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Addressing and Understanding Climate Change Triggers in the Indian Telecom Environment

Green Energy Initiatives: Gaps and Opportunities

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1.0 Objective of Research

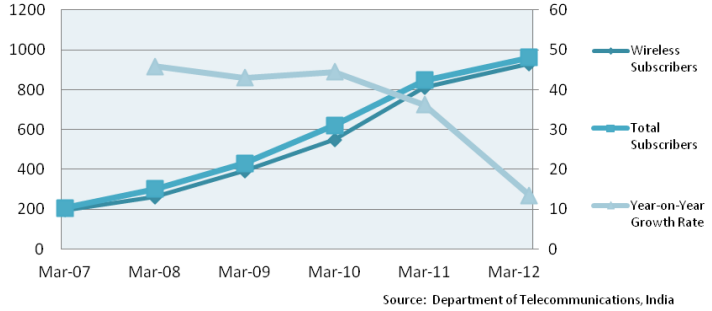
The objective of this research is to analyse the gaps and opportunities, costs and implications of investing in Green Telecom infrastructure. In line with TATA Teleservices' (TTL) endeavours to make positive contributions to the wider community, this research project will be approached from a Corporate Sustainability perspective. As such, its analysis will not be limited to examining the business costs of utilizing Green Telecom cell sites. The social and environmental impacts of these initiatives will also be explored.

2.0 Background of Indian Telecom Industry

2.1 Growth Trends

India is one of the largest telecom markets in the world today, and its telecom sector has continued to emerge as the prime engine of economic growth.[1] Based on recent statistics released by the Telecom Regulatory Authority of India (TRAI), the number of telephone subscribers has increased to 960.90 million by the end of May 2012. Of this, wireless subscribers accounted for 96.7% of the total number of telephone subscribers.[2] While these statistics indicate that the number of subscribers has increased overall, growth has slowed down significantly since 2011. As charted in Figure 1, growth rate from 2008 to 2011 averaged at 42% per annum, but fell to 13.5% between 2011 and 2012.

Fig 1. Telecom Subscription Data (millions)



Source: Department of Telecommunications, India

2.2 Tele-density and Grid Connectivity

With reference to Figure 2, tele-density stood at 79.28%, of which rural tele-density remained approximately at a low 40%.[3] In comparison to April 2012, the urban subscriber share had declined to 64.65%, while the rural subscriber share had increased to 35.35% by May 2012.

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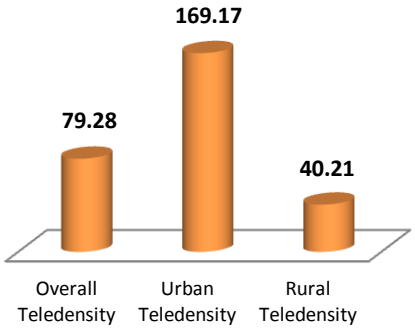
[1] Business Review India, *http://www.businessreviewindia.in/technology/software/-telecom-industry--indias-success-story*
[2] Telecom Regulatory Authority of India, *Press Release No. 143/2012*
[3] Telecom Regulatory Authority of India, *Press Release No. 143/2012*

Fig 2. Tele-density, %

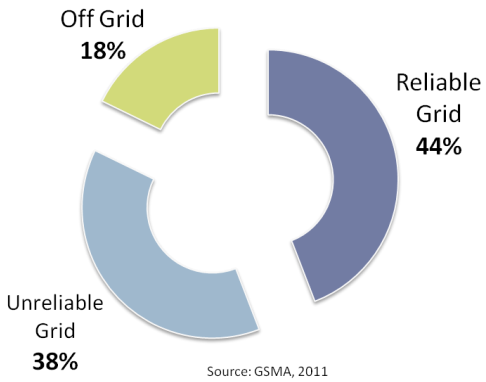
Source: Telecoms Regulatory Authority of India



Given the sector's slow-down in growth and existing low tele-density, rural telephony has been recognized as a potential growth avenue. However, increasing rural telecom penetration has been severely hindered by both the availability and reliability of grid power in the hinterlands. The low load factor of rural areas has had a negative influence on plant operating cost and high transmission losses make it costly to supply grid electricity in these regions.

The current lack of reliable grid electricity access is as suggested in Figure 3. Based on the feedback from telecom tower operators gathered and published by Groupe Speciale Mobile Association (GSMA), 38.1% of India's 400,000 telecom towers have unreliable access to the grid, while 17.8% are off the grid.[4] In sites lacking reliable electrical grid supply, operators use diesel generators, batteries and power management equipment for 7 to 21 hours per day to address this demand-supply gap.

Fig 3. Grid Connectivity for Cell-Sites



Source: GSMA, 2011

A consistently greater reliance on diesel generators has resulted in disproportionately higher energy costs of operating and maintaining rural telecom cell sites. As suggested in Table 1, this can be attributed to diesel costs being more than three times that of grid per unit of electricity.

[4] GSMA, *Energy for the Telecom Towers: India Market Sizing and Forecasting*

	URBAN (RELIABLE GRID) TOWER SITE		RURAL (UNRELIABLE) TOWER SITE	
Average usage of diesel generators	**4h**		**14h** [GSMA, 2011]	
Diesel cost per day @ ₹18/unit of electricity	4h* 3kW * ₹18 = **₹216**		14h* 3kW* ₹18 = **₹756**	
Grid cost per day @ ₹5/unit of electricity	20h* 3kW* ₹5 = **₹300**		10h* 3kW* ₹5 = **₹150**	
Monthly energy cost (30-50% of OPEX)	30* (216 + 300) = **₹15,480**	**USD 277**	30* (756 + 150) = **₹27,180**	**USD 487**
Examples of states	Chennai, Kolkata, Mumbai, Delhi		Uttar Pradesh, parts of West Bengal	

Table 1. Urban-rural cell site cost comparison

With monthly energy costs comprising of approximately 35% or more of total telecom operating costs,[5] telecom service providers penetrating into rural markets are continuously hindered by high operating expenditure.

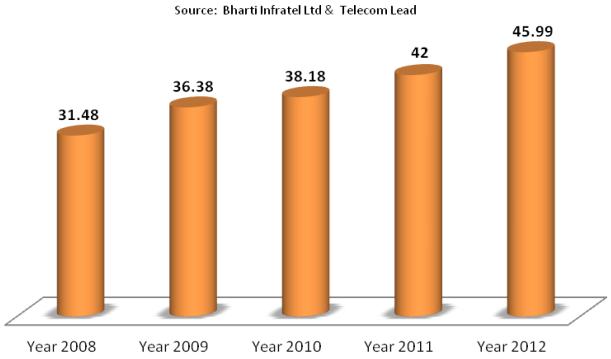
2.3 Challenges to Rural Conventional Cell-Sites

There are several key challenges rural conventional cell sites currently and increasingly face, namely rising diesel prices, the incidence of diesel pilferage, massive CO_2 emissions and governmental regulations.

Firstly, in addition to the existing high operation expenditure (OPEX), rising diesel prices is a major cause of concern for telecom tower providers. While diesel remains a commodity subsidized by the Government of India, diesel costs have increased overall by 46% over a span of 4 years.[6] [7] Figure 4 depicts this rising trend between 2008 and 2012. With diesel subsidies simultaneously being an increasing burden on the government's budget, they are expected to be reduced progressively over the next few years. As such, conventional rural cell sites heavily dependent on diesel face an even higher cost structure in the future.

[5] India Infrastructure Publishing Private Limited, *http://www.tele.net.in/green-corner/item/6649-keen-on-green-telecom-operators-explore-renewables-to-cut-costs-and-emissions*
[6] Bharti Infratel, *Business Drivers for Indian Telecom to Implement Green Strategies*
[7] Telecom Lead, *http://telecomlead.com/inner-page-details.php?id=10111&block=Whitepaper*

Fig 4. Cost of Diesel, ₹/L



An estimated figure of fuel losses accounting for 15 to 20% of total diesel consumed further poses a challenge to the telecom sector. In particular, diesel pilferage at telecom cell sites is rampant.

Environmentally, 2.5 billion litres of diesel consumed by telecom towers in India emit 6.6 million metric tonnes of CO_2 annually.[8] This makes the current use of diesel generators not only an economically unattractive solution, but also an environmentally damaging one. In 2010, the Economics for Equity and the Environment Network has estimated the social cost of each metric tonne of CO_2 to be USD 839.[9] While this amount varies across countries, it is a clear indication that annual emissions from conventional telecom towers would come at enormous costs to both nature and society.

As per policy initiatives recently approved by the Indian government in January 2012, telecom service providers are recommended to have at least 50% of all mobile telecom towers in rural areas and 20% in urban areas run on hybrid power (a combination of renewable energy and grid power) by 2015. By 2020, the government suggests that share of hybrid power should be increased to 75% and 33% in rural and urban areas respectively.[10] While current regulations remain as guidelines rather than mandatory legislation, stricter enforcement procedures are a future possibility. If so, green energy infrastructure would become a necessity, rather than an option.

As such, the rising operation costs, logistical issues, environmental damage of using diesel and state pressure are cumulatively calling for a search for green and sustainable alternative solutions in the telecom industry.

3.0 Exploring Green Alternatives

Three green alternative solutions that will be explored in this report are solar cell sites, intelligent hybrid systems, and bio-mass generators respectively. These alternative energy technologies will be individually

[8] Telecom Lead, *http://telecomlead.com/inner-page-details.php?id=10111&block=Whitepaper*
[9] Economics for Equity and Environment, *http://www.e3network.org/social_cost_carbon.html*
[10] Telecom Regulatory Authority of India (TRAI), *Approach towards Green Telecommunications*

analysed in a corporate sustainability framework. Questioning not only the costs and returns of investing in these technologies, but also their impacts on the environment and society is consistent with TTL's corporate strategy. Prior to launching into an in-depth analysis of the economic, social and environmental case for green telecom infrastructure, their general functions and feasibility will first be discussed.

3.1 Solar Cell Sites

In line with the Indian government's initiatives, solar-powered telecom towers are clean energy solutions and strong alternatives to conventional sources of energy. In particular, the top five states in India with solar photo-voltaic (PV) potential are Gujarat, Rajasthan, Maharashtra, Tamil Nadu and Andhra Pradesh respectively.[11]

AVAILABILITY

A key strength of solar solutions lies in its availability. There is abundant sunlight in India, from Kashmir to Kanyakumari, where numbers of clear sunny days range from 200 to 300 in a year.[12] Daily average solar energy incident varies from 4 to 7 kWh/m² and this solution poses little concerns over exhaustion and renewability.

LIFESPAN AND ADAPTABILITY

The installation of solar panels provides value for 30-40 years.[13] Since there are no moving parts and no inputs required such as oil, coal or gas or even water, solar PV projects have a long shelf life.[14] Furthermore, solar energy is modular and scalable. This offers the option of adding more PV modules in the future, possibly when cost savings from initial investments in solar panels at a certain location have been reaped.

RELIABILITY

Solar systems naturally do not generate power 24 hours a day since the sun does not shine at night. Additionally, seasonal limitations at certain sites mean that they would still have to be complemented by other power systems.

COST

The initial capital cost of installing solar panels is extremely high and may be unsustainable in the short to medium run. There is a long break-even period which reduces profitability. While an average site has the potential to cater to 3,000 subscribers, it can take from 5 to 8 years to recoup initial investments.

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[11] Energy Alternatives India, *India Solar PV Advisor*
[12] TATA BP Solar Services, *http://www.tatabpsolar.com/page_details.php?pg_id=Environment---Society-*
[13] India Infrastructure Publishing Private Limited, *http://www.tele.net.in/telefocus/telecom-infratsructure/item/7510-towering-costs-telecom-companies-explore-alternative-energy-solutions*
[14] TATA BP Solar Services, *Ibid*

3.2 Hybrid Cell Sites

A hybrid system functions by utilizing various energy sources optimally and intelligently to reduce diesel consumption and energy costs.[15] This solution has diesel generators, grid and batteries as its minimum essential components. Varying across sites, other renewable energy sources are complemented into the hybrid system.

WIND/SOLAR FUNCTION

Wind speed profile in India throughout the year is generally bell-shaped; lowest in January and February and goes to its maximum from June to September. During the latter period, an optimum wind-solar hybrid design allows system sizing to keep the system at a lower capacity, thus minimizing wastage.[16] On the other hand, a mains supply or diesel generator may be operated to recharge the battery bank during leaner months. The injection of power from the grid or diesel generator as back-up therefore guarantees power supply to users throughout the year.

ENERGY SAVING FUNCTION

The use of high temperature-resistant batteries utilizes efficient free cooling and eliminates the need of battery cooling, thus saving on fuel costs. With an intelligent control battery charger, the master controller can convert the AC input from the mains or diesel generator and charge the battery with DC in about 3 to 4 hours. Furthermore, efficiency is optimized with an automated master controller, which monitors energy output from the battery and keeps track of balance energy remaining inside battery as well.[17]

3.3 Bio-mass Generators

Bio-mass generators utilize bio-fuels from renewable energy sources, such as agricultural waste and residues, to power telecom towers instead of relying on diesel.

CLEAN

Bio-mass is considered a clean alternative to fuels such as petrol and diesel as it biodegrades fast, results in lower emissions and is made of renewable resources.[18] Examples include agricultural waste and residues including wood waste, coconut shell, babool wood, rice husks and sugar cane waste.

COST EFFECTIVE

While generating almost the same amount of energy as petrol diesel, bio-mass can cost less even after factoring the cost of delivery. The equivalent amount of bio-mass can cost 30-40% lesser than diesel in generating energy to power telecom towers.

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[15] Luminous Teleinfra Ltd, *Green Energy Solutions for Your Telecom Infrastructure*
[16] Luminous Renewable Energy, *http://luminousrenewable.com/Off-grid-telecom-tower.php*
[17] Luminous Teleinfra Ltd, *Ibid*
[18] Biodiesel Technologies, *http://www.biodieseltechnologiesindia.com/recent.html*

AVAILABILITY

While India has more than 20 bio-diesel producers with a combined capacity of more than 1 million tonnes a year,[19] this production capacity is largely insufficient to ensure a steady supply of fuel for telecom towers. Nonetheless, the approved National Policy on Bio-fuels aims to raise blending of bio-diesel with diesel and ethanol with petrol from 5% to 20% by 2017, thus increasing the availability of bio-fuels in the near future.[20]

4.0 Business Cost Analysis

4.1 Cost Analysis of Solar Cell Sites

SOLAR PV SYSTEM		***PURE DG SYSTEM***	
Fixed capacity	8 kWp	**Monthly yield**	2,100 kWh
Annual sunlight h	2500 h	**Daily diesel consumption**	40 kWh
Annual yield	20,000 kWph	**Monthly diesel cost**	₹21,600
Annual OPEX	₹240,000	**Monthly OPEX**	₹41,600
(OPEX) Cost/kWh	₹12/kWh	**(OPEX) Cost/kWh**	₹19.8/kWh
CAPEX (+ battery)	₹2,000,000 *(USD 35,894)*	**CAPEX per DG**	₹200,000 *(USD 3,589)*

Table 2. Solar PV and pure diesel generator system business cost comparison

Table 2 compares the cost structure of a solar PV system to that of a pure diesel system, in a hypothetical off-grid location. As suggested, the OPEX cost for solar-powered cell sites may be as low as 12 ₹/kWh in the most solar-intensive states such as Gujarat, Rajasthan and Maharashtra. This is significantly lower than pure diesel usage cost of 20 ₹/kWh. Notably, the capital expenditure (CAPEX) required to invest in solar panels, however, comes at 8 to 10 times the cost of each diesel-backed conventional system.

[19] Livemint and The Wall Street Journal, *Biodiesel Producers Looking for Tie-ups with Telecom Tower Firms*
[20] Ministry of New and Renewable Energy, *Strategic Plan for New and Renewable Energy for 2011-17*

4.2 Cost Analysis of Hybrid Cell Sites

HYBRID (SOLAR) PV SYSTEM	
BTS load	1,400 W
Solar array capacity	3 – 4 kWp
Battery	800-1,000 Ah
DG set	15 KVA
Estimated OPEX per month	₹35,800
Estimated monthly yield	2,520 kWh
(OPEX) Cost/kwh	₹14.3/kWh
Estimated CAPEX	₹800,000
Typical payback period	2 – 3 years

Table 3. Hybrid solar system business cost structure

The cost structure displayed below in Table 3 assumes that a hybrid solar system has the potential to reduce power-related OPEX costs and accumulate savings of about 50% per site.[21] The diesel generator is expected to run for 3 to 9 hours per day and once the required battery charge is achieved, the generator stops automatically. The solar system also does not need to be oversized, since it is normally dimensioned to take a share of 25-35% of the required energy generation load. This leads to significantly lower initial investments, as shown in a significantly lower CAPEX.

4.3 Cost Analysis of Bio-mass Fuel

SYSTEM	*BIO-MASS*	*PURE DG*
Bio-mass gasification	50 kW	-
Monthly yield	2,000 kWh	2,000 kWh
Monthly bio-fuel cost	₹13,000	₹21,600
Monthly OPEX	₹33,000	₹41,600
(OPEX) Cost/kWh	₹16.5/kWh	₹20.8/kWh
CAPEX per generator	₹250,000 *(USD 4,513)*	₹200,000 *(USD 3,589)*

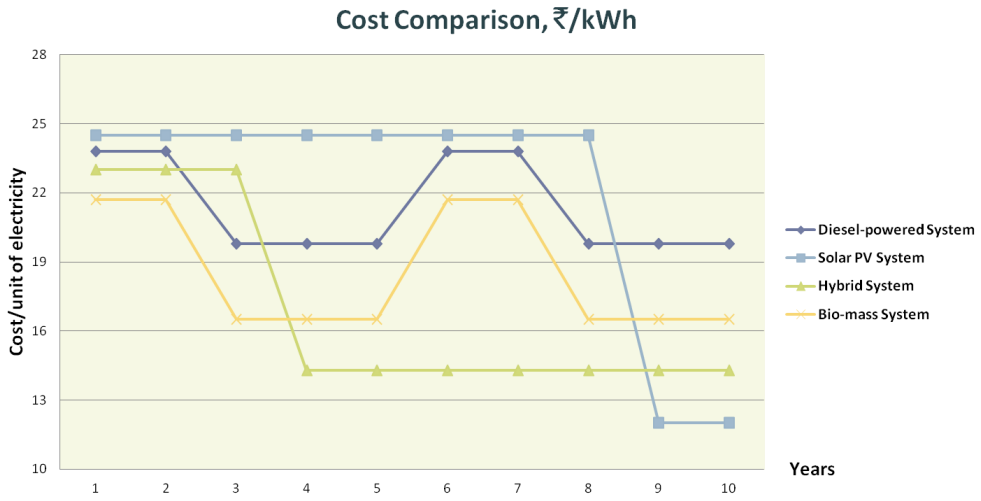
Table 4. Bio-mass system business cost structure

[21] Luminous Teleinfra Ltd, *Green Energy Solutions for Your Telecom Infrastructure*

While the energy cost saving potential can be up to 50% for a bio-mass generator,[22] a more modest reduction of 40% was factored in the above analysis as shown in Table 4. Given that its efficiency is comparable to diesel, an equal monthly yield was assumed. A 25% higher CAPEX was factored with the costs of additional filters required for a bio-mass generator, whereby producer gas is cleansed before being fed in to the gas engine. Although the business cost structure for a bio-mass system is favourable as an alternative to conventional diesel generators, a key obstacle lies in ensuring a steady and continuous supply of bio-mass inputs.

4.4 Long Run Cost Comparison

To analyse the OPEX and CAPEX involved in three green technologies alongside that of a conventional diesel-dependent site, Figure 5 below compares their respective business costs both in the short and long run. The graph is based upon the general assumption that payback from diesel-powered and bio-mass-powered systems begin after 2 years, that of a solar PV system begins after 8 years and that of a hybrid system begins after 3 years. Notably, a diesel generator system has the shortest payback period of 2 years, but generally requires replacements at the frequency of every 5 years. The cost per unit of electricity for a solar PV system decreases significantly after its long payback period. The cost for a hybrid system similarly decreases after its shorter payback period of 3 years. The latter appears to be a viable green alternative to the costly implementation of solar PV panels.



While cost per unit of electricity is high in the short and medium run for green technology, long run cost savings are evident from Figure 5. Notably, these expected cost savings have yet to take into account the accumulation of carbon credit. Furthermore, the mid to long term cost differences are anticipated to widen in the future, in the favour of green alternatives. This can be attributed to increasing trends in diesel prices and possible reductions of diesel subsidies by the Indian government. On the other hand, government subsidies on solar energy are simultaneously stated to increase. As of April 2010, this includes plans announced by the government to provide a 30% subsidy towards the building of solar panels in conjunction with the National Solar Mission. A

[22] Bharti Infratel, *Business Drivers for Indian Telecom to Implement Green Strategies*

greater demand for solar energy would directly result in economies of scale and greater price competitiveness for solar technology. While the Ministry of New and Renewable Energy's prediction of solar PV being cost competitive with grid tariff by 2017 may be optimistic,[23] it is highly likely that solar solutions will be increasingly viable as a green alternative.

5.0 Findings from Site Visits

5.1 Solar Sites in Haryana

Two solar site visits were conducted. They were at Ardana Chowk and Kheri Man Singh respectively, in the state of Haryana. Both of them were in off-grid locations and were mainly surrounded by agricultural land. They similarly supported a 48 kW system, consisting of twelve solar panels of 4 kW each. In both of these sites, diesel generator usage was unnecessary during the hot summer months and required for up to 6 hours during the winter and monsoon seasons. As far as possible, solar energy was utilized in recharging the battery banks in the day to provide electricity in the nights.

5.2 Bio-mass Sites in Rajasthan

The bio-mass site studied was located at Gandala, in the district of Alwar under the state of Rajasthan. It was running on unreliable grid electricity, which was available for approximately 10 hours on an average day. It supported a 48 kW system and had been in operation for four years. The bio-mass generator ran from 6 to 8 hours per day, contingent on the supply of dry wood for fuel.

6.0 Socio-economic Impact Analysis

6.1 Connectivity on Roads

The construction and operation of telecom towers meant better coverage and mobile connectivity for major roads. In the case of the three sites studied above, they were the Karnal-Jind, Karnal-Indri-Yamuna Nagar and Delhi-Jaipur highways. Mobile connectivity is highly complementary to roads and transport infrastructure.[24] Not only does mobile communication improve economic efficiency, it also allows road users to make calls in cases of emergencies.[25]

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[23] Ministry of New and Renewable Energy, *Strategic Plan for New and Renewable Energy for 2011-17*
[24] Earth Institute, Columbia University, *Millennium Villages Project*
[25] The Times of India, *Soon, Mobile Connectivity All Along Highways*

6.2 Connectivity in Local Villages

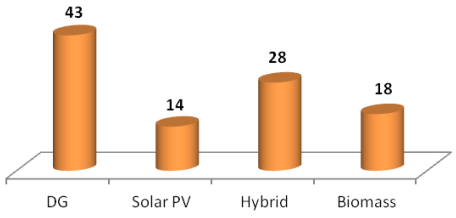
For the village at Ardana Chowk, three villages at Kheri Man Singh and town at Gandala, a total population of 13,000, equivalent to an average of 2,500 households, mobile connectivity would have brought about significant socio-economic benefits. Connectivity and communication over distances is known to strengthen social networks, reduce vulnerability and isolation. Access to health and education services would improve with mobile communication, and this simultaneously opens new opportunities for information transmission and business. Hence, the possibilities for mobile health and mobile commerce increase.

7.0 Environmental Impact Analysis

7.1 Reduced Carbon Emissions

With much lesser diesel usage, both the solar and hybrid systems are projected to emit significantly lesser amounts of CO_2. Similarly, bio-mass projects reduce emissions of greenhouse gases by replacing fossil energy and avoiding methane emissions. Referring to the previously-discussed estimated social cost of each metric tonne of CO_2, the amount of ₹46,000 (USD 839),[26] reducing carbon emissions would equate to significant savings. As suggested in Figure 6 below, the estimated CO_2 emissions for the solar PV system is almost a third that of a conventional cell-site, while a bio-mass system emits less than half comparatively.

Fig 6. Estimated CO_2 emissions per year, tonnes



Estimates based on data from Bharti Airtel Ltd & Telecom Lead

7.2 Reduced Noise Pollution

Noise pollution produced from running diesel generators are also minimized with alternative green technologies. Although noise is a significant environmental problem, it is often difficult to quantify associated costs. While non-quantitative and varying across communities, the social cost of noise pollution is commonly associated with the loss of sleep, poor concentration, communication difficulties and fatigue due to insufficient rest.

[26] Economics for Equity and Environment, *http://www.e3network.org/social_cost_carbon.html*

8.0 Way Forward

1) The challenges of rising diesel costs, rampant diesel pilferage, and more importantly increasing environmental pollution call for alternative green solutions to existing diesel-dependent telecom towers.
2) While a solar PV system is a viable option in India, its high capital expenditure remains a key concern from a business viability perspective.
3) A hybrid system is an effective mid-way alternative which balances the costs and benefits of alternative and conventional functions.
4) Bio-mass is a clean alternative to diesel, but its usage and viability is contingent on continual supplies.
5) In examining long-term cost structures of both conventional and green solutions, the latter require larger initial capital investments but their costs are comparatively lower after a period of 4 to 8 years.
6) The gap between business costs for conventional and green models is expected to widen in the future, with conventional models growing increasingly expensive.
7) Operating telecom towers, particularly in off-grid locations, brings about connectivity in villages and on major roadways, thus improving rural telephony and contributing to economic progress.
8) Utilizing green alternative technologies will majorly reduce environmental pollution and bring about social change – a very desirable end state for sustainable business practices.
9) From a corporate sustainability perspective, it is an imperative to consider the investing in green telecom.

Bibliography

Ackerman, F., & Stanton, E. A. (2011, July). *Climate Risks and Carbon Prices: Revising the Social Cost of Carbon.* Retrieved August 2012, from Economics for Equity and Environment: http://www.e3network.org/social_cost_carbon.html

Biodiesel Technologies. (2011, December). *Railways to Set Up Four Biodiesel Plants*. Retrieved August 2012, from Biodiesel Technologies: http://www.biodieseltechnologiesindia.com/recent.html

Datta, A. (2010). *Biodiesel Producers Looking for Tie-ups with Telecom Tower Firms.* Livemint and the Wall Street Journal.

Earth Institute. (2010). *Millennium Villages Project.* Columbia: Ericsson.

Energy Alternatives India. (2011, September). *India Solar PV Advisor.* Retrieved August 2012, from Energy Alternatives India Club: http://www.eai.in/ref/reports/solar.html

Green Power for Mobile. (2011). *Energy for the Telecom Towers: India Market Sizing and Forecasting.* London: GSMA.

Intelligent Energy India. (July, 2012). *The True Cost of Providing Energy for Telecom Towers in India*. Retrieved August 2012, from Telecom Lead: http://telecomlead.com/inner-page-details.php?id=10111&block=Whitepaper

Luminous Renewable Energy. (2012). *Off-Grid Telecom Towers*. Retrieved August 2012, from Luminous Renewable Energy: http://luminousrenewable.com/Off-grid-telecom-tower.php

Luminus Teleinfra Limited. (2010, September). Green Energy Solutions for Your Telecom Infrastructure. New Delhi, India.

Ministry of New and Renewable Energy. (2011). *Strategic Plan for New and Renewable Energy for 2011-17.* India: Government of India.

Panigrahy, K. C. (2010, September). Bharti Infratel: Business Drivers for Indian Telecom to Implement Green Strategies. India.

(2012). *Press Release No.143.* New Delhi: Telecom Regulatory Authority of India.

Tata BP Solar Services. (2011). *Environment and Society*. Retrieved August 2012, from Tata BP Solar Services: http://www.tatabpsolar.com/page_details.php?pg_id=Environment---Society-

Tele.Net. (2010, November). *Keen on Green: Telecom Operators Explore Renewables to Cut Costs and Emissions.* Retrieved August 2012, from India Infrastructure Publishing Private Limited,: http://www.tele.net.in/green-corner/item/6649-keen-on-green-telecom-operators-explore-renewables-to-cut-costs-and-emissions

Tele.Net. (2011, February). *Towering Costs: Telecom Companies Explore Alternative Energy Solutions*. Retrieved August 2012, from India Infrastructure Publishing Private Limited: http://www.tele.net.in/telefocus/telecom-infratsructure/item/7510-towering-costs-telecom-companies-explore-alternative-energy-solutionsTATA%20BP%20Solar%20Services%20-

Telecom Regulatory Authority of India. (2011). *Approach Towards Green Telecommunications.* New Delhi.

Thakkar, P. (2012, June). *Telecom Industry: India's Success Story.* Retrieved August 2012, from Business Review India: http://www.businessreviewindia.in/technology/software/-telecom-industry--indias-success-story

The Times of India. (2011, December). Soon, Mobile Connectivity All Along Highways. New Delhi, India.