure uninterrupted operation . Each operator has its own SMPS and battery set.

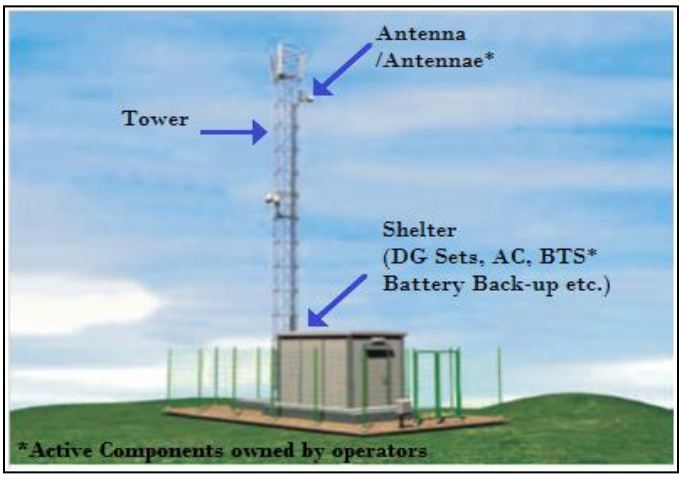

Fig.1: A Typical Telecom Tower Site

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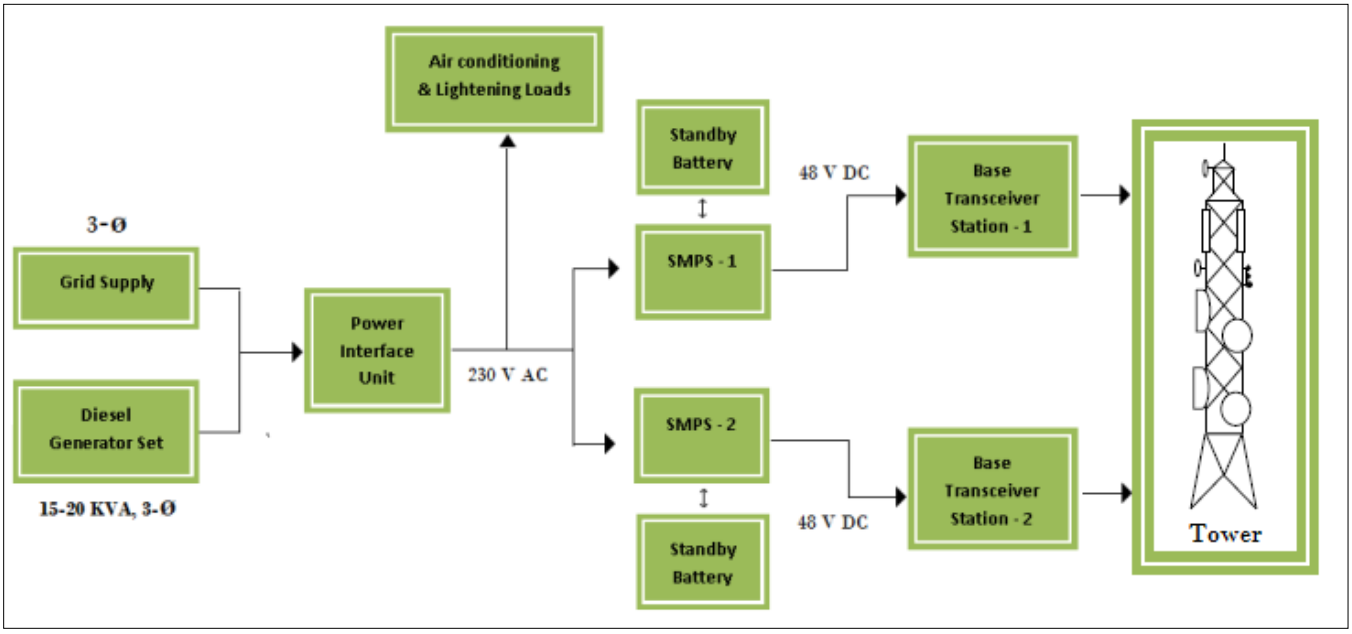

Fig. 2: Schematic Power Supply Arrangement at Telecom Tower Sites

The BTS consumes 50% of overall power consumed in wireless networks. The electrical load of BTS depends on the configuration. Generally BTS of 2/2/2 configuration are used at rural sites while at urban sites BTS of 6/6/6 configuration are used. The electrical load of various configurations of BTS is shown in table 1.

Table 1: Electrical Load Detail of BTS

Type of Base Transceiver Station (BTS)	Average Electrical Load
GSM base station (2/2/2 Configuration)	1.3 kW
GSM base station (4/4/4 Configuration)	2.5 kW
Macro/fiber–4/4/4 base station	1.3–1.7kW
Large WiMaxi base station	1.3–1.6kW
GSM base station (6/6/6)	3.5kW

As BTS sites have become more energy efficient it is more economically and technically feasible to use the alternative energy sources.

TRAI (2011) has identified the following alternative energy solutions that can be used singly or in combination at BTS sites in India:

A. Solar energy
B. Wind energy
C. Biomass energy
D. Fuel cell energy

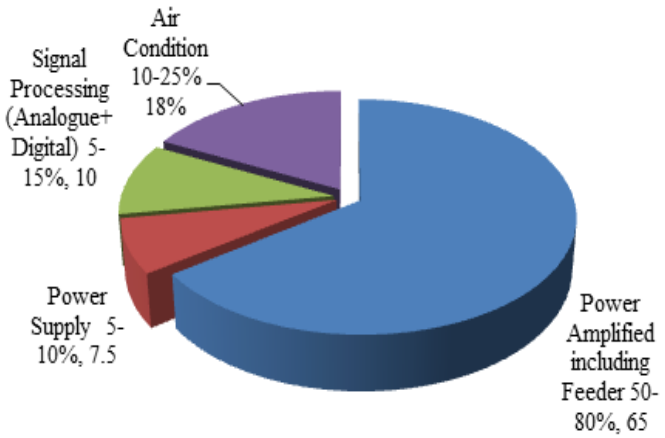

Fig. 3: Breakup of Power Consumption at BTS Sites

Table 2 illustrates the comparative features of these renewable energy options to power the mobile telecom sites.

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Table 2: Comparative Analysis of Alternative Energy Options for Mobile Telecom Sites

Energy source	Solar Energy	Wind Energy	Biomass	Fuel Cell
Principle of Operation	Photovoltaic energy generating systems convert sun's energy into electricity	The kinetic energy of wind is converted to mechanical energy and then into electrical energy	Waste matter composed of parts from living or recently dead organisms are used to produce alternative fuels for producing energy	Chemical energy in hydrogen is converted to electricity, water vapour and heat
Efficiency	6.2-19.7%	20%	20%	40-60%
Carbon Foot Print	Zero at point of use	Zero at point of use	Minimal	Zero at point of use
Limitations	1. Dependent on sunshine availability 2. Requires equivalent storage capacity hence needing additional investment 3. large area required for installation	1. Dependent on the quality of wind speed and duration of wind availability requirement 2. Requires equivalent storage capacity needing additional investment	1. Load uptake cannot be limited to telecom, hence need load aggregation from the other source	1.Underdeveloped hydrogen logistics as of date
Maintenance	Minimal maintenance	Minimal maintenance	Biomass fuel cost and plant maintenance	Hydrogen fuel cost and system maintenance

Let us consider the case for the BTS site as follows:-

Table 3: Detail of Mobile Telecom Site for Alternative Energy Use

BTS Site Type	Outdoor Site
Load	3 kW
Grid Power Availability	16 hrs/day
Diesel consumption per hour	2.5 liters
Output Power Requirement	3*8=24 kWhr/day
Battery Output Voltage	48 volts

Based on the above mentioned case assumptions, the site requires 8 hours or 24 kWh/day equivalent of back-up power.
Diesel Consumption for the Site Considering a 15-20 KVA DG Set

Diesel consumption for 3kW load= 2.5 liters/hour
Diesel consumed in one day= 2.5*8=20 liters
Diesel consumed per annum=20*365= 7300 liters

Case I
Let the diesel price be Rs 50/liter
Liters of diesel consumed per annum=7300
Total Diesel cost per annum= 7300*50 =Rs 3, 65,000
DG Maintenance Cost: Rs 14.8/hour
DG Replacement Cost: Rs. 14.71/hour
DG Maintenance Cost per annum: 14.8*8*365=Rs 43,216
DG Replacement Cost per annum: 14.7*8*365=Rs 42,953
Total diesel cost saving per annum= Rs 4,51,169

Case II
Let the diesel price be Rs 60/liter
Liters of diesel consumed per annum=7300
Net diesel cost per annum= 7300*60 =Rs 438000
DG Maintenance Cost: Rs 14.8/hour
DG Replacement Cost: Rs. 14.71/hour
DG Maintenance Cost per annum: 14.8*8*365 = Rs 43,216
DG Replacement Cost per annum: 14.7*8*365 =Rs 42,953
Total diesel cost saving per annum= Rs 5, 24,169

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Case III
Let the diesel price be Rs 70/liter
Liters of diesel consumed per annum=7300
Net diesel cost per annum= 7300*70 =Rs 5, 11,000
DG Maintenance Cost: Rs 14.8/hour
DG Replacement Cost: Rs. 14.71/hour
DG Maintenance Cost per annum: 14.8*8*365 =Rs 43,216
DG Replacement Cost per annum: 14.7*8*365 =Rs 42,953
Total diesel cost saving per annum=Rs 5, 97,169

Table 4 explains the detail of fuel switching option for Indian BTS sites with capacity and capital cost of the solution. The capital cost is based on market price of SPV, WTG, Biomass Gasifier, Fuel Cell and batteries in India. The operations cost of fuel switching option is not taken in to consideration while determining the payback period by NPV method.

Table 4: Alternative Energy Options for Mobile Telecom Sites in India

S. No.	Fuel Switching Option	Capital Cost in Rs.	Pay Back Period		
			Case 1 Diesel Price @Rs. 50 / Per Liter	Case 1 Diesel Price @Rs. 60 / Per Liter	Case 1 Diesel Price @Rs. 70 / Per Liter
1.	Solar Photovoltaic (SPV) Solution 8kW Solar Panel with Batteries	15.99 Lakhs	4.35 Years	3.63 Years	3.10 years
2.	Wind Turbine Generator WTG 10kW with Batteries	14.32 Lakhs	4.48 Years	3.64 Years	3.07 Years
3.	Biomass Gasifier 10kW	10.18 Lakhs	2.78 Years	2.32 Years	1.98 Years
4.	Hydrogen Fuel Cell 4kW	10.68 Lakhs	3.90 Years	3.08 Years	2.54 Years

The solution discussed here includes a combination of Solar photovoltaic and batteries, thus replacing the diesel generator at mobile telecom sites.

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