EMPLOYING BIOGAS POWERED BASE TRANSCEIVER STATION IN BANGLADESH: CURRENT AND FUTURE PROSPECT

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Abstract: Biogas is gaining popularity for providing green power in Bangladesh. Since the last decade, market penetration rate of cell phone has almost doubled especially in rural areas. Due to power scarcity, most operators are taking more and more BTSs off-grid. Some of them are renewable energy powered and most of those are solar based PV-cell powered. But as initial CAPEX is very high and efficiency is quite low so many operators are looking for better alternatives. Biogas can be an answer to their call. At present one biogas powered BTS is running on test basis. In this paper, current state and future prospect of biogas in telecom sector of Bangladesh is discussed.

1. INTRODUCTION

In Bangladesh, cellular connectivity is a widely explored field now. With the surge of wide variety of low priced handset and mobile centric socio-economic culture the no. of users especially in the rural areas are increasing day by day. Currently in the end of the month April 2011 the total no. of subscribers amassed by the entire operators combined is 74.188 million [1]. Whereas just 5 years back the no. of total subscriber base was only 26.66 million [1]. These high growths are fuelled by cheap call rates, availability of nationwide network coverage and decreasing trend of operating expenses by all the operators. But unfortunately this growth in subscriber would have been much higher only by ensuring country-wide 24/7 electricity especially to the base transceiver systems (BTSs). The current situation of electricity in Bangladesh is worsening day by day. In January 6, 2009 electricity production was 3267.5 MW. In June 5, 2011 electricity production raised only up to 4629 MW [2]. In the table below energy shortage per day is stated [2]:

Peak Hour (MW)	June 6, 2011	June 5, 2011	June 6, 2010
Supplied	4629	4548	4293
Shortage/load Shedding	696	679	269

From the table, it can be seen that per daily basis the power shortage is increasing and the scenario is not going to change in the near future. As a result, operators are facing this problem. Grid connectivity is unavailable in many rural points in Bangladesh. Even if there is hope of connectivity no guaranteed time frame is there to ensure electricity within deadline. These lead times for grid extension are affecting the network planning. So far it is found the average lead time is estimated up to 2 years. Even in many gridded locations, the grid uptime is also considerable. In Bangladesh, the average grid outages are

URBAN: 4X1 hrs outages/day
RURAL: 2X4 hrs outages/day [3].

Due to such power crisis, operators are trying to implement reliable yet cost effective solution for long term uninterrupted power supply. Currently Bangladeshi operators are relying mostly on Diesel generators (DG). Though diesel generators are very reliable, still constant soaring fuel price is setting this power option to bay worldwide. Keeping in touch with the modern trend, Bangladeshi operators have also set foot in the world of renewable energy. Grameenphone (GP), the largest cellular company of Bangladesh, was the pioneer in this field of implementing renewable energy powered network infrastructure. Currently Grameenphone has 27 off-grid sites operational by renewable energy. Of those, 26 sites are fully powered by solar based photovoltaic cells and 1 is a hybrid combination of wind and solar energy. Banglalink, the second largest operator in Bangladesh, has 4 solar powered sites. The state owned Teletalk has also empowered its most remote BTS site in Shuvlong, Ranagamati (Chittagong Hill Tracks) with a 7 KW peak solar system. Currently GP is the only operator to operate a hybrid wind and solar powered BTS in Sandweep (A remote island in Bay of Bengal).

Despite initial popularity of solar backed BTS, slowly the operators are finding several pitfalls of these systems. First of all, the initial capital expenditure (CAPEX) was quite high due to equipment, land, site-protection and maintenance; up to USD 60,000/site. The payback period was also high; up to 5.0-5.5 years [3]. Secondly, the sites were mostly in rural areas. As a result, any troubleshooting required means complete halt of operation. Thirdly, availability of expert vendors with high efficiency system is still very limited. Lastly, the stations stored power to backup mostly up to 72 hours. As

a result, in monsoon season the prolonged rains hamper the generation process.

Biogas can stand up in these scenarios. Bangladeshi climate is favorable for biogas production. Moreover, raw material for biogas digester is available and cheap in Bangladesh. Since cow dung and poultry liter are the common raw materials for biogas digester in Bangladesh, the operational supply chain predictability is high. Thus output predictability is also high. On average, the load of a BTS site is nearly 5 - 10 KW which can be easily ensured from a mediocre sized biogas plant.

2. POWER CONSUMPTION OF BTS

The power consumption of a certain BTS site depends on many attributes e.g. area covered, location, temperature/humidity, sectoring etc. In BTS sites, the power is mostly utilized in five main areas. They are the BTS radio-link, cooling equipment, backhaul, lighting and monitors. BTS equipment and cooling system consume more than 80% of the total power. BTS equipment in Bangladesh are mostly procured from Ericsson, Huawei, Alcatel-Lucent etc. vendors. The most common components used in all these vendors are: combiner and divider unit, transceiver module, transmission and management unit, transmission extension unit etc. Combined, the total power required is 1.2 - 2.2 KW. The most energy efficient units deployed by Huawei recently consumes up to 0.6 - 1.2 KW [3]. Secondly comes the cooling system; air conditioned indoor BTS consumes a high amount of power; ranging from 2 – 4 KW. Newly deployed BTSs are outdoor unit based. Thus they require no air conditioned cooling system. Rather only implementing high graded fans and heat sinks can do the work. The backhaul power consumption is location depended. BTS sites with fiber optic connected backhaul require less than 50 W power. On the other hand, sites connected through long range microwave links absorbs up to 200 W power. Lighting and monitors require less than 250 W combined. But in case of long towers, aircraft warning light requires several hundred extra watts. So in total, nearly 4 – 7 KW of power is required on average in remote BTS sites

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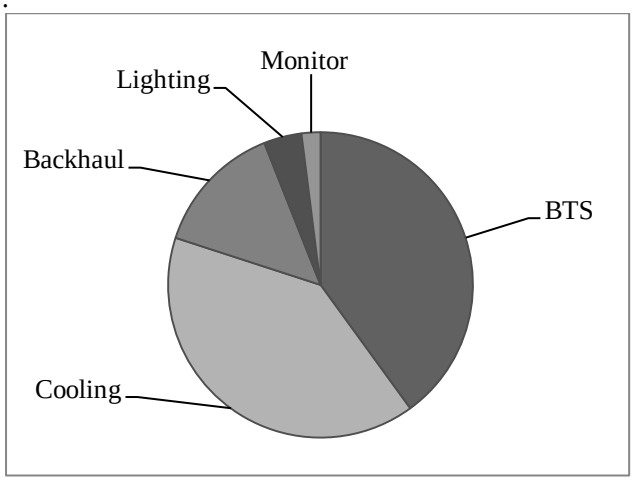


Fig. 1 Pie diagram of power consumption of BTS [3]

3. PRODUCTION OF BIOGAS AND ELECTRICITY FROM BIOGAS

Biogas is a highly flammable gas with a chemical composition of methane (CH_4), carbon dioxide (CO_2), ammonia (NH_3), hydrogen sulfide (H_2S) etc. CH_4 is often between 50 and 75% depending on digestion method. Biogas is 20% lighter than air and has an ignition temperature of 650 – 750^0C. Biogas originates from biodegradable material and is produced by the anaerobic digestion or fermentation of biomass, manure, sewage, municipal waste, green waste, plant material and crops. The gases methane, hydrogen and carbon monoxide can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel.

The raw input is first fermented until all the lipids, proteins and the polysaccharides divide into basic propionates and butyrate. This process is called hydrolysis. After hydrolysis, the anaerobic digestion will occur best within a pH range of 6.8 to 8.0. More acidic or basic mixtures will ferment at a lower speed. A high pH will encourage the production of acidic carbon dioxide to neutralize the mixture again. After the acidic phase, the output gas is purified and separated from the byproduct and a non-return valve equipped pipe lets out the biogas into a desired chamber. This is a continuous feed process for nonstop production of biogas. It also requires watchful eye for the desired temperature and constant stirring in the fermentation chamber.

Then the gas is directed to a internal combustion engine or generator to get the output electricity. The schematic diagram below depicts the biogas production and production of electricity from it.

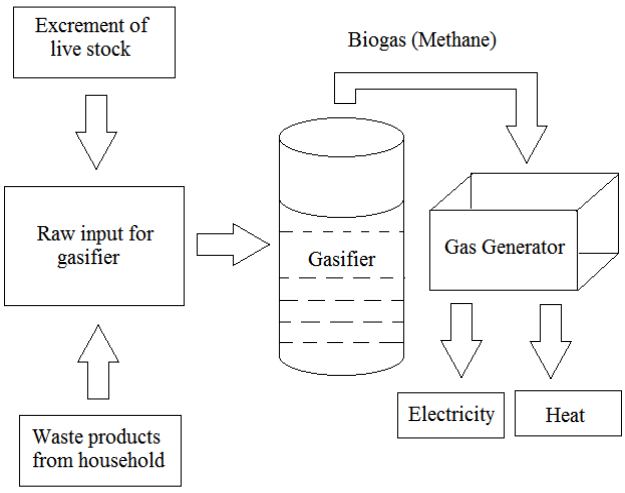


Fig. 2 schematic diagram of production of biogas and electricity

4. A CASE STUDY OF BIOGAS POWERED BTS IN BANGLADESH

The case study here depicted is the project undergone by Grameenphone (GP) as an experimental step towards third party based purchase of energy from renewable sources. To reach GP's goal as a green company by reducing use of fossil fuel hence cutting out carbon emission by 15% before 2015, GP was experimenting on several other renewable energy technology at the same time.

A. Background Information:

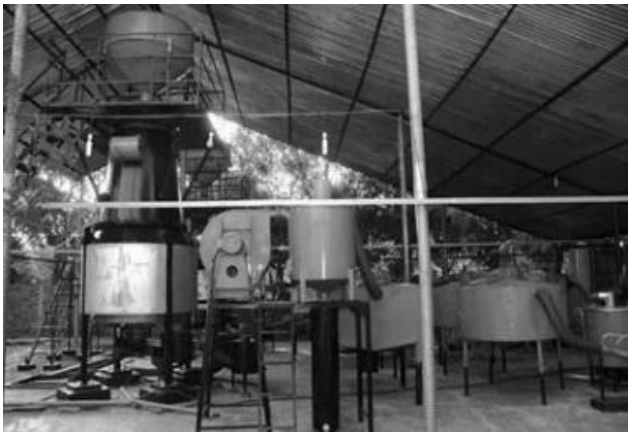
Gazipur is a densely industrialized district adjacent to the capital Dhaka; nearly 60 km North. There are five Upazillas (Sub-districts) in Gazipur. This 1770.54 sq Km district has a total population of approximately 28 Lac (2010) and population density of approximately 1300 person/sq km [5]. Though the industrial parks are ensured with uninterrupted electricity for the production hours, the local communities are deprived of electricity for a major portion of the day. In some Thanas, the grid up time is as low as 4hrs/day only in summer. The situation is so dire that the locals even vandalized the local 'Rural Electricity Board' office several times. However, the situation hasn't been the same since DreamPower, a distributed renewable energy supply start-up company, decided to setup a trial biomass gasifier power plant to supply electricity to the local Grameenphone (Bangladesh's leading mobile operator) base station as well as to Gazipur's 'Kapashia Thana' community.

DreamPower Private Ltd. is a Bangladeshi ventured company which developed the biogas powered project. It was an Infrastructure Development Company Ltd. (IDCOL) financed initiative. IDCOL provided the concessionary loans and grants for this project. The project started its operation from October 2007. The Biogas plant was actually a rice husk, an agricultural residue, fuelled power generator. The gasifier unit was a downdraft type. The total capacity of the plant is 250 KW and the rated gas flow is 625 Nm^3/hr [6]. The gasifier had efficiency up to 75%. The feeder installed is manually operated continuous feed type. As the initial power required by the plant cannot be met by the biogas itself, an auxiliary power supply of 11 KW was also installed. The raw gas was purified through a locally made three stage purifier. After the purification process, the gas was fed into a duel fuel generator (DFG). The capacity of the DFG is 300 KW. Due to the low initial heating value of the biogas, diesel is required to run it to a certain stage. The biogas to diesel ratio in this generation process is 70:30 [6].

B. Operation:

The Grameenphone site in Gazipur, which is an indoor site equipped with Ericsson's RBS with a 4 TRX system having an average power load of 6kW, was setup in July 2007, powered by two 30 kVA diesel generators (one of them is used as a back-up). However, when DreamPower constructed a 250 KW rice husk-based biomass gasifier plant in the area in early 2008, Grameenphone decided to draw power from this plant. There were several regulatory, technical and business considerations before the Gazipur Community Power infrastructure was setup. However, the Government offers power distribution license exemptions to small scale renewable energy based energy suppliers. DreamPower took advantage of this exemption while implementing Community Power applications at Gazipur.

The rice husk-based biomass gasifier plant was conceptualized and implemented by DreamPower. At present, the plant's biomass gasifier runs for about six hours a day, from 6 PM to 12 AM, since this is the period when the local community draws the highest amount of power, ensuring high Plant Load Factor (PLF). The Grameenphone base station draws power from the biomass plant for these six hours, which also charges the site's batteries. The base station runs on batteries and diesel generators for the remaining eighteen hours of the day. Before the biomass plant was setup, the diesel generators at the Grameenphone site used to run for nearly nine hours a day. [3]



a

b.

Fig. 3a. Gasifier and b. Purification unit of Dream Power Private Ltd

C. Business Model and Charging:

Running the site on diesel generators costs Grameenphone about 46 Bangladeshi Taka (USD 0.58) per KWh unit of electricity even after the subsidy of government of 33.40 Taka, whereas running the site on power supplied by the biomass plant costs Grameenphone about 10 Taka (USD 0.12) per kWh unit, which is very close to the cost of grid electricity, which is about 5.3 Taka (USD 0.067) [3]. As the site is providing service to more than thousands of local subscribers, Grameenphone's site power requirement without any interruption is quite demanding. Certain agreements were made between GP and Dream Power e.g. constant monitoring of on duty personnel, capability to ensure smooth maintenance and other repairs promptly etc.

5. LEARNING'S AND FUTURE PROSPECT

The project was very first of its kind. It was an eye opener for both Biogas based electricity production companies and telecom operators- not only of Bangladesh but also of South-Asian subcontinent.

The learning curve of the project was not that steep as assumed primarily. The business model initially derived was re-evaluated to cope with changing circumstances. As this dynamic business model is beneficial for both parties it can be implemented in many other sites. Another significant learning was that this sort of projects requires sustainable supply chain for uninterrupted service. As the generation is continuous-feed-dependent, it requires to be sourced locally, contributing to security of supply. Another major finding from the project was the necessity of customized, scenario specific analytical assessment to predict the outcome of employing a certain technology of renewable energy. Not all renewable sources are suited for all the base stations. The prospect of biogas powered base stations in telecom sector especially in Bangladesh has high hope. Agriculture is the driving part of the economy in Bangladesh. As a result the residues from this sector can fuel new biogas plants in different locations of Bangladesh. Locally secured source can reduce the cost for the end users by shredding logistics and transportation costs. Moreover, manure of human and poultry farms are also biodegradable. On an average, these manures can yield up to 77% of methane gas (CH_4). Considering the total number of buffalo, cow, goat and other poultry livestock in financial year 2008-2009, the possible biogas production is about 0.209910237 TCF/ year which is nearly equivalent to total natural gas production in financial year 1992-1993 in Bangladesh [4]. Besides straddling the Tropic of Cancer, Bangladesh has a warm and humid weather for most of the year which is ideal for biogas production.

6. CONCLUSION

Wireless telecommunication sector is penetrating aggressively in Bangladeshi market. With the increase of base station to support the growing number of subscriber in remote locations, biogas fuelled power can be a ray of hope. The per unit price of electricity purchased/generated from biogas fuelled generator is almost same as the national grid's per unit price; a helpful fact for the operators to keep its operational expenses at bay.

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