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Study on Environmental Impact and Regulatory Aspects of Sustainability of Telecom Industry

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Abstract - *India has the second largest and the fastest growing telecommunication market across the world with 1.18 billion telephone subscribers (overall teledensity of 87.37%) connected through over 5 lac telecom towers. The power and energy consumed in the operation of the telecommunication network contributes a major share of carbon emissions in this industry. Thus, it's significant for the telecom service providers (TSPs) to move to green technologies and alternative energy source. The Telecom Regulatory Authority of India (TRAI) and Department of Telecommunication (DoT) have been taking steps towards combating climate change. With the offset of 5G technology and day-by-day increasing teledensity, the energy demand is likely to increase manifold; which will further increase the energy consumption patterns of this industry. As its major contribution, this report delineates the said issues, analyzes the ongoing practices, and suggests the way forward. The responses received on the public indicate that the citizens are aware about the radiations emitted from the telecom towers but are not sure about their scientific evidences. Also, the hypothesis testing of the results proves that there is a strong dependence of the following statements –*

- *There is a dire need for telecom industry to approach towards sustainability*
- *With the advent of new technologies like 5G, internet of things, artificial intelligence; the carbon footprint emission will increase if measures are not taken*

Key Words: **Telecommunication industry, green telecommunication, carbon footprints, sustainability, telecom service providers, government initiatives**

1. INTRODUCTION

The Indian telecom industry is accountable for around 1% of the total carbon dioxide emissions in the country, which exceeds the global standard of 0.7%. Hereby, it should be rigorously pushed to formulize and adhere to the alternate energy solutions since the surfacing technologies like 5G, Internet of Things (IoT), Artificial Intelligence (AI) etc. would exalt the energy consumption manifold.

Basis the analysis done by Vertiv, 5G is expected to rise the utilization of the total network energy by 150 – 170% by 2026. In 2018, the telecom towers are account for 51% volume share in the consumption of commercial diesel gensets (DG) consumption in India. Henceforth, the scope of Sustainability and green telecom are direly important to cater the emerging technological developments without causing a damage to the environment.

Amongst the constituents of the mobile network, the base station, mobile switching centers and core transmission consumer 59%, 21% and 18% of the power in the network. Presently, up to two-thirds of the network demand in the rural areas is met by diesel and only one-third of the demand is sufficed by utility power. If the networks are planned better, infrastructure is shared effectively, energy efficient technologies are adopted with renewable energy sources and the available power is utilized judiciously; then the consumption of the power at the site can be optimized. As the requirement of the transmission of data in the networks becomes twice in every five years and the site power usage constitutes about 71% of the carbon emissions in the Indian telecom sector; thus, containing the power consumption in telecom networks would be pivotal for any green telecom strategy [1].

1.1 Overview of Indian Telecom Industry

- Currently, India is the world's second-largest telecommunications market with 1.18 billion [2] subscribers and has recorded a substantial growth in the past 15 years.
- Telecom sector contributed 6.5% of gross domestic product (GDP) of the country in 2019.
- The teledensity of Indian telecom industry (wireless plus wire line) was 3.60% in March 2001 [3], which has now exalted to 86.03% till July 2020 [2].
- The telecom industry is a huge source of revenue for the government of India. The government fetches revenue majorly as licence fees and spectrum usage charges (SUC) from TSPs, which is calculated upon the adjusted gross revenue (AGR) of TSPs.

1.2 Green Telecommunication

As the telecommunications infrastructure grows, the requirement of the electricity, to provide power to it, increases. Partially, the electricity is obtained from the power grid and the rest through burning of fossil fuel, for example diesel. But these sources lead to the emission of greenhouse gases (GHG) with hazardous environmental impact. Greening of telecom is defined as the process of reducing the GHG that the telecom sector produces or causes

to be produced. Green telecom has various dimensions. It can be broadly categorized as –

- **Green telecom networks** – Minimization of the energy consumption by using energy efficient technology, alternate sources of energy and environment friendly consumables.
- **Green manufacturing of telecom equipment –** The manufacturing procedure off telecom equipment should include environment friendly components, energy efficient manufacturing equipment, recycling of electronic and mechanical waste and disposal, minimizing the use of harmful substances and reducing the hazardous radio emissions.
- **Eco-friendly design of telecom buildings –** Optimization of **e**nergy and thermal power consumption and minimizing the emission of GHG.
- **Safe disposal of telecom waste –** Eco-friendly disposal of mobile handsets, network equipment, etc. to avoid the channelization of any toxic material, used in manufacturing, into atmosphere and underground water.

1.3 Carbon footprint

Carbon footprint is defined as the total GHG emission caused by burning fossil fuels to generate electricity. It is usually expressed in terms of CO_2 equivalent tons i.e. CO_2e. Carbon footprints can be broadly categorized as follows –

- **Primary footprint** – It is measured as the amount of CO_2 emitted directly from the burning of mineral oil in the operations of a carbon-printed business. The telecommunications service provider may include, for example, network operating costs, lighting, construction and cooling, heating and transportation. The service provider will have direct control over these.
- **Secondary footprint –** It is a measure of the indirect emission of CO_2 associated with the production and final deterioration throughout the life cycle of the products used. The energy used in the manufacture of equipment such as the base transceiver station (BTS) results in the second printing of the service provider who uses it.

1.4 Motivation for Green Telecommunication

The hazardous impact of climate change has drawn a lot of attention across the globe and thus, people have become concern and conscious for the same. Presumably, ill climate change instances like temperature increase, melting of glaciers, rising of sea level, natural calamities are results of greenhouse effect which is caused by the emissions from burning fossil fuels to generate energy.

Various factors have resulted in exalted interest going green for service-sector industries. The following factors are leading to the heightened actions towards greening of telecommunication –

- Reducing the operational costs of telecom network by decreasing the cost of energy they run upon.
- Network expansion in rural regions with poor power availability.
- Availability of alternative energy technology at reasonable costs
- Confluence against global warming.
- Sustainability in business has become crucial wherein the objective is to minimize the impact on the environment in addition to creating products and offering services ethically.

2. MEASURES TAKEN BY TELECOM REGULATORY AUTHORITY OF INIDA (TRAI)

India is the second largest and the fastest growing telecom market in the world. So, we should be very wary about the concerns in this regard. There is a huge scope for sustainable and innovative steps to be taken to make telecommunications green as India is heavily dependent upon the import of petroleum products despite being abundant in renewable sources of energy. It is in this regards TRAI and TSPs (upon the consultation with TRAI) have taken several measures.

2.1 Consultation Paper on Green Telecommunication, February 3, 2011 [1]

TRAI has suggested the following categories to be examined for the measures that could be adopted to reduce the carbon footprint of telecom industry –

- **Adoption of energy efficient equipment and innovative technologies**
  - **a.** The cost of Energy account for more than 50% of the holistic operating costs for mobile operators and nearly 65% for tower site equipment.
  - **b.** Efficiency of energy in radio station products is a key factor in the CO_2 reduction. This feature enables less power consumption on networks at the times of low traffic times by placing network services, unused, in standby state.

- **Using renewable sources of energy**
  - **a. Solar energy –** Hybrid and diesel solar solutions can result to a 50% reduction in the costs related to energy.
  - **b. Wind energy –** Mount the smaller systems on the existing radio masts to reduce the

cost and select the sites carefully that include wind–turbines.

c. **Ocean/tidal energy –** Ocean thermal energy conservation (OTEC) utilizes ocean temperature differences to generate energy.

d. **Biomass energy –** It absorbs CO_2 from the air while growing and releases equal amount of CO_2 when it is processed to produce electricity. Thus, can reduce the effects of global warming. Using biomass instead of fossil fuel for the DG which is a part of the previous hybrid solution.

- **Sharing of infrastructure –** TSPs can save 40% more as a benefit of opting passive infrastructure sharing. It also saves upon other resources like steel (about ten tons), cement, concrete, Zinc (500 liters used in galvanizing), conservation of land and soil, and power optimization.

- **Improving grid supply** – Provides reliable and better quality of power at a reasonable cost. Making grid power available in rural and remote areas, the use of diesel for telecom tower sites would, as a result, lessen the carbon footprint emission.

- **Better network planning –** More outdoor BTS, less air conditioning to cool down the sites
  a. Reduce the utilization of energy by designing the network solutions and services in a way that they use lesser sites and thus, reduce the consumption of consumption.
  b. Design backhaul for sharing with adaptive Ethernet transmission rate switching that depends up on the load of traffic.
  c. Telecom towers can be used as wind towers and solar panels as shelter roofs and other such innovative methods can also be advantageous.
  d. TSPs can use power management systems based on software to monitor and manage the energy consumption in their respective facilities. Better planning of the systems can reduce the energy costs by 15 – 35%.

- **Standardization of equipment, testing and certification**
  a. Telecom equipment should conform the existing global standards for green telecom; for instance, ISO 14001:2004, OHSAS 18001:1999.
  b. TRAI can push and emphasize upon star ratings or equivalent rating systems on products used by TSPs, as BEE (Bureau of Energy Efficiency) is framing the star ratings for industrial equipment.

- **Efficient manufacturing process –** Renewable materials and recycled packaging material should be used by the product manufacturer as far as possible.

- **Monitoring and reporting –** Frame comprehensive consultation guidelines with industry for the estimation and reporting of carbon footprint, as **s**uggested by stakeholders at the time of pre-consultation.

2.2 Consultation Paper on Approach Towards Sustainable Telecommunication, January 16, 2017 [4]

This consultation paper by TRAI explains the importance of energy efficiency in the modern telecom networks and gives suggestive consultation to optimize the performance of the network based on the energy demands. This paper comprehensively discussed the methods that might be deployed to calculate the carbon footprint emitted by the network and ways to achieve the renewable energy goals in this sector.

Calculation of carbon footprint [5]

A detailed approach needs to be followed to calculate the of carbon footprint precisely, as shown below –

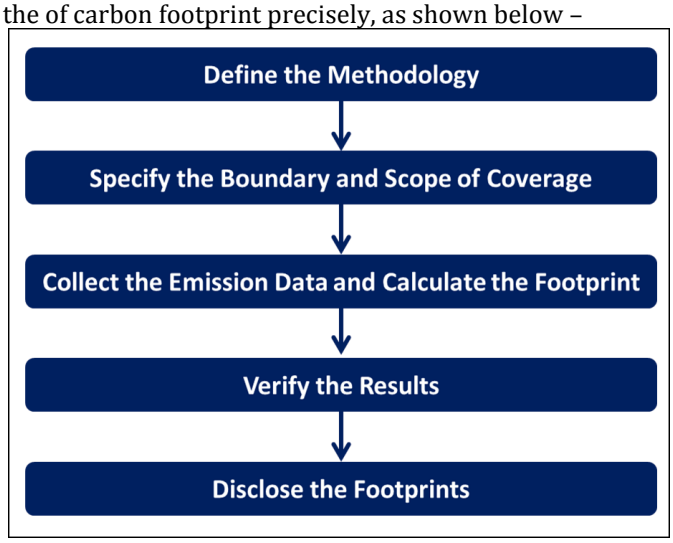

Fig - 1: Approach to calculate carbon footprint

1. **Define the Methodology for Calculating Carbon Footprint –** A comprehensive and precise methodology to calculate the carbon footprint is needed.

2. **Specify the Boundary and Scope of Coverage –**A boundary should be clearly defined so that the emissions from the telecom network can be practically quantified.

3. **Collection of Data for Emissions and Calculation of Carbon Footprint –** The carbon footprint can be calculated precisely if the accurate data is collected. It might include information collection on the following fronts –
   - Fuel consumption in DG sets
   - Telecom equipment operating hours
   - Electricity consumption by telecom equipment from the supply of grid power

   Set the threshold value for the precision level as a possible option, to achieve the said requirement, that can be utilized by incumbent TSPs during the collection of emission data. This would minimize the uncertainties in calculations as far as possible and thus, precise results would be obtained.

4. **Result Verification –**If the results of carbon footprint are verified and validated by a third party, it shall provide authenticity to the carbon footprints claimed by the TSPs. Validation usually includes the analysis of the methodology adopted, technique of collecting the data collection and the process used for calculations.

5. **Declaration of Carbon Footprint –** The TSPs are supposed to disclose their calculated carbon footprint before TRAI to ensure the transparent presentation of the data, sharing the detailed information in regard to the process followed and implication of the information. The total carbon footprint is the sum of the carbon footprint emissions from the combustion of diesel in DG sets and utilization of electricity purchased.

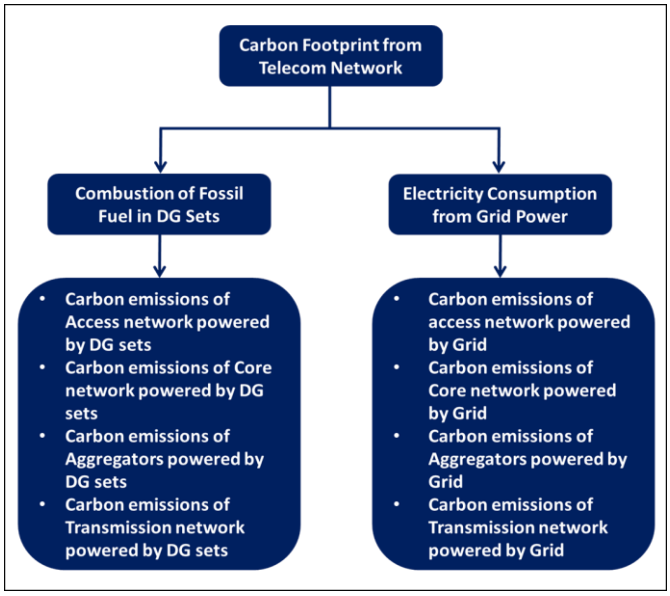

Fig - 2: Total carbon footprint of telecom network

Calculation of Average Carbon Footprint of the Telecom Network

Option 1: Average across total subscribers

Let N_{SUB} be the overall number of subscribers, then the average carbon footprint per unit subscriber is –

$$C_{TOTAL\_PER\ UNIT\ SUBSCRIBER} = \frac{CTOTAL}{NSUB};$$

in tons per unit subscriber

Option 2: Average across total unique users

Let N_{USERS} be the overall number of unique users, then the average carbon footprint per unit subscriber is –

$$C_{TOTAL\_PER\ UNIT\ USER} = \frac{CTOTAL}{NUSERS};$$

in tons per unit subscriber

Option 3: Averaging across total traffic carried

Let T (in Exabytes) be the traffic carried by the telecom network , then the total carbon footprint per unit traffic is –

$$C_{TOTAL\_PER\ UNIT\ TRAFFIC} = \frac{CTOTAL}{T};$$

in tons CO_2e per unit Exabyte

3. MEASURES TAKEN BY DEPARTMENT OF TELECOMMUNICATION (DoT)

With an aim of achieving the objective of the green telecom and reduction in the carbon footprint, TRAI had issued recommendations on "Approach towards sustainable telecommunications". Government of India has taken the consultation into consideration and has decided to set up the process to measure the carbon footprint and execute the goals of reducing the carbon emission. The following directions are issued to the licensees for implementation with immediate effect [6] –

- The precision of the carbon footprint should be taken adequately basis the self-certification by the TSP. They shall submit the carbon footprint report on self-certification.
- Carbon footprint report to be submitted annually within 45 days after March 31.
- The TSPs should willfully deploy the renewable energy technology solutions, equipment with high energy efficiency and storage solutions with high capacity fast charging for achieving goal of reducing the carbon footprint. They shall submit a finalized road map to achieve the said targets within a quarter from the issue date of these directions.

- RET deployed in telecom network, irrespective of source of funding of RET project, should be counted towards saving from overall carbon emission.
- The TSPs can deploy a voluntary code of practice to encompass the energy efficient planning of the network, sharing the infrastructure, deploying the energy efficient technology, and adopting the RET in their operations.
- TSPs might evolve carbon credit policy with carbon credit norms with an aim to meet the ultimate target of reducing the carbon footprint – Meeting a 50% and 66% upon the carbon footprint levels of the base in rural and urban areas respectively by the year 2020. The current status report in this regard may be submitted within three months.
- The target for reduction in average carbon emissions shall be 30% for2019 – 20 and 40% by 2022 – 23, taking year of reference as 2011 – 12. For TSPs whose services had started after 2011 – 12, the base average year carbon emissions shall be considered as the average base year carbon emission of TSP with highest subscriber basis in the year 2011 – 12. The targets shall be reviewed in 2022 – 23.

4. MEASURES TAKEN BY INIDAN TELECOM OPERATORS

4.1 Reliance Jio Infocomm Limited (RJIL)

RJIL has been the newest entrant in the Indian telecom industry with a sky-rocketing subscriber base within merely 4 years of operations. RJIL has been very wary about the environmental sustainability since its conception. The various sustainable measures taken by RJIL have been enlisted below [7] –

- The camouflaged 4G ground-based masts (GBM) designed to utilize only 600-700 W which is 25% of the power consumed by existing conventional towers.
- They run on Li-ion batteries that eliminate the requirement of space and fuel-gulping diesel generators.
- Strategic decision of using high energy density Li-ion battery over conventional Lead acid battery to eliminate 80% of Jio sites (< 8 h power outages) from using Diesel Generators.
- Solar based solutions considered to address 20 % of Jio sites with long power outages and off-grid sites with an aim to eliminate/minimize DG utilization.
- Fuel cells was considered as potential alternate to diesel generators for telecom backup power applications especially for the sites with long power outages (> 8 h/day).
- For the FY 2017-18, across all the locations we collected total 44.77 KL waste oil generated from DGs and safely disposed it through the authorised vendor from pollution control board.
- Installed mobile dispensing units at 4 lac towers to reduce diesel spillage and thus soil pollution.

4.2 Bharti Airtel

Bharti Airtel is a telecom giant with 317.80 million subscribers [8] in India with a market share of 27.78%. The highlights of its sustainability performance in FY 2017 – 18 [9] is as follows –

- Reduced 83% CO_2 emissions/TB in network infrastructure in the past 2 years and 92% in the past 4 years.
- Over 5,000 tons of e-waste recycled, and 8.4 lacs DTH Set Top Boxes refurbished in the past two years.
- Over 3250 solar-enabled towers deployed.
- Reduced 28% CO_2 emissions/ft^2 in their facility and 25% CO_2 emissions/rack in data center operations, as compared to FY 2015-16.
- Increased more than 15% in procuring the RET by pushing into their operations to over 90 Mn units per annum that saved over 73,000 tons of CO_2 emission/annum.
- Reduced 23.6 million liters of diesel in network infrastructure in FY 2016-17.
- Saved over 2500 MWh of electricity in facilities by adopting energy conservation initiatives.

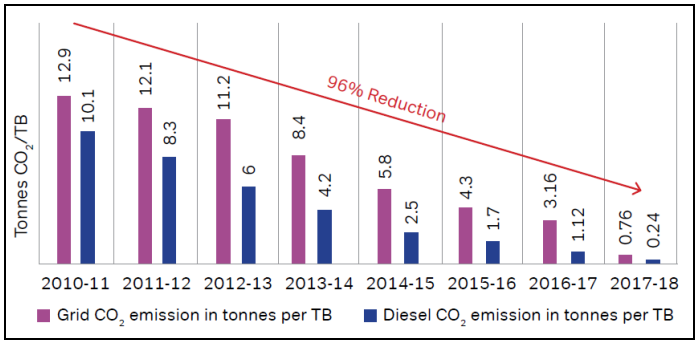

Chart -1: Emission trends on network infrastructure [9]

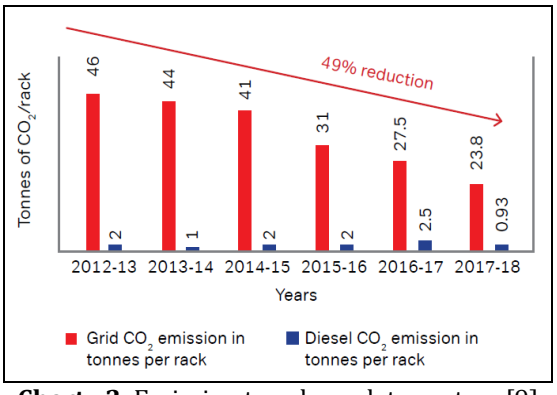

Chart - 2: Emission trends on data centers [9]

Table - 1: Airtel Sustainability Plan – 2020

Approach	Action Items	Target 2020
Responsible approach towards sustainability with a low-carbon economy. In addition to sustainable steps to develop eco-friendly solutions for a sustainable future.	• Reduction in hazardous impact of telecom infrastructure on the environment • Reduction of carbon footprint in operation • Optimization of resource and waste	• Recycle 100% e-waste • Reduction in carbon emissions intensity per TB by 90% • 10% reduction in direct emission, Diesel and energy consumption 50% increase RET usage

4.3 Vodafone Idea Limited

Vodafone Idea is a merged TSP in India that came into existence as one entity on August 31, 2018.

Steps Taken or Impact on Conservation of Energy in Network [10]

- More than 50,000 green sites from internet protocol (IP) partners
- In FY 2018-19, over 2600 indoor sites were converted to outdoor sites. Mostly outdoor sites are considered under new deployment
- The entire procurement of the telecom hardware consumes much lesser power.
- More than 95% of the sites deployed in FY 2018-19 were at existing 2G sites and/or shared sites for reduction of carbon emissions and consumption of energy.
- Continued with initiatives on equipment energy saving such as future of saving power on (mobile gateway)MGW cards at the time of low traffic.
- Renewable energy-based generation through Power Purchase Agreement (PPAs), versus its consumption is 8.85 MW.

Steps Taken for Utilizing Alternate Sources of Energy [10]

- **Implementation of solar energy at on-site:** Continued with the already installed operation capacity of 25 KW.
- **Deployment of renewable energy at off-site:** Basis the carbon abatement principle, in FY 2018-19 the following solar units were generated:
  - 3.1 million Solar Units generated from 3 MW Solar PPA in Andhra Pradesh
  - 0.75 million Solar Units generated from 1.25 MW Solar PPA in Madhya Pradesh
  - 2.4 million Wind Units generated from 2 MW Wind PPA in Tamil Nadu circle
  - 0.3 million Solar Units generated from 2 MW Solar PPA in Maharashtra Circle

5. MEASURES TAKEN BY INTERNATIONAL TELECOM OPERATORS

5.1 Telecom Italia Mobile (TIM)

TIM is a telecom service provider headquartered in Rome, Italy.

Energy Efficiency [11]

- TIM has made investments in the energy auto-generation in the form of distributed generation projects – electricity micro-generation models with renewable energy sources, under its risk management strategy.
  - Under distributed generation projects, TIM has dedicated 100% of the small hydroelectric power plants in Minas Gerais to its operations. This promotes the renewable energy usage in the national power grid.
  - About 50% of its energy consumption was obtained from renewable sources in 2019. TIM commits to increase it to 60% by the end of 2020 and to 70% by 2025, under its 2020-2022 Strategic Plan.
- TIM also makes continuous investments in various energy efficiency initiatives like Decommissioning project in which the equipment from the sites are deactivated and removed to decrease the power consumption and release space for new projects.

Waste and Recycling Management – Collection of used cell phones, batteries, modems, and other accessories to recycle. Achieved 0.6 ton (targeted was 0.5 ton in 2019). Target for 2020 is 1.5 tons [11].

Table - 2: Emissions Management by TIM [11]

Scope	Type of Emission (measured in tCO_2e)	2018 to 2019 % change
Scope 1	**Direct Emissions** • Burning fuel in company fleet • Burning diesel oil • Fugitive emissions from gases used in refrigeration and firefighting equipment	(-) 172.27%
Scope 2	**Indirect Emissions Associated with Energy Generation –** Consumption of purchased electricity	(+) 3.38%

Scope 3	**Other Indirect Emissions**
	• Burning fuel
	  ○ Air travel by employees
	  ○ Daily commuting by employees
	  ○ Outsourced fleet and vehicles of sales consultants
	  ○ Cargo air freight
	• Waste management
	• Production of purchased inputs
	• Production of energy inputs Losses in transportation and distribution of electricity
		(-) 28.78%

5.2 China Mobile Limited

China Mobile Limited is one of the leading Telecom services providers in China. It had 950 million wireless subscribers and 187 million wireline broadband customers [12], as on December 31, 2019.

Achievements in 2019 [12]

- 43% reduction of total annual per unit energy consumption of information flow.
- 69% increment in the rate of green packaging and implementation of green procurement and promotion of the green development of the supply chain.
- Reduction of 2.21 billion units in the annual consumption of power which is equivalent to the 1.415 million tons of GHG emissions.

Table - 3: Emissions Management by TIM

Parameter	Indicator	2018 to 2019 % change
Energy	Coal consumption (10,000 tons)	(-) 300%
	Diesel fuel consumption (million liters)	(-) 12.97%
	Coal gas consumption (million m^3)	(+) 37.5%
	Reduction in equivalent annual GHG emission (10,000 tons)	(-) 20.56%
	Reduction in per unit of information flow of energy consumption (%)	(-) 32.56%
Emissions	CO_2 emissions (million tons)	(+) 6.64%
	Carbon emission t business travel (10,000 tons)	(+) 13.3%
Green Operations	Number of video conferences at group level	(+) 18.07%
	Reduction in paper with e-procurement (10,000)	(+) 70.63%
	Number of online e-procurement projects (10,000)	(+) 70.59%

Goals 2020 and Beyond

- Exploration of ways for the application of 5G technology for the protection of environment.
- 15% and 10% reduction of total consumption of energy per unit of information flow and per unit of telecom business respectively by 2020
- Obtaining a 60% or more green packaging ratio by 2020.
- Promotion of green procurement and logistics; and establishment of green supply chain system to cover the overall process of procurement.
- Formulation of energy saving, and environmental protection targets so as to promote green packaging, reverse logistics, Radio Frequency Identification (RFID) embedded packaging, and traceability of the entire process.
- Reduction of total energy consumption, carbon emissions and network (connection) scale from year-by-year.

6. GROWING TEELCOM INFRASTRUCTURE AND SUSTAINABILITY CHALLENGES

There have been constant operational and deployment challenges for the telecom network operators to resonate technology and infrastructure they have with the service opportunities to foster the generation of revenue. The cost incurred in the operations of the telecom network operations are quite high because of the stringency of the next-generation technology which is based on the network, and moreover to fetch the appropriate skill set to integrate and maintain the infrastructure of the network is becoming even more difficult.

6.1 Dipping ARPU and Revenue

The Telecom Industry in India have the lowest average revenue per user (ARPU) in the world i.e. ₹74 [14]. With dipping revenue generation from voice calls (6 paisa per minute) and with the cheapest data tariffs in the world.

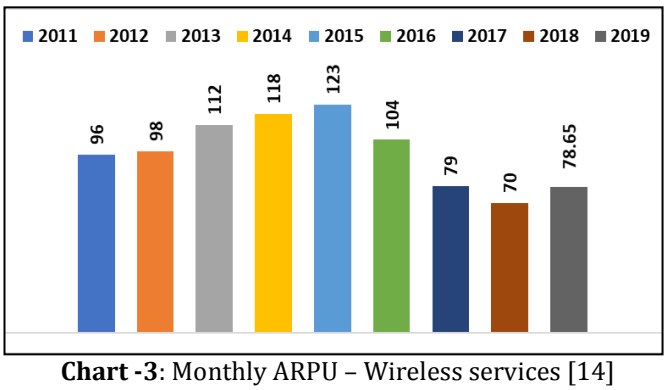

Chart -3: Monthly ARPU – Wireless services [14]

The primary reason behind the falling ARPU is dipping call rates that give rise to competitive pricing and therefore making them affordable for the lower income subscribers. The TSPs in India function upon low tariffs and high-volume model while their revenue generation operates upon the

contrary model i.e. high tariffs and low volume. Moreover, TRAI had decreased the interconnect usage charge (IUC) for the voice calls by about 57% i.e. it was brought down to 6 paise from 14 paise per minute in 2017 which was to be abolished in January 2020 [15], but this has been deferred by another year till January 2021. This rate cut had reduced the revenue generation and thus had created a dent in TSPs' margins and profits. Furthermore, Mobile Number Portability (MNP) has also contributed to the declining revenues of the TSPs.

6.2 High Levies and Taxes

There is plethora of taxes implied on the TSPs. In addition to a high fee of licence in spectrum acquisition, they have to pay other charges related to spectrum like spectrum allotment and radio waves usage charges. Furthermore, the GST has enhanced the current financial burden on TSPs.

Table - 4: Levies and Taxes on Telecom Sector

SUC	3% of AGR; additional 0.5% if a spectrum band is shared amongst TSPs
Licence Fee	8% of AGR
Goods and Services Tax (GST)	18%
Universal Service Obligation Fund (USOF)	5% of revenue

6.3 Lack of Infrastructure

Initially, the growth of grid penetration growth was not matching with the penetration of the telecom services. Therefore, restricted or unavailability of the basic infrastructure like power supply and unstable grid power system resulted in enhanced downtime and lack of connectivity to reach the hinterland. Gradually, the situation is improving with the government of India's full electrification scheme. Although there are still some bottlenecks in terms of the quality, infrastructure, and intermittent lack of supply.

6.4 Low Penetration in Rural Areas

The tele-penetration in urban areas has attained a level of maturity with tele-density of 137.47%, while that in rural areas is only 59.14% [2]. Therefore, rural India is an opportune area. Low revenues clubbed with high capital expenditure in terms of unavailability of grid system, lack of quality, high consumption of diesel and high costs of alternate energy sources is required to provide infrastructure, lacks basic services and trained personnel, which furthermore are obstructions in the deployments.

6.5 Limited Spectrum Availability

The spectrum for rolling out the commercial 5G services is available only in the bands of 700MHz and 3,300 – 3,600MHz. Therefore, this might limit the commercial spectrum TSPs can use for public services.

6.6 Health and Environment

Guidelines on the emission of Electromagnetic Field (EMF) from the wireless services were issued by DoT in 2012. Additionally, the Telecom Enforcement Resource and Monitoring (TERM) cells, conduct audits regarding the self-certification given by the TSPs. A penalty of ₹5 Lacs has been imposed per BTS per TSP for non-compliance. In 2013, this amount of penalty was doubled to ₹10 Lacs.

6.7 Huge Investment in Next-Generation Technologies

The TSPs have already disbursed huge investment to unfurl the 4G infrastructure. This folding up is vital for faster data speed in India. The adoption of the 4G technology in India has not matched with the expectations so far. In the contrary, the global industry has taken a leap towards 5G. The vital challenge and concern are the huge investment cost along with low returns.

7. RESEARCH METHODOLOGY AND SURVEY

The results obtained from the survey questionnaire were used as the primary data. This was then analyzed and statistically tested, to achieve the objectives.

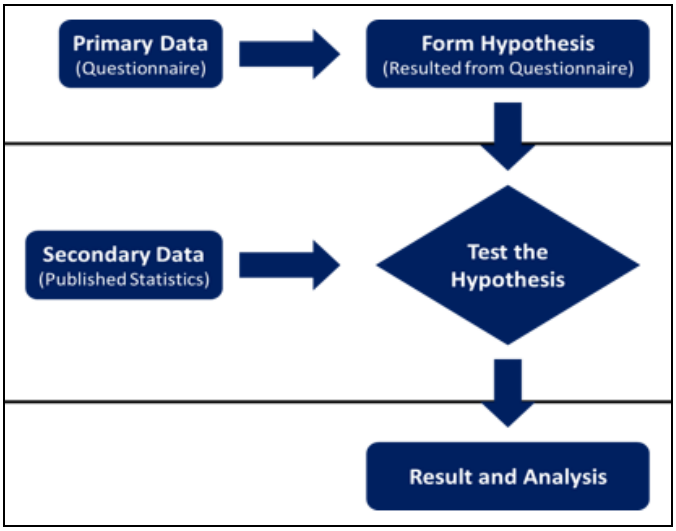

Fig - 3: Research structure overview

7.1 Data Collection

With the objective of understanding the views, awareness, energy source of the telecom towers and impact on health from these towers; we had conducted the survey in about 17 states of the country (235 responses received in all). The respondents included the authorities from different telecom service providers, TRAI, DoT, Central Pollution Control Board (CPCB), authors from the international publishers, researchers in the field of telecom, doctors, working professionals and students. Taking the time and geography constraints into consideration, the survey questionnaire was floated over emails and other social media platforms to guarantee the minimum sampling size and to expedite the data collection process.

The following were the highest rated factors fetched by processing the responses of the survey questionnaire –

- Mode of power supply in telecom network towers
- Views on impact of these towers on the health of the living beings
- Awareness about the initiatives taken by the telecom service providers and the government
- Suggestions about the green telecommunication measures

7.2 Data Analysis

We had received 235 responses on the survey questionnaire. Out of which 38 (16.2%) were from the telecom sector and the rest were from non-telecom sector. The questionnaire had four sections –

- **Section 1:** Demographics of the respondents
- **Section 2:** Awareness about telecom network towers and their impact
- **Section 3:** Opinion matrix
- **Section 4:** Suggestions on the measures for green telecom

Geographies of the respondents – Basis the designed questionnaire, the results of the vital questions are shown in the graph below.

The chart shows that 53.61% were from Delhi/NCR; 9.36% from Maharashtra; 8.93% from Uttar Pradesh; 8.08% from Madhya Pradesh; 6.80% from Karnataka; 3.8% from Rajasthan and 9.36% from states that included Punjab, Haryana, Chhattisgarh, Assam, Tamil Nadu, Gujarat, Odisha, Himachal Pradesh, Uttarakhand, and Andhra Pradesh.

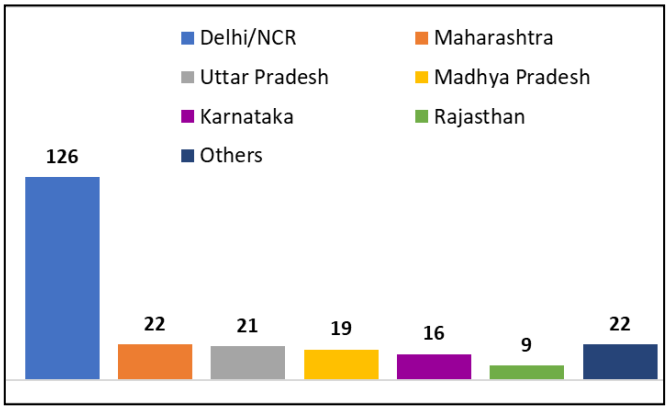

Chart - 4: Geographies of respondents

Telecom infrastructure power supply – The respondents were asked about the power supplies (more than one) to the telecom infrastructure in their area.

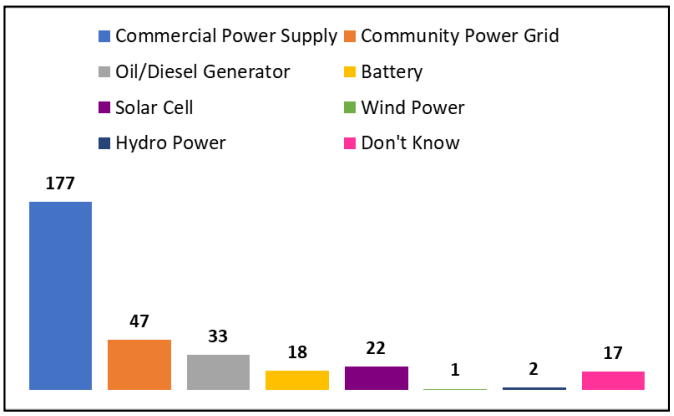

Chart - 5: Power supplies to telecom infrastructure

The results from the survey questionnaires represent that 75.3% of the telecom infrastructure runs on the commercial power supply and 7.22% of the respondents were unaware about the power supply for the telecom infrastructure in their locality. In this scenario, the telecom service providers and government should spread awareness amongst the resident of the locality near which the telecom tower has been erected. In view of the green telecom, the dependency from the commercial power supply should move towards alternative energy sources like solar energy.

Objection on erection of a telecom tower nearby – The respondents were asked if they would object if a telecom tower is erected in the nearby their residency. Also, were asked to state the reason for the objection, if any.

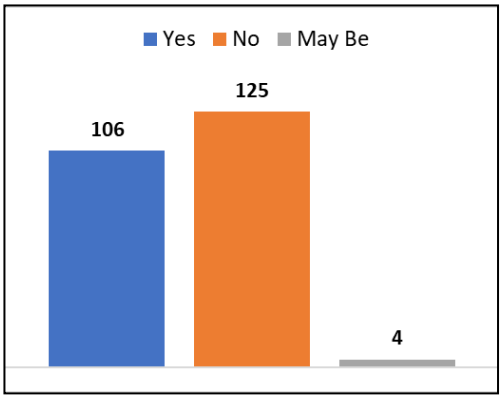

Chart -6: Objection on nearby erection of tower

The results from the survey analysis showed that 45.10% of the respondents would object if a telecom tower is erected in the nearby area of their residence, while 53.19% of the respondents will have no objection regarding the same and one point 7% were not sure about this. The main reasons behind this objection – 85 respondents say that they will object because of the emission of harmful electromagnetic radiations from the telecom tower which How hard is impact on the health of the living beings an environment. Moreover, these harmful radiations might also lead to health hazards like cancer.

On the contrary, all the respondents from the telecommunications sector (16.2% od 235) have a strongly worded that the telecom towers are neither injurious to health nor environment and are totally safe if they are erected near the residential areas. Also, the respondents who have no objection have stated that the erection of the tower should be done at a plausible distance from the residential area.

Environmental or health issues due to radiation emission from telecom tower nearby – The respondents were asked if they have come across any environmental or health issue due to the radiations emitted from the telecom tower in their locality.

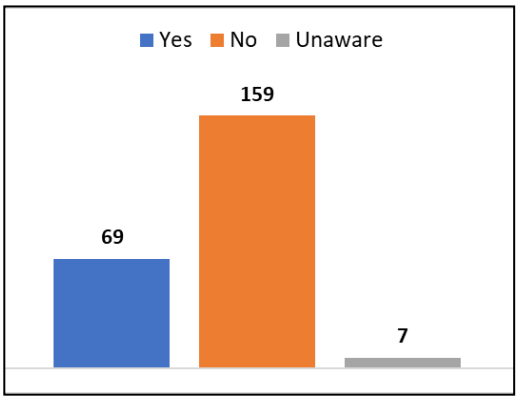

Chart - 7: Environmental or health issues due to telecom tower radiations

As per the results fetched from this survey analysis, 29.36% of the respondents say that they have come across environmental or health issues due to the radiations emitted from the telecom tower in their nearby area; while 67.66% say that they have not come across any such issue. They also say that they have not personally experienced but have read a lot on social media and in research papers. Only 2.9% of the respondents were unaware about the same.

The respondents who have either personally experienced or read about these issues have enlisted the following hazards which were caused by the radiations from the telecom towers –

- 25 respondents say that they have seen carcinogenic effects in which the radiations had caused cancer
- Short term diseases like fatigue, headache, skin problems, insomnia, and depression etc.
- disappearing birds from the locality in which the towers are erected
- health issues amongst senior citizens infertility and miscarriage
- Environmental stress

Respondents also say that since the erection of these telecom towers is banned from hospitals and school buildings, this proves that they are hazardous to the health. While some of them feel that they only have heard about such issues while they haven't come across any scientific evidence is behind these stating that the telecom towers are the sole reasons for the cropping up of these health and environment issues.

Initiatives taken by the government/TSP towards green telecom – The respondents were asked if they are aware about the initiatives being taken by the government and the telecom service providers as an approach towards green telecom.

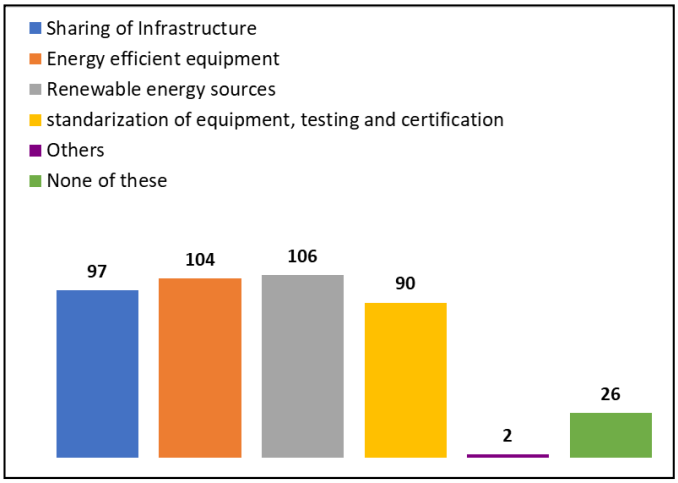

Chart - 8: Awareness about initiatives taken by the government/TSP towards green telecom

As per the analysis of the survey responses, the respondents were mostly aware about the usage of renewable sources of energy (45.1%), usage of efficient equipment (44.3%) followed by sharing of infrastructure (41.3%) and standardization of equipment, testing and certification (38.3%). There were 11.06% of the respondents who were unaware about any of these initiatives. In addition to these four initiatives, there were two more measures which the respondents were aware of (included under 'Others') –

- Enforcement and monitoring of minimal EMF radiation from the towers
- Tree-like looking eco-friendly Reliance Jio's GBM

Desirable attributes from a TSP – The respondents what asked which are the most desirable attributes they look for while choosing a telecom operator.

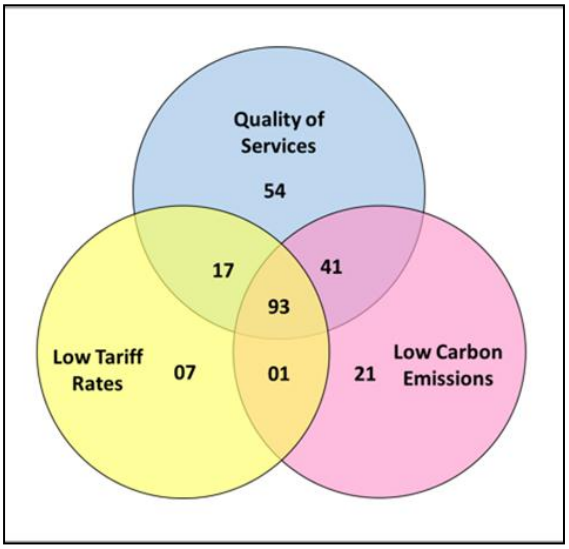

Chart - 9: Desirable attributes from a TSP

Table - 5: Desirable attributes from a TSP

Attribute(s)	Number of respondents	Share of respondents (%)
All of these	93	39.57
Quality of services and low carbon emissions	41	17.45
Low carbon emissions and low tariff rates	1	0.42
Low tariff rates and quality of services	17	7.23
Only quality of services	54	22.98
Only low carbon emissions	21	8.93
Only low tariff rates	7	2.98

The survey results showed that the countrymen want all the three attributes together followed by quality of services alone.

Close-ended questions – The responses were assessed using five-point Likert scale ranging from 1 to 5.

- Strongly disagree scores 1
- Disagree scores 2
- Neutral scores 3
- Agree scores 4
- Strongly agree scores 5

To assess the responses fetched from the respondents of the survey questionnaire, the Weighted Mean Score was calculated. Basis these, the statements were ranked in the decreasing order.

The six statements, which were a part of the survey questionnaire, are as follows –

1. There is a dire need for telecom industry to approach towards sustainability.
2. Government/telecom operators are making the subscribers aware about the initiatives taken.
3. There is a hazardous impact of the telecom towers on environment and health of the people residing nearby
4. Telecom towers should be installed far away from the residential areas.
5. Telecom towers can be installed near the residential areas if they are eco- and health-friendly.
6. With the advent of new technologies like 5G, IoT, AI; the carbon footprint emission will increase if measures are not taken.

The statements in the table below are analyzed in the same sequence as mentioned above.

Table - 6: Five-point Likert scale analysis of the responses

S. No	Strongly disagree (1)	Dis-agree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	Weight-ed Mean
1	0	0	12	82	141	**4.55**
2	17	34	70	82	32	**3.33**
3	6	12	45	87	85	**3.99**
4	5	19	47	76	88	**3.95**
5	4	6	39	105	81	**4.07**
6	5	5	34	90	101	**4.18**

Basis the five-point Likert scale, the statements are ranked as (in the decreasing order of the weighted mean) –

1. There is a dire need for telecom industry to approach towards sustainability.
2. With the advent of new technologies like 5G, IoT, AI; the carbon footprint emission will increase if measures are not taken.

3. Telecom towers can be installed near the residential areas if they are eco- and health friendly.
4. There is a hazardous impact of the telecom towers on environment and health of the people residing nearby.
5. Telecom towers should be installed far away from the residential areas.
6. Government/telecom operators are making the subscribers aware about the initiatives taken.

The top two statements were put taken forward for further hypothesis analysis.

Suggestions/inputs to approach towards green telecom – The respondents had come up with various solutions, in their opinion, which have been bucketed and are presented below.

43.37% of the respondents say that we should rely over renewable sources of energy phone operating the telecom infrastructure, 10.5% of the respondents say that the infrastructure should be shared amongst the telecom service providers and investment should be made in R&D to understand the latest technology or come up with innovative solutions in order to dwindle the emission of the carbon footprints from the telecom operations and also check the compatibility of the international practices and policies in India in order to support the green telecommunication initiative. 8.68% of the respondents say that energy efficient equipment should be used in telecom network towers , there should be strict norms and guidelines by the government for the telecom service providers so that they can stick to it and carbon footprint emission should be periodically monitored by the TSPs and the figures should be made public. As per 3.65% respondents, an awareness campaign might contribute in the same; 2.28% suggest two ways – afforestation and increasing the capacity of the towers so that lesser number of them is installed. Lastly, 1.37% has suggested other ways like standardization of equipment and using lithium (Li^+) ion battery in power supply.

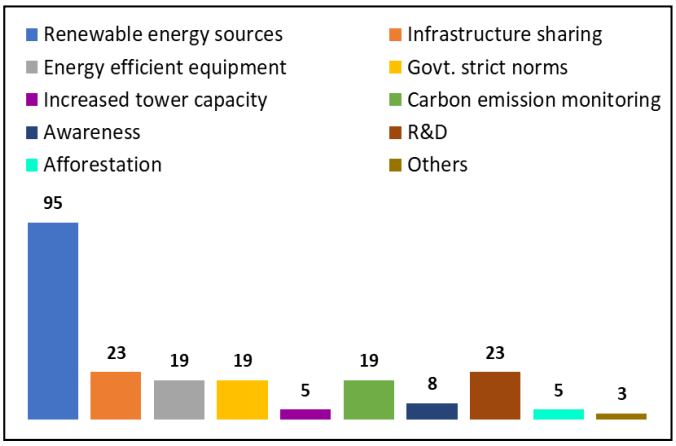

Chart - 10: Suggestions from respondents for green telecom

7.3 Hypothesis Testing

As mentioned above, considering the following two statements for testing the hypothesis for this survey questionnaire –

1. There is a dire need for telecom industry to approach towards sustainability.
2. With the advent of new technologies like 5G, IoT, AI; the carbon footprint emission will increase if measures are not taken.

With the help of null hypothesis, we would analyze the test scores of two the above two statements and would assess if these two differ from each other.
A possible null hypothesis would be if the mean male score for both these variables are same –

$$H_0: \mu_1 = \mu_2$$

where

H_0 = the null hypothesis,
μ_1 = the mean of statement 1; and
μ_2 = the mean of statement 2.

If the two samples are drawn from same population, hereby their variances are also equal, then the null hypothesis is strong.

If in case, the null hypothesis gets rejected, we go for alternative hypothesis which can be stated as follows in the inequality –

$$H_1: \mu_1 \neq \mu_2$$

where

H_1 = the alternative hypothesis
Also, Level of significance, $\alpha = 0.05$

Table -7: Data collection for two statements (values taken from five-point Likert scale)

Statement 1: There is a dire need for telecom industry to approach towards sustainability.	**Statement 2: With the advent of new technologies like 5G, IoT, AI; the carbon footprint emission will increase if measures are not taken.**
0	5
0	10
36	102
328	360
705	505

Table - 8: t-Test: Two sample assuming unequal variances

	Statement 1	Statement 2
Mean	213.8	196.4
Variance	94338.2	50572.3
Observations	5	5
Hypothesized Mean Difference	0	
df	7	
t Stat	0.102207867	
P(T<=t) one-tail	0.460728967	

The variable which were compared have been highlighted in the table above. The value of the variable **t Stat** can either be compared with **t Critical one-tail** or **t Critical two-tail**.

We find that

t Stat < t Critical one-tail

Thus, the data supports H_0 and these two statements can be considered equal or dependent on each other.

8. CONCLUSION

The telecommunication sector must be provided with sustainable energy sources. It depends on the location of sites; cell towers must collect energy from appropriate sources of sustainable energy. Some of the alternative sources of energy are – solar cells, wind power, hydrogen fuel cells, biomass energy. Small scale electricity for hydropower are also considered by telecom operators in partnership with their vendors. Energy harvesting technology is becoming more and more popular and new green energy production strategies are emerging every year. The Indian government is also promoting and rolling out initiatives for green telecom. Presumably with proper control and monitoring, Indian telecom sector can be made sustainable in the decades to come. In the telecommunications sector, sustainability is very important as the sector grows rapidly and has vast infrastructure that runs upon energy. Telecommunication has been proposed as a viable solution and considered as a green option for several business processes. This sector now covers more than 90% of human settlements. It has a direct impact on environment. Therefore, the sector should be made sustainable in all aspects.

8.1 Keys to seizing the opportunities

The biggest opportunity of reducing the consumption of energy and cost lies in the following mentioned areas [16] –

Table - 9: Opportunities for reducing energy consumption and cost

Driver	Description
Smart sleep and shutdowns	• **Site level:** power amplifier symbol, adaptive power consumption, multiple-input and multiple-output muting • **Multisite level:** carrier shutdown, cell shutdown, cross-base station optimization, cross-radio (3G/4G) optimization
IoT - enabled energy optimization	• Sensors to optimize cooling • Fuel monitoring
Structural and architectural transformation	• 2G or legacy shutdowns • Newer cooling systems, insulation, reflective paints
Strategic and sustainable energy sourcing	• Purchase or generate green energy • Direct procurement/competitive sourcing

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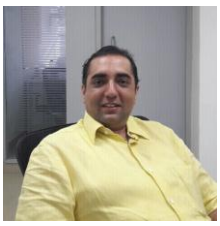
BIOGRAPHY



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