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Compliance driven Cost Control for Telecom Infrastructure Operation Management

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Abstract

For a major telecom infrastructure company operating pan India including the state of Haryana, over 400 of their telecom infrastructure operation sites in Haryana had connected running power load more than the load sanctioned by the Haryana State Electricity Board (HSEB). As per the Standard Operating Procedure of this telecom infrastructure company (SOP), these 400 plus sites did not qualify under load upgrade category since the load had been increased without attracting any new tenancy i.e. Base Transceiver Station (BTS) of other telecom operators (service providers). Power load at these 400 sites had increased because of additional load due to sector expansion, cabinet expansion and 3G additions.Since running power load for a BTS cannot be more than the sanctioned load, these 400 sites were non compliant as per HSEB norms. If these sites were to be inspected by State Electricity Board inspectors and identified for non-conformity, it would have lead to heavy commercial penalties and even permanent disconnection of electricity to these sites. This inturn would entail using 24x7 diesel generators to keep sites active, increasing the operation cost manifold and also threatening environment pollution.A business case was prepared for this problem using the Define, Measure, Analyze, Improve and Control (DMAIC) methodology, a Six-Sigma approach. Cause of power overload and its effect was detailed out using root cause analysis and possible optimal remedial solution was arrived at for this project. The total penalties calculated as per the HSEB guidelines came out to be Rs.35 million whereas the total expenditure being involved in complying and coming out of this issue came out to be Rs.12 million approximately, thus making it a net saving of Rs.23 million for the telecom company. It was also observed that for the sites where the sanctioned load was 35% - 50% of the required load, net saving potential was more compared to the sites where the sanctioned load was 55% - 80% of the required load. A similar business case was carried out by the same company in the state of Himachal Pradesh and found that net saving potential was more compared to the state of Haryana.This was practically achieved by calling different partners (vendors) to discuss this project in an open forum. Non compliant site allocation was carried out on the basis of partner's confidence, band width and operational capabilities to deliver these sites. A reward per site was declared to motivate the partners for quick achievement of the desired results (compliance) with a gate criterion of ≥80% of the total site allocation done. The partners provided power usage receipts from HSEB as a proof of job done and payments were released accordingly. The change in power load was reflected in the subsequent electricity bills. The target set for the change over to the HSEB compliance was three months during which rigorous monitoring and review mechanism was put in place including circulation of Daily Progress Report to all internal and external stakeholders. To ensure that this issue does not repeat in future, the technical guidelines (SOP) was amended in terms of the power load to be upgraded for every new asset being deployed at site.

Keywords: Base Transceiver Station, Compliance, DMAIC, HSEB, Non-Conformity, SOP, Six-Sigma

1. Introduction

A major telecom infrastructure company, one of the largest tower infrastructure providers in India, owns and operates in 11telecom circles (18 states) of India with

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some of them in the remotest and tough terrains. The company is a pioneer in the tower infrastructure sharing concept in India benefiting the telecom operators in many ways viz.

- Reduced Capital Investment - as new infrastructure need not be created exclusively for them.
- Faster Time-to-Market - as these towers have a large geographic footprint and cover existing, high-revenue telecom circles.
- Operational efficiencies - as best practices adopted by the market leader automatically benefit them too.
- Revenue maximization - The savings in Opex and Capex due to sharing of infrastructure can be diverted to provide better, newer and more innovative services that yield higher Average Revenue Per User[1].

For this company operating in the state of Haryana, having huge network coverage across the state, it was found that over 400 of BTS i.e. Base Transceiver Station (telecom infrastructure sharing) sites in the state had connected running power load more than the load sanctioned by the Haryana State Electricity Board (HSEB).

1.1 Problem Statement

Since running power load for a BTS cannot be more than the sanctioned load, these 400 telecom sites were non compliant as per HSEB norms.

1.2 Goal Statement

75% of the current bucket of 400 non compliant telecom sites to be made compliant to the HSEB norms within a stipulated time.

2. Telecom Infrastructure Operation Management

2.1 Base Transceiver Station

Base Transceiver Station is part of telecom infrastructure operation to facilitate wireless communication between user device and telecom operator. Any user device can communicate with operator's network through Code Division Multiple Access, Time Division Multiple Access or Global System for Mobile communication platform.

BTS system consist of Transceiver (TRX) which maintains transmission and reception of signals; handling signals to or from higher network entities, a Combiner that combines several TRXs feeds to be sent through a single antenna thus reducing the number of antennas, a Power amplifier to enhance signal from TRX for transmission through the antenna, a Duplexer used to separate sending and receiving signals from the antenna and an Antenna outside of the BTS[6].

Base Transceiver Station system is secured in a protective enclosure from conditions such as external corrosion, theft, dust etc. Additionally, an air conditioner, a battery bank for power supply and security lights are also there (Figure 1). Air conditioner serves a dual function of cooling the space as a result of the heat generated by the equipment and dehumidifying for maintaining the acceptable humidity levels.

2.2 Load/Energy Requirements of BTS

Telecom network specifications are the main differentiator for energy need of equipments across the sector (Table 1)[5]

2.3 Process for BTS Load Upgradation

As per the Standard Operating Procedure of this company (SOP), the process for load upgradation includes the following steps;

Step 1 - SO received for NT/Cabex.

Step 2 - "Required Load" data for a BTS is given by the planning team based on planning guidelines.

Step 3 - O and M team confirms the current "Sanctioned Load" on site.

Step 4 - Deployment team (EB Manager) gets the load enhanced from currently sanctioned load to meet the required load.

Step 5 - EB Manager signs off.

The company's 400 telecom sites did not fall in Load Upgrade bucket as they didn't qualify for load upgradation since the site power load had been increased without attracting any new tenancy i.e. BTS of other telecom operators (service providers).

3. Reasons and Consequences of Power Overload at Sites

Power load at these 400 sites had increased because of additional load due to sector expansion, cabinet expansion and 3G additions.If these sites were to be inspected by Haryana State Electricity Board inspectors and identified for non-conformity, it would have lead to heavy commercial penalties and even permanent disconnection of electricity to these sites.

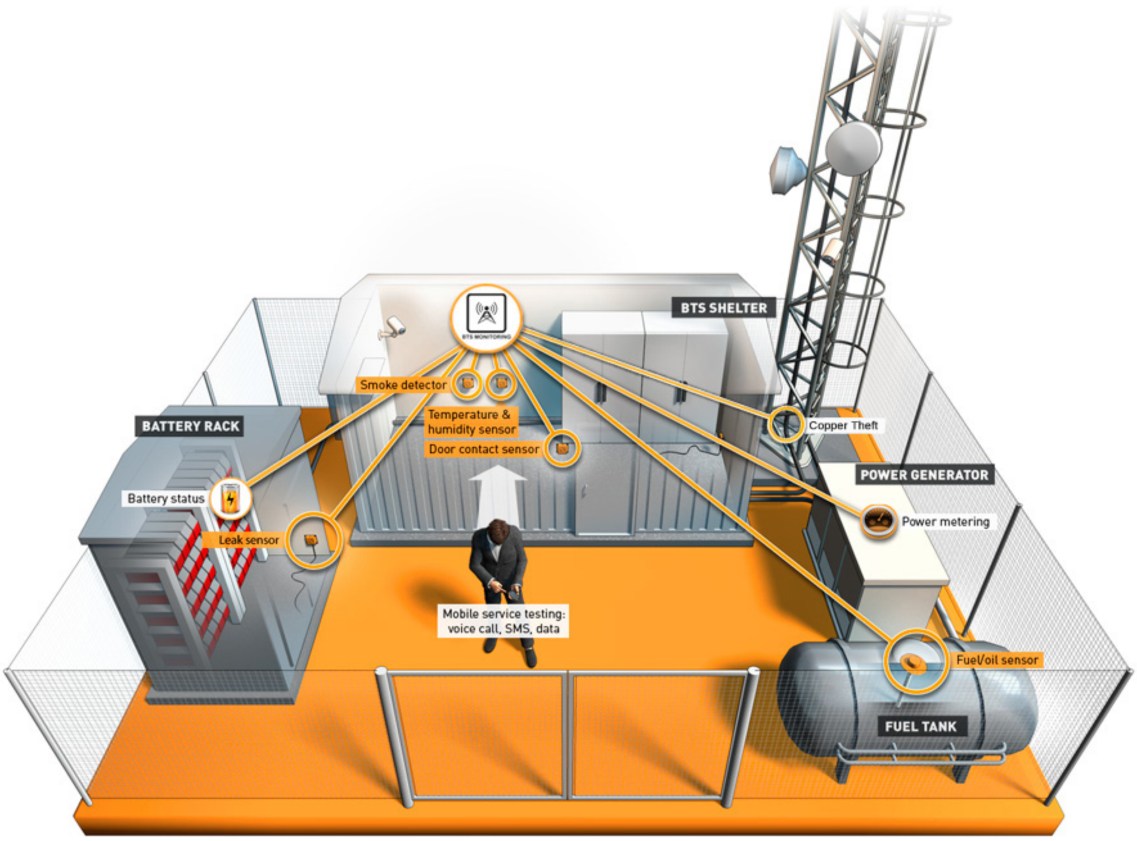

Figure 1. BTS System
Source: www.btsmonitoring.com.

Table 1. Load requirements of BTS

Types of Base Stations	Load Requirements (kW)
Global System for Mobile communication Base Station 2/2/2	1.8-2.0
Global System for Mobile communication Base Station 4/4/4	2.3-3.5
Universal Mobile Telecommunications System Base Station Outdoor Macro/fibre 4/4/4	1.7-2.0
Large WiMaxi	1.6-1.8

Source: http://www.esru.strath.ac.uk/EandE/Web_sites/10-11/Mobile_mast/bts.htm) (Additional Source; http://www.umtsworld.com/technology/overview.htm

This in turn would entail using 24x7 diesel generators to keep sites active, increasing the operation cost manifold and also threatening environment pollution.

3.1 Environmental Pollution Impact and Mitigation

Globally, 98-99% of telecom infrastructure operation sites are powered with conventional petroleum fuel based generators as secondary backup or at times as the main source of power for the BTS system. The major environmental impact of diesel generators is constant CO_2 emissions during operation life cycle[3].

A diesel generator used to power a BTS consumes about 18,000 litres of fuel per year. CO_2 emission from one litre of diesel fuel is 2.68kg. Therefore a total of 46.5 metric tons of CO_2 is emitted annually from a BTS and thus harms the environment. Renewable energy solutions are a positive alternative in this direction. There are currently 10,233 renewable powered BTS which reduces carbon emissions globally by 480,000 metric tons per year (Figure 2.)[4].Indian government started a programme in April 2010 to promote use of solar powered systems in the telecom sector. Through this programme, incentives and cost ben efits upto 50% for solar systems were made available to the telecom sector companies. This programme is a big step forward towards green energy and carbon emission reduction in the telecommunication industry[2].

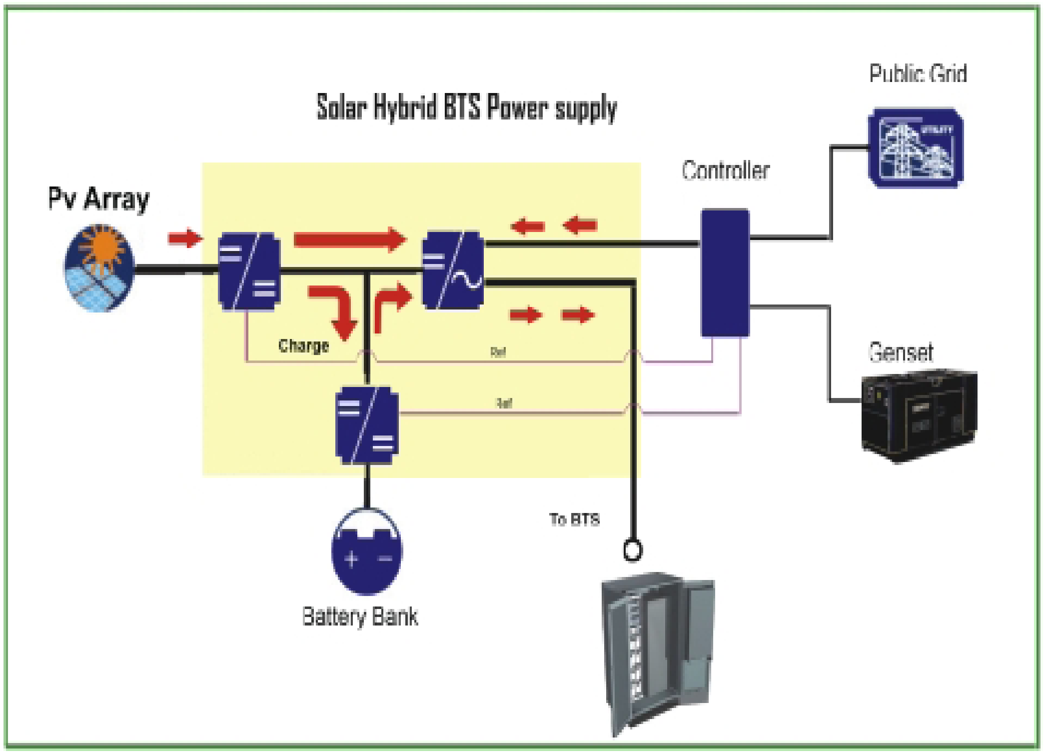

Figure 2. Solar Power Hybrid Power supply for BTS
Source: http://www.solarpowerplant.co.in/solar-power-plant-for-telecom.html

4. Business Case (Methodology)

4.1 DMAIC Methodology

DMAIC refers to a data-driven improvement cycle used for improving, optimizing and stabilizing business processes and system designs. The DMAIC improvement cycle was the core tool used to drive this Six Sigma project[9].

DMAIC is an abbreviation of the five improvement steps and comprises:

1. Define.
2. Measure.
3. Analyze.
4. Improve and
5. Control.

Every DMAIC process step is mandatory and is followed in the given sequence.

4.1.1 Define

The process step clearly specifies the operation issue/problem, goal, available resources, project scope and timeline.

It defined the following

- Problem (Non compliance to the HSEB norms).
- The customers.
- Voice of customer and its criticality to quality.
- Project targets or goal (Conformity to HSEB norms).
- Project boundaries or scope.

4.1.2 Measure

The purpose of this step was to objectively establish current baselines as the basis for improvement (upgradation). This was a data collection step, the purpose of which was to establish process performance baselines (compliance driven). The performance metric baseline (s) from the measure phase was compared to the performance metric at the conclusion of the project to determine objectively whether significant improvement was made.

- Found the gap between present and expected performance.

- Collected information to prepare a performance driven baseline for this project.
- Evaluated the system for required accuracy and precision.
- Established a process flow baseline of high standard/ level.

4.1.3 Analyze

This step identified, validated and selected the root cause for removal. Root cause analysis helped identify large number of root causes of the project problem. The most impact root causes were selected using consensus tool for further validation. This process was repeated until "valid" root causes were identified. Of the "validated" root causes, some were

- Listed and prioritized based on possible reasons of the problem.
- Prioritized the key/main causes to start with the Improve (next) process step.
- Identified how the system outputs were affected the inputs. Information was analyzed to understand the impact of each root cause to the project. Statistical tools were used to do this.
- Detailed process maps were created to precisely identify where in the process root causes resided and what might have contributed to the occurrence of power overload and non-compliance to HSEB norms (Figure 3).

4.1.4 Improve

This step identified, tested and implemented a solution (partly or completely) to the problem. Innovative solutions were identified to remove the root causes in order to fix and avoid process problems. For some project sites, complex analysis tools were used for solutions.

- Created innovative solutions.
- Focused on the simplest and easiest solutions.
- Tested solutions using Plan-Do-Check-Act (PDCA) cycle.
- Based on PDCA results, attempt was made to anticipate any avoidable risks associated with the "improvement" using FMEA.
- Created a detailed implementation plan.
- Improvements were deployed.

4.1.5 Control

The purpose of this step was to sustain the gains. Improvements were monitored to ensure continued and sustainable success. Created a control plan. Updated SOP documents, business processes and training records as required.

A Control chart was used during the Control stage to assess the stability of the improvements over time by serving as

- A guide to continues tracking of the system.
- Provided a response plan to monitor the measures taken for unstable system processes[8].

5. Important Causes and Case Solutions

5.1 Cause 1

Telecom infrastructure sites where load had been increased for sector expansion and 3G services were not considered before implementation of EB load upgrade process.

5.1.1 Solution

EB Load monitoring was developed to track the system load using a satellite unit. There are two units, one in the centralized control office and the other in the circle area office. In the control office, a microcontroller unit was connected with a Dual Tone Multi Frequency encoder fitted with a digital display. In the user area, a microcontroller unit was connected to a telephone line. Based on power usage, the microcontroller would send signal to the driver section and thereby operate a telephone. Also, the microcontroller operated corresponding relays sent electric meter reading through the telephone line. On the other side, the telephone line received the signal through a Dual Tone Multi Frequency encoder; the signal was converted to digital signal and given to the microcontroller. According to the signal type and strength, the microcontroller would send the signal to a digital display of metered readings in the user area.

Thus individual load for a site was sensed and monitored on real-time basis in the control office. This data is checked by O and M team, and then they apply for load upgrade process (Step 3 of BTS load upgradation above).

5.2 Cause 2

Cabinet expansions cases were not considered as load upgrade.

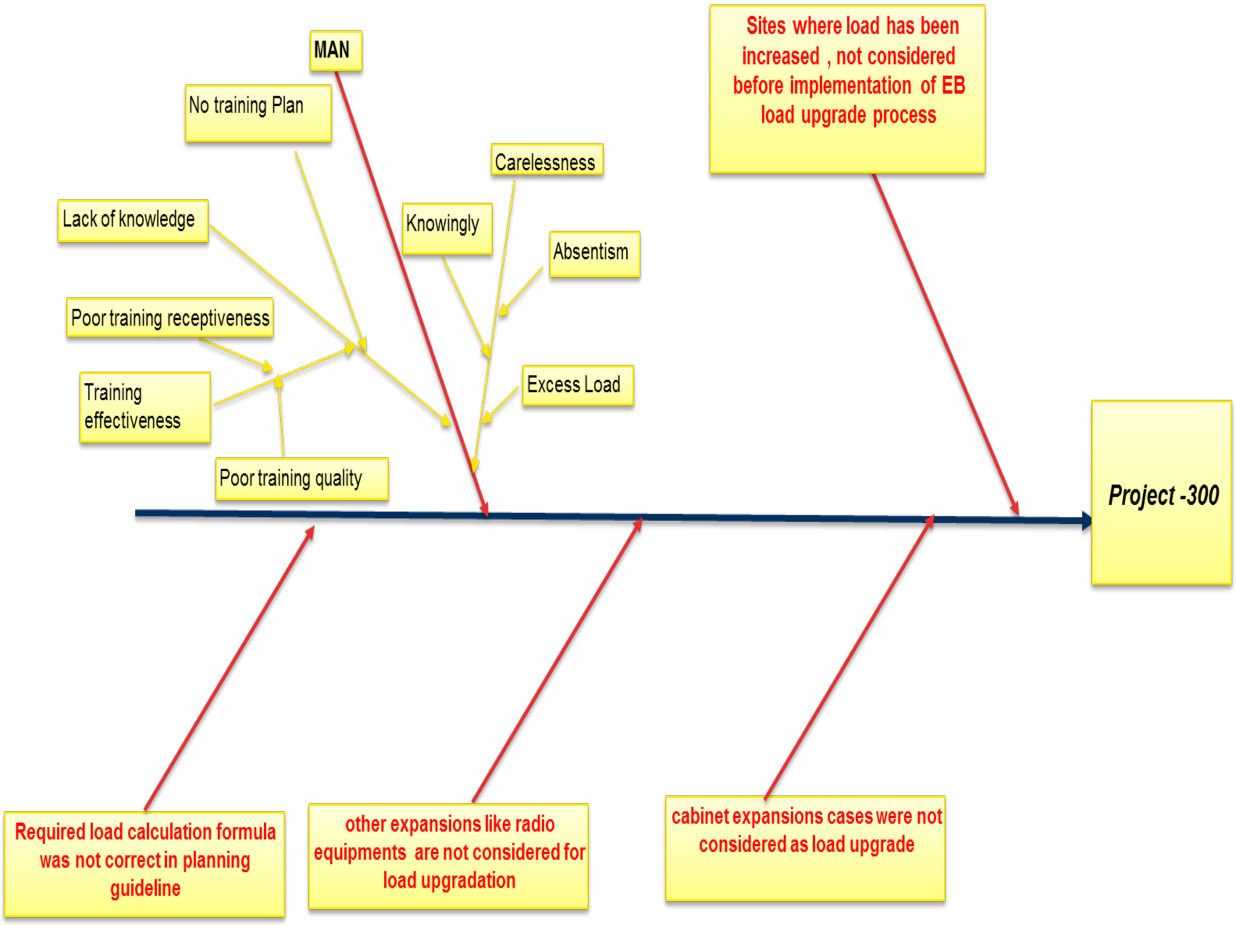

Figure 3. Cause and Effect (Fish-Bone) diagram for power overloading and non compliance at telecom sites.

5.2.1 Solution

Cabinets enable you to enhance your circle presence (LMC), to provide a better next-generation access offering, whether broadband and /or 3G cellular services.
Cabinets host telecommunications devices, are designed to fully protect all equipments against atmospheric agents and temperature changes. These cabinets come in standard size, designed for integration of equipment with power supply or an ups system.
In the improvement step, the company included cabinet expansion cases as load upgrade.

5.3 Cause 3

Other expansions like radio equipments were not considered for load upgradation

5.3.1 Solution

Terminal equipment covers all radio frequency based tools, mobile communication tools like cellphones, Citizens B and radio, broadcast transmitters and all other equipments connected to telecom networks. Expanding the capacity of these equipments to standard maximum limit helps to upgrade the load on the BTS.

6. Cost Control through Compliance (Results)

Using DMAIC methodology and root cause analysis; possible optimal remedy solution was arrived at for this project. The total penalties calculated in case of non compliance as per the HSEB guidelines came out to be Rs.35 million whereas the total expenditure incurred in complying and coming out of this issue came out to be Rs.12 million approximately, thus making it a net saving of Rs.23 million to the telecom operator.

6.1 Savings through this Project

- Total Penalties for Load overrun (LDHF x Rate@1.5 time x 6 months) = Rs. 35,557,072.
- Total expenses involved in Load Upgrade {incl liaison+ R and R (Rs 11000), ACD (1KW x Rs.1000), Service connection charge and Processing charges (Required Load x Rs.800) and materials (average Rs. 5000)} = Rs. 11,745,310.
- Net savings (Penalties - Expenditure) = Rs. 23,811,762.

It was also observed that for the sites where the sactioned load was 35% - 50% of the required load, net saving potential was more compared to the sites where the sactioned load was 55% - 80% of the required load.

A similar business case was carried out by the same company in the state of Himachal Pradesh and found that net saving potential was more compared to the state of Haryana.

7. Discussion and Conclusion

The above cost savings was practically achieved by calling different partners (vendors) to discuss this project in an open forum. Cause and effect of the power over load and present condition of non compliance was detailed out to the partners. Non compliant site allocation was carried out on the basis of partner's confidence, band width and operational capabilities to deliver these sites. A reward per site was declared to motivate the partners for quick achievement of the desired results (compliance) with a gate criterion of ≥80% of the total site allocation done. The partners provided power usage receipts from HSEB as a proof of job done and payments were released accordingly. The change in power load was reflected in the subsequent electricity bills. The target set for the change over to the HSEB compliance was three months during which rigorous monitoring and review mechanism was put in place including circulation of Daily Progress Report to all internal and external stakeholders.

To ensure that this issue does not repeat in future, the technical guidelines (SOP) was amended in terms of the power load to be upgraded for every new asset being deployed at site.

Finally in the present market scenario where we are seeing a rapid growth in the number of mobile telecom users, it is becoming very difficult for a telecom operator to handle the load on the present standard operating procedure as laid down by the telecom authority.

Therefore to upgrade the load of the current BTS which may or may not be compliant to the norms, business tools and analysis as discussed in this paper are cost effective and confirming.

8. Refrences

1. Bharti Infratel Limited the pioneers of Shared Tower Telecom Infrastructure services. Available from: http://www.bhartiinfratel.com/cps-portal/
2. Solutions Paper: Alternative Power for Mobile Telephony Base Stations, Motorola Inc. 2007, p. 8 Available from: http://www.motorola.com/web/Business/Solutions/Technologies/WiMax/
3. Global Mobile Market Shares. Available from: http://www.3gamericas.org/index. cfm?fuseaction=page&pageid=565
4. Solar Power Hybrid Power supply for BTS (Open source and assessed on 2014 Aug 14. Available from: http://www.solarpowerplant.co.in/solar-power-plant-for-telecom.html)
5. Energy demand of a telecommunication equipment differs according to its network specifications.Available from: http://www.esru.strath.ac.uk/EandE/Web_sites/10-11/Mobile_mast/bts.htm

6 Monitoring the Infrastructure of Distributed Sites, the BTS system monitoring. Open source and Assessed on 10-09-2014. Available from: Servercheck http://www.btsmonitoring.com/

7. Haryana Electricity Board tariff plans, open source and assessed on 12-09-2014 Available from : http://www. uhbvn.com/ , http://dhbvn.org.in/web/portal/commercial, http://www.hpgcl.gov.in/aboutus_1.hp
8. Six Sigma Methodology Utilization in Telecom Sector for Quality Improvement- A DMAIC Process Available from: http://www.researchgate.net/publication/50384415_Six_Sigma_Methodology_Utilization_in_Telecom_Sector_for_Quality_Improvement-_A_DMAIC_Process , also http://www.sixsigmaonline.org/six-sigma-training-certification-information/articles/applying-dmaic-to-the-telecom-industry.html
9. Book - Erick C. Jones , Quality Management for Organizations using Lean Six Sigma Techniques.

Appendix 1. Site wise sample data of sanction load and required load for the state of Haryana.

S.no	Site IDs	Tech-ID	Circle	Cluster	Sanction Load	Required load	Saving Potential		
							Penalties	Expenditure	Net Savings
100	ABL122	HART11036	HR	Ambala	12	16	71,280	32,800	38,480
101	YMN116	HART10959	HR	Yamuna Nagar	12	16	71,280	32,800	38,480
102	TRW119	HART10956	HR	Kurukshetra	12	16	71,280	32,800	38,480
103	SHBD68	HART10933	HR	Ambala	12	16	71,280	32,800	38,480
104	HSSR45	HART10930	HR	Hissar	11.86	16	73,775	32,940	40,835
105	RWRI45	HART10915	HR	Rewari	12	15	53,460	31,000	22,460
106	PLWL66	HART10866	HR	Palwal	12	16	71,280	32,800	38,480
107	KSTR43	HART10850	HR	Kurukshetra	12	16	71,280	32,800	38,480

Appendix 2. Allocation of site to Partners.

Sl No	Vendor Name	Site Alloted	WIP	Not Started	Work Completed	% completed	Status	R&R Gate (>80%)
1	Anil Kumar	10			10	100%		Qualified
2	Everest Infra Services	28		18	10	36%		
3	Future Communication	3		1	2	67%		
4	Gutpa Agencies	55		6	49	89%		Qualified
5	Karnal Consultancy	36		1	35	97%		Qualified
6	Sai Bholey	14	1		13	93%		Qualified
7	SH Enterprises	37			11	30%		
8	Shiv shakti	49	0		49	100%		Qualified
9	Shri Shyam	71		7	64	90%		Qualified
		26	13		13	50%		
10	Tripod	46			46	100%		Qualified
11	Deepak Enterprises	29	17		12	41%		
	Grand Total	378	25	23	330	87%		

Appendix 3. HSEB Tariff schedule for supply of Energy[7].

Distribution and Retail Supply Tariff for FY 2012-13 Approved by Haryana Electricity Regulatory Commission (effective from 01.04.2012)									
Sr. No	Category of consumers	Tariff for FY 2011-12				Tariff for FY 2012-13			
		Energy Charges (Paise/ kWh)	Fixed Charge (₹ per kW per month of the connected load / per kVA of sanctioned contract demand in case supply is on HT)	FSA (Paise /kWh)	MMC (₹ per kW per month of the connected load)	Energy Charges (Paise / kWh or/ kVAh)	Fixed Charge (₹ per kW per month of the connected load / per kVA of sanctioned contract demand (in case supply is on HT) or as indicated	FSA (Paise / kWh)	MMC (₹ per kW per month of the connected load or part thereof)
2	**Non Domestic**								
	Upto 5 kW (LT)	450	Nil	31	180	525 /kWh	Nil	31	₹180 upto 5 kW and ₹ 160 above 5 kW upto 20 kW
	Above 5 kW and Up to 20 kW (LT)	450	Nil	31	160	550 /kWh	Nil	31	
	Above 20 kW upto 50 kW (LT)	470	115	31	Nil	550 /kWh	130 /kW	31	Nil
	Existing consumers above 50 kW upto 70 kW (LT)	470	115	31	Nil	575 /kWh	150 /kW	31	Nil
	Consumers above 50 kW (HT)	470	115	31	Nil	525 /kWh	130 /kW	31	Nil
3	**HT Industry (above 50 kW)**								
	Supply at 11 KV	415	120	31	Nil	470/kVAh	130 /kVA	31	Nil
	Supply at 33 KV	403	120	31	Nil	460/kVAh	130 /kVA	31	Nil
	Supply at 66 KV or 132 KV	391	120	31	Nil	450/kVAh	130 /kVA	31	Nil
	Supply at 220 KV	383	120	31	Nil	440/kVAh	130 /kVA	31	Nil
	Arc furnaces/Steel Rolling Mill	415+15	120	31	Nil	470+18 Paise per kVAh if supply is at 11 kV	130 /kVA	31	Nil