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Green ICT: India and the World Future Information & Communication Technology

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Abstract—

There is a strong need to develop a viable independent power resource that serves the Information & Communication Technology equipment by providing cost-effective electricity through the environmentally responsible and efficient development of the available energy resources. The other objective of this paper is to highlight the Green Telecom Technology (GTT) in term of need, types of GTTs, features, deployment barriers, applications, drawbacks, challenges, etc. GTTs are not only simple power sources for telecom or other applications rather helpful in keeping environment as clean and green. The Information & Communication Technology industry must be involved by switching generation sources to more sustainable sources and working with customers to help them use energy more efficiently. Green ICT theme is to promote carbon accountability in the telecoms industry. The demand of renewable energy for environmental concerns has been increasing rapidly. Though the Green Telecom Technologies are readily available in the market, but there are some issues and challenges along with barriers in implementation.

Keywords: GTT, IPCC, UNFCC, NSM

I. INTRODUCTION

Operation of telecommunications networks requires electrical power. The expense on energy accounts for a significant share of the operational cost of these networks. This is particularly so in the rural areas where availability of power is uncertain. The use of diesel generators to ensure continuous power supply has the disadvantage of increasing the greenhouse gas emission and consequent enlargement of the carbon footprint which has a deleterious impact on the environment. While contribution of the ICT (Information & Communication Technology) sector to the global carbon footprint is low compared to other sectors like transportation and construction, it nevertheless contributes a noteworthy share and increasingly so with growing reach of the telecommunications network. Efforts are afoot, all over the world, to find measures to deal with this issue.

In recent years, the rise in the world's average ambient temperature has become a matter of global concern, and is now recognised as one of the key challenges facing humanity. "Global warming", "Climate Change", "Greenhouse Effect" etc are common expressions used to describe the threat to human and natural ecosystems resulting from enhanced emissions of heat trapping or greenhouse gases (GHGs) arising from the activities of humankind in an increasingly industrialized and globalizing world. These emissions are changing the composition of the atmosphere at an unprecedented rate. While the complexity of the global climate system makes it difficult to accurately predict the impact of these changes, the evidence from modelling studies as interpreted by the world's leading scientists assembled by the Intergovernmental Panel On Climate Change (IPCC), indicates that global mean temperature may increase by 1.4°C to 5.8°C, with a doubling of carbon dioxide concentrations, relative to pre-industrial levels; over the next 40 to 100 years. The magnitude of the predicted climate change, as well as the anticipated rate of this change, poses serious risks for human lifestyles as well as the global ecosystem. Global warming is expected to lead to numerous secondary effects such as the melting of the polar ice cap, changes in precipitation patterns, changes in vegetation as well as in the composition of the atmosphere.

Climate change and global warming is a phenomenon largely attributed to anthropogenic (human-caused) emissions of pollutants; particularly carbon-di-oxide (CO2) that traps heat within the Earth's atmosphere. A substantial portion of these pollutant emissions have their origin in the combustion of fossil fuels. As the world's need for energy-based services increases, and in the absence of a significant transition to non-fossil energy sources, global temperature rises and its attendant impacts are expected to become increasingly pronounced over the coming decades.

A milestone in the international efforts to address the anthropogenic causes of climate change was the "Kyoto Protocol" to the United Nations Framework Convention on Climate Change" (UNFCC), an agreement among the nations of the world to reduce emissions of six greenhouse gases over specified timelines. This protocol adopted at Kyoto, Japan in 1997, requires that industrialized countries cut their greenhouse gas emissions by an average of 5.2% relative to 1990 levels over target years ranging from 2008 to 2012. As an extension of the Kyoto protocol, the 2009 United Nations Climate Change Conference, commonly known as the Copenhagen Summit, was held in Denmark. The Copenhagen Accord recognized that climate change is one of the greatest global challenges of the present day and that actions should

be taken to keep further ambient temperature increases to below 2°C. Consequently, India has agreed to cut carbon emissions intensity by 20–25% below 2005 levels by the year 2020.

It is estimated that the ICT sector worldwide is responsible for around 2% of global CO2 emissions. This includes the impact of personal computers, servers, cooling equipment, fixed and mobile telephone instruments and networks, local area networks, office communications and printers. The world's increasing need for the computation, data storage, and communication is driving the rapid growth in telecommunication and enhancing the emissions associated with such technologies. By 2020, ICT is expected to account for about 3% of global emissions worldwide. Of the current CO2 emissions, the contribution from the global telecommunication systems – mobile, fixed and communication devices- is estimated to be around 230 million tons of CO2, or approximately 0.7% of global emissions. The worldwide growth in the use of mobile phones as well as the multiplication of data centres are expected to contribute to this trend. However the pervasive use of ICT is expected to simultaneously lead to significant positive net externalities on account of what are called the second order and third order effects of the use of ICT's worldwide.

Second order effects are the immediate consequences of the use of ICT is in terms of changing processes like reducing travel for business reasons and for social interactions, while third order effects are the expected changes in the organisational structures and modalities of transacting business and social interactions over the longer-term, which would reduce the need for travel and face-to-face interactions.

India has the second largest and fastest growing mobile telephone market in the world. Power and energy consumption for telecom network operations is by far the most important significant contributor of carbon emissions in the telecom industry. However large parts of the country are power deficient and with increasing coverage of mobile services in off grid areas, network operations will increasingly have to rely on alternative sources of energy until the rural electrification process is complete. India has presently around 400,000 telecom towers, with average power consumption per tower being 3 to 4 kW. Assuming 8 hours of operation by DG sets, an average fuel consumption of 8760 litres of diesel every year per tower, total carbon emission on account of diesel use by telecom towers is estimated to be around 10mt of CO2, while the emissions on account of power drawl from the grid by towers is estimated to be around 6mt of CO2. As the second largest and fastest growing market in the world, there is need for India to be conscious of the concerns in this regard. Besides, as a country heavily dependent on import of petroleum products while being abundant in renewable energy sources there is scope for innovative measures towards making telecommunications green. It can thus be seen that the contribution of the Indian telecommunication industry to the total CO2 emissions is worse than the world average in percentage terms. The greening of the telecom sector assumes significance in this context as well as the need to effect economy in operations.

Energy costs are among the largest operating expenses for telecom network operators, and energy consumption from telecom networks is an increasing contributor to global greenhouse gas (GHG) emissions. As an ever increasing number of people around the world become connected by fixed and mobile telecommunications networks, the challenges related to providing electricity to these expanding networks are becoming greater as well. While telecom is relatively energy-lean, the telecom networks are still driven largely by fossil fuel energy and the energy costs represent a significant opex item. With the double whammy of increasing energy consumption and rising cost of fossil fuel, it is important that the focus shifts to energy efficient technologies and alternate sources of energy.

Increasing public demand for corporate social responsibility and a genuine desire to effect positive change in the environment are leading telecommunications service providers and their suppliers to reduce their carbon footprint. Going Green has also become a business necessity for telecom operators with energy costs becoming as large as 25% of total network operations costs. A typical communications company spends nearly 1% of its revenues on energy which for large operators may amount to hundreds of crores of rupees.

Whether out of compulsion of reducing cost or fulfilling corporate social responsibility (CSR) and projecting a humane face to the society, telecom service providers and manufacturers, all over the world, have taken steps towards greening of telecom. Efficient power management, infrastructure sharing, use of eco-friendly renewable energy sources and cutting down carbon emission over the complete duration of the product lifecycle have been under intense consideration by telecom industry all over the world.

Besides being part of the problem, ICT is also a part of the solution. It enables significant reductions in the GHG emissions and costs across a range of sectors of the economy using multimedia communication, machine to machine communication and software control of processes to deliver smart solutions like smart grid, teleconferencing, smart logistics and transportation. For each tonne of greenhouse gas the ICT industry produces through servers, data centres, networks, etc, it can leverage a reduction or avoidance of up to 9 tonnes across the economy.

The paper will be addressing:

- What is Information & Communication Technology **(**ICT) & Green ICT?
- Why Green ICT?
- Carbon Credit Policy for ICT industry
- Measures for reducing telecom carbon footprint
- Moving towards green ICT
- Promoting R&D for green ICT
- CSR and community service
- Government of India's role
- Conclusion

II. WHAT IS INFORMATION & COMMUNICATION TECHNOLOGY & GREEN ICT?

ICT (information and communications technology - or technologies) is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning.

Growing telecommunications infrastructure requires increasing amount of electricity to power it. Part of the electricity comes from the grid and remaining through burning of fossil fuel like diesel. Both of these sources contribute to emission of greenhouse gases (GHG) with the attendant negative environmental effects. Reduction of the GHG produced or caused to be produced by the telecom sector is referred to as greening of telecom. Green telecom has many facets. It can be classified broadly in terms of greening of telecom networks, green telecom equipment manufacture, environment friendly design of telecom buildings and safe telecom waste disposal. These aspects are briefly described below:

- **Green Telecom Networks:** In telecom networks greening would refer to minimizing consumption of energy through use of energy efficient technology, using renewable energy sources and eco-friendly consumables.
- **Green Manufacturing:** The greening process would involve using eco-friendly components, energy efficient manufacturing equipment, electronic and mechanical waste recycling and disposal, reduction in use of hazardous substances like chromium, lead and mercury and reduction of harmful radio emission.
- **Design of green central office buildings:** optimization of energy power consumption and thermal emission, minimization of greenhouse gas emission.
- **Waste disposal:** disposal of mobile phones, network equipment etc., in an environment-friendly manner so that any toxic material used during production does not get channelized into the atmosphere or underground water.

III. WHY GREEN ICT?

The Global Scenario

Currently, the ICT sector globally accounts for 0.9 metric giga-tons of GHG emissions annually, or about 2% of total global emissions; which includes personal computers, servers, cooling equipment, fixed and mobile telephony, local area networks (LAN) and printers. The world's increasing need for computation, data storage, communications and entertainment is rapidly growing and at the same time there is an increase in the emissions associated with such technologies. By the year 2020, total emissions globally from the ICT sector is expected to be around 1.43 metric gigatons, accounting for around 3% of total global emissions of greenhouse gases.

These emissions include emissions from both the embodied devices and components during manufacturing, as well as from the use of devices and equipment.

Table: % Global CO2 emissions

Global	Gigatons CO2e (2002)	Gigatons CO2e (2020)
Global CO2 emissions	40	51.9
Total ICT footprint	0.540 (0.11 from embodied and 0.43 from Network use)	1.430 (0.35from embodied and 1.08 from Network use)
% of Global emissions	1.3%	2.8%

*% of Global emissions (2007): 2%

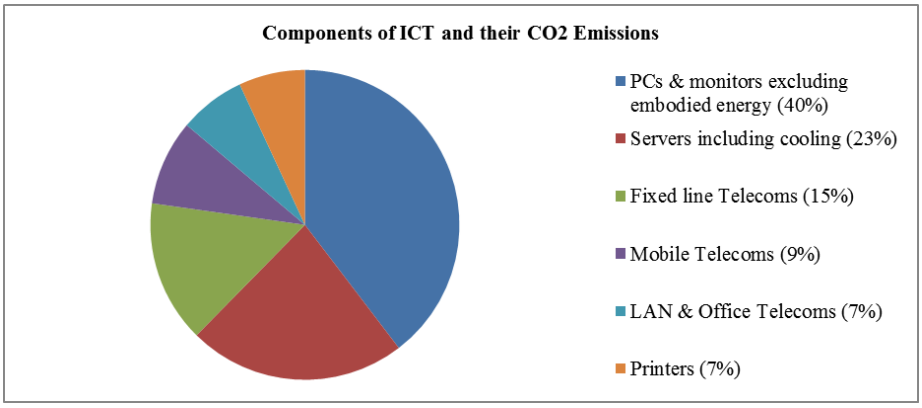
Source: http://www.smart2020.org

The total emissions of the ICT industry emanate mainly from three different sectors –Telecommunications, Data centers and PCs, peripherals and printers. The Telecom sector comprises of telecom devices and telecom infrastructure, and emissions from this sector are rising on account of the increasing global permeation of telecom. In data centers, the increase in the number of servers, cooling equipment and data storage are the reasons for increased GHG emission. With the growth in purchasing power in countries like India and China, PC dissemination is expected to sharply increase. However, due to technological innovations, the efficiency of ICT devices and systems is also expected to increase, leading to consequential attenuations in emissions.

By the year 2020, almost a third of the global population is expected to own a PC, while 80% are expected to own mobile phones and one in 20 households to have broadband connections. By 2020, when a large part of the populations of developing countries are expected to be able to afford ICT devices, they are expected to account for more than 60% of the carbon emissions from ICT's compared to less than half today. The demand for energy for ICT is expected to increase by 70% by the year 2020, driven by the demand for broadband, customer premises equipment and power hungry devices like HDTV services.

The enhancement of the data center carbon footprint is due to the increased numbers of servers, network equipment, power supplies, fans and other cooling equipment. Only about half of the energy used by data centers powers the servers and storage, the rest is needed to run back-up, uninterruptible power supplies (5%) and cooling systems (45%). It is expected that there will be 122 million servers in use by 2020. A major trend driving down the overall growth in the footprint of data centers is 'virtualisation'. By allowing the temperature of the data centre to fluctuate along a broader operating temperature range, a 24% reduction in energy consumption from cooling is also possible. Cloud computing is also expected to play a major role in reducing the carbon footprint of data centers.

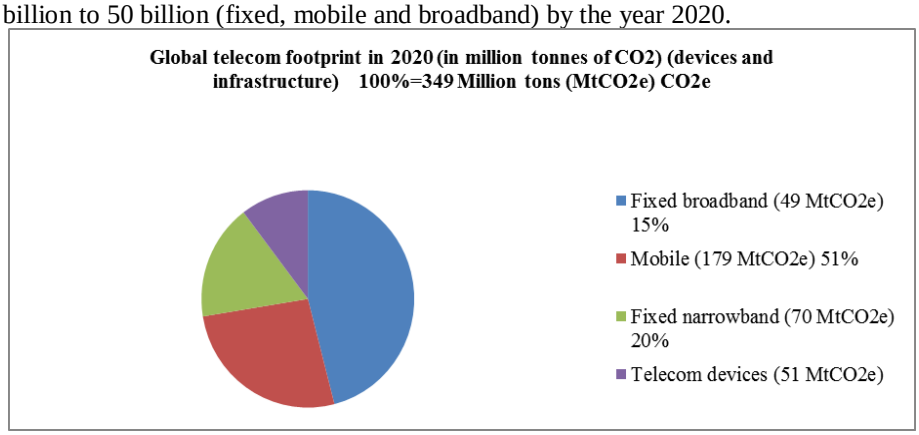
The various components of ICT and their CO2 emissions in the ICT sector and their footprints are shown below and around 25% of the emissions are from the telecom sector.



Source: Gartner Group (2007)

Carbon footprint due to telecom infrastructure is expected to increase from 25% of total ICT emissions to 30% of total ICT emissions by the year 2020. It is also estimated that 51% of the emissions in telecom will be from the mobile segment. The mobile industry is forecast to invest $800 billion during the next five years; $550 billion of this is earmarked for mobile broadband, potentially connecting 2.4 billion people to the Internet.

The telecom devices' global footprint was 18 MtCO2e in 2002 and is expected to increase almost threefold to 51 MtCO2e by 2020. The number of mobiles is expected to increase from 1.1 billion to 4.8 billion, routers from 67 million to 898 million and IPTV boxes from 0 to 385 million. The main increment in telecom devices emission is attributed to routers, IPTV boxes and modems, while the increase in the carbon footprint of telecom infrastructure would mainly be due to increases in base stations and mobile switching centers. As the demand for telecoms services and devices grow, the need for infrastructure that supports it will also grow. This growth is due not only because of the increase in the number of broadband and mobile accounts in emerging economies, but also because of emerging new applications like sharing of videos and games and other peer-to-peer content exchange. One of the main reasons for the increase in the carbon footprint in telecom infrastructure is expected to be the increase in the number of telecom accounts from the present level of 6 billion to 50 billion (fixed, mobile and broadband) by the year 2020.



Source: http://www.smart2020.org

The carbon footprint mentioned above would cause direct emission impacts, called first order effects of carbon emission in the network. There are also indirect positive impacts called second order and third order effects; which can reduce carbon emissions of the other sectors by increasing the use of ICT. These second order and third order effects of the pervasive use of ICT could increasingly lead to the sector becoming a key player in global efforts to contain carbon emissions. Human behaviour as well as organisational structures and interaction protocols are rapidly changing on account of the pervasive adoption of ICT in almost every sphere of human endeavour, reducing the need for physical face-to-face interactions and long-distance travel, especially by air.

The Indian Scenario

In India around 4% of the GHG emissions are from the ICT sector which is around 80 million tones of CO2 emission every year. And around 25% of this emission i.e. 1% of the GHG emissions is from the telecom sector which is around 20 million tones of CO2.

S.No.	Network Elements	Total Carbon Emission in Telecom(in Tonnes)	Total Carbon Emission (in Tonnes)
1	BTS	13 million	
2	BSC	1.3 million	
3	MSC	0.1 million	

4	Exchanges	6 million	
5	Network Controllers & Transmission	0.08 million	
6	Core & Serves	0.05 million	
	Total	**20.5 million**	**1904 million**
	% CO_2 emission of the total	**1%**	

Table Source: % CO2 emissions from the telecom Sector

Of the 100 million tonnes of carbon dioxide emission reduction target by 2015, set by the NMEEE [National Mission on Enhanced Energy Efficiency], ICT adoption in buildings, transport and nine other sectors under the PAT (perform, achieve and trade) scheme could contribute about 31 million tonnes — approximately 30% of the 2015 target.

In June 2008, the National Action Plan on Climate Change (NAPCC) was launched, outlining the nation's strategy to manage greenhouse gas (GHG) emissions. India has announced the goal of reducing the emissions intensity of its GDP by 20-25% by the year 2020 compared to 2005. The Planning Commission is also in the process of defining a low-carbon growth map for the country. The GHG reduction opportunities via ICT (Information & Communication Technology) solutions mainly focus on the three mitigation-related missions of NAPCC - National Mission on Enhanced Energy Efficiency (NMEEE), National Mission on Sustainable Habitat (NMSH) and National Solar Mission (NSM).

While NMEEE and NMSH focus on reducing energy consumption and improving energy efficiency, NSM seeks to increase India's solar energy generation. Identified ICT solutions can potentially lead to GHG emission savings of up to 450 million tonnes CO2 per annum in 2030, which is approximately 10% of estimated GHG emissions in 2030 for the different sectors. ICT solutions can potentially lead to energy cost savings of around INR137,000 crore per annum in 2030 - approximately 2.5% of India's current GDP.

Targets for ICT solutions in key sectors could also be identified, such as Railways, Power Transmission and Iron & Steel. These three have more than 90% GHG emission savings potential in NMEEE mission sectors. Projected GHG emissions from NMEEE mission sectors would be about 1.55 billion tonnes CO2 in 2020 and 3.2 billion tonnes CO2 in 2030. The electricity saved by ICT adoption in the power sector in 2030 can help electrify more than 14,000 villages with an average population of 2,000-3,000. Implementation of ICT measures in the paper sector in 2030 can reduce emissions by an amount equivalent to that sequestered by 3 million trees.

Savings achieved via video-conferencing and tele-commuting with moderate ICT penetration in 2030 can offset GHG emissions more than 70 times the current GHG emissions due to the annual air traffic between Delhi and Mumbai. At multi-location and disintegrated consumption points such as telecom towers, ATMs and retail outlets, Remote Management Systems (RMS) can deliver up to 10% energy savings and their faster implementation is recommended. For instance, with each of the 400,000 telecom towers in India consuming 3 kW of power, the total electricity consumed is around 11169 million kWh annually. With RMS, around 10% energy consumption can be reduced, leading to savings of 1116.9 million kWh, equivalent to GHG emission reductions of more than 938 000 tonnes of CO2.

The total cost of ICT usage in NMEEE mission sectors - considering moderate penetration of ICT solutions in 2020 and 2030 - is estimated at Rs.49,700 crore and Rs.156,100 crore. These investments correspond to cost savings of around Rs.7,300 crore per annum and Rs.29,200 crore per annum respectively. Similarly, the deployment of ICT technologies in Transport, Buildings and Solid Waste Management sectors can lead to cost savings of Rs. 26,300 crore in 2020 under a moderate scenario.

Power Scenario in the Telecom Industry

- Power deficit in India is a continuing problem due to issues in generation (feedstock, land acquisition), transmission (lag in investments, ROW issues) and distribution (high losses and poor financial health of utilities).
- Combined effect of this is indiscriminant load shedding across India particularly in rural/ semi urban areas.
- Due to the precarious power scenario ~40% of the telecom towers face load shedding for more than 12 hours per day.
- All India Power availability at various cell sites is very poor. As shown in the table below:

Cell Sites	**EB Availability**	**Description**
10%	>20 hrs.	Mainly metro cities of Mumbai, Kolkata, Chennai, some cities of Gujarat, Chattisgarh, some cities of Punjab
20%	16-20 hrs.	Covers most other major cities & towns in the rest of the country.
30%	12-16 Hrs	All semi-urban & small urban towns in all states
25%	8-12 hrs.	Mostly rural areas
15%	8 hrs. Off grid	Mostly parts of Bihar and some towns of Assam, NE States, UP and J&K.

Source: Intelligent Energy Limited

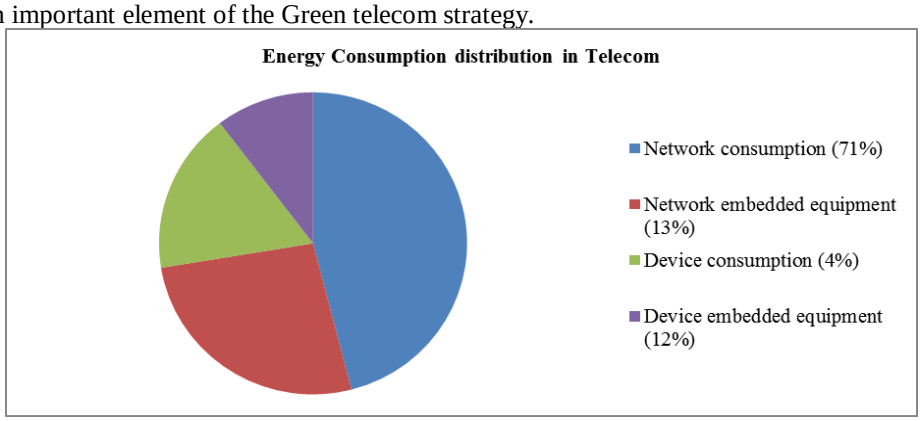
- Because of limited and uncertain grid power situation telecom tower companies are increasingly relying on diesel as primary fuel to keep them up and running. Presently ~40% power requirements are met by grid power and 60% by diesel generators.

Today telecom tower companies are facing multiple challenges as discussed below:

Challenges faced by Telecom Tower Companies

- **High operating expenditure:** Energy costs account for ~30% -34% of total operational expenditure for a telecom tower company. Grid power typically is available at Rs. 6-8 per unit whereas cost of power through DG is around Rs. 12-14 per unit.
- **Diesel pilferage losses:** Diesel pilferage losses ~20% have been observed in the industry which further increases the energy costs. In extreme cases overall cost of generation has sky rocketed to Rs 22-26 per unit.
- **Increased carbon emissions:** It is estimated that telecom towers alone consume ~2 billion liters of diesel per year. Diesel consumption from telecom towers accounts for ~5 million tons of CO2 per year, which is 2% of total green-house gas emissions from India.

Around 71% of the carbon emissions in the Indian telecom sector are on account of network power consumption and hence containing power utilization in telecom networks would be the cornerstone of any green telecom strategy. Carbon emissions by network and device embedded equipment contributed 25%. Thus, green manufacturing and waste disposal is also an important element of the Green telecom strategy.



Source: http://www.gsmworld.com

Presently of the power consumed by the network, around 67% is met by the contribution of diesel power, while around 33% is met by recourse to grid power in rural areas, while Renewable Energy Technologies (RETs) are deployed, at a few locations purely on a pilot basis. In urban areas, while the contribution of diesel power is around 33% and around 67% is met by the grid power. However, in backward areas the situation is alarming, where around 87% is met by contribution of diesel power and only around 13% is met by grid power. The objective of the green telecom endeavour in India would be to ensure that the consumption of diesel for powering telecom network is substantially reduced to a level of 33% by the year 2020 resulting in diesel to grid power ratio of 1 to 3, in both rural and backward areas. The RETs use for powering network operations is also to be ramped significantly to a level of around 25% by 2020.

Lately, people have become more conscious and concerned about the ills of climate change. Newspapers and TV are regularly carrying features about rising temperature, melting glaciers, rising sea levels, natural disasters and general deterioration of the ecosystem; all presumably because of green house effect created by emissions produced by burning fossil fuel for energy. Among the various sectors the service industries have been less visible pollutants. A number of factors have led to heightened interest in greening of service sector industries.

In the case of telecommunications the factors that are leading to enhanced action on greening are as follows:

- Need to reduce the cost of operations of the telecom network by reducing energy cost.
- Need to expand network into rural areas where power availability is poor.
- Renewable energy technology becoming available at increasingly reducing cost.
- Confluence of socio-political trends towards environmental responsibility, pressure groups against global warming.
- Creating sustainable businesses has become important where the objective is not only to create products and services through ethical means but also minimize environmental impact and improve communities.
- International treaties like Kyoto Protocol.

IV. CARBON CREDIT POLICY FOR ICT INDUSTRY

- One carbon credit is equal to one tonne of carbon dioxide, or in some markets, carbon dioxide equivalent gases. A carbon credit is a generic term meaning that a value has been assigned to a reduction or offset of greenhouse gas emissions. Carbon credits and markets are key components of national and international attempts to mitigate the growth in concentrations of Green House Gases (GHGs). Greenhouse gas emissions are capped and then markets are used to allocate the emissions among the group of regulated sources. The goal is to allow market mechanisms to drive industrial and commercial processes in the direction of low emissions or less carbon intensive approaches than those used when there is no cost to emitting carbon dioxide and other GHGs into the atmosphere.

- A country needs to have a carbon credit policy to encourage reduction of carbon footprint. Such a policy is administered by the Government or a nominated authority. The policy would usually involve setting a limit or cap on the amount of a GHG that can be emitted by a company or an industry. The limit or cap is allocated or sold to firms in the form of carbon credits which represent the right to emit or discharge a specific volume of the greenhouse gasses. Firms are required to hold a number of carbon credits equivalent to their emissions. The total number of credits cannot exceed the cap, limiting total emissions to that level. Firms that need to increase their credits must buy them from those who have a smaller footprint than permitted. This transfer of credits is referred to as carbon trading. In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for having reduced emissions. The policy provides a real or implicit price of carbon. It can create incentives for producers and consumers to significantly invest in low GHG products, technologies and processes. Such policies could include economic instruments, government funding and regulation.
- A carbon credit policy would indicate the services that have high carbon footprints so that customers can use them sparingly. The service providers would get an indication of products that use more, less or no carbon during the manufacturing process so that firms can go for low carbon inputs. It may also specify the rating of various products that are used in a telecom network so that the ones that emit lesser CO2 can be selected. This would also lead to market incentives for inventors and innovators to develop and introduce low-carbon products and processes that can replace the current generation of technologies. A polluting company that has to buy too many carbon credits to be within its cap would see its products become more expensive than the competitors. It is also possible to have subsidies and incentives.
- When a firm in India invests in a renewable energy source to meet growing energy needs, it would be able to acquire carbon credits. These carbon credits are sold on international markets generating income for the owner of the credits. Firms in the European Union and the OECD member countries are buying carbon credits, also called CER (Certified Emission Reductions, from firms in India.
- The Indian government has approved more than 1,400 projects as part of the Clean Development Mechanism (CDM) that could attract around $6billion (Rs 28,000 crore) into the country by 2012 through sale of Certified Emission Reduction (CER) certificates5. A 6.5-megawatt (MW) wind energy project in the state of Madhya Pradesh was issued 10,413CER for offsetting greenhouse gas emissions over a 13-month period.
- Move to renewable energy sources can generate millions of carbon credits that could offset the opex on their towers. In addition saving in the energy bill would further reduce the operating expense.

V. MEASURES FOR REDUCING TELECOM CARBON FOOTPRINT

Carbon footprint reducing Methods

International experience shows that there can be considerable reduction in the telecom carbon footprint through a number of activities of the telecom value chain. From the manufacture of electronic components through telecom network equipment and handsets to their operational life span and eventual disposal there are activities that produce green house gases directly or indirectly. We have seen earlier that telecom operators' 80% energy use is for network operation and 20% for remaining activities. Of the energy used for network operation 90% is used for radio network and 10% for the core network. The base stations consume the largest amount of energy. Energy is required both for running the base stations as well as to provide air conditioning to keep the equipment within operational range of temperature. Energy from the grid causes lesser emission compared to diesel gensets but many of them are located in areas of poor grid power availability and need to be powered by diesel. The service providers can take a number of steps to reduce their carbon footprint e.g. proper radio planning to reduce number of BTSs, sharing of passive and active infrastructure, sharing of backhaul, adoption of green shelters, replacing air-conditioners with forced air cooling, HFC free cooling systems, precision air-conditioning, intelligent remote air conditioning control, installing outdoor base-stations, using energy efficient technology and renewable energy sources. Mobile device lifecycle emission could be reduced through recycling.

Besides what the telecom operators and manufacturers could do, according to the stakeholders, there are other steps that need to be taken to encourage telecom ecosystem to go green. Metric for certifying products, equipment and services as green need to be defined for the Indian milieu. There should be test and certification labs for validation of telecom equipment and networks as green. Further funding from USOF may also be given to projects that use alternative or hybrid sources of energy for tower and related equipment. Spectrum charges may also be linked with carbon credits earned by various operators. Public funding and support in the form of tax benefit may be considered for various projects in the green space. There is also need to monitor and report on the carbon footprint of different segments telecommunications industry.

The measures that can be undertaken to reduce the telecom sector footprint under the following categories:

- Adoption of energy efficient equipment and innovative technologies
- **Use of Renewable sources of energy**
- **Infrastructure Sharing**
- Improvement of grid supply
- Waste Management
- Better network planning: more outdoor BTS, less BTS, less air conditioning requirement to cool sites
- Standardization of equipment, test and certification

- Manufacturing process
- Monitoring and reporting
- Government support – incentives, subsidies, taxes & levies

Some of them were discussed below:

Use of Renewable Energy Technologies

Renewable energy sources also called non-conventional energy, are sources that are continuously replenished by natural processes**.** For example, solar energy, wind energy, bio-energy - bio-fuels grown sustain ably), hydropower etc., are some of the examples of renewable energy sources.

A renewable energy system converts the energy found in sunlight, wind, falling-water, sea-waves, geothermal heat, or biomass into a form, we can use such as heat or electricity. Most of the renewable energy comes either directly or indirectly from sun and wind and can never be exhausted, and therefore they are called renewable. However, most of the world's energy sources are derived from conventional sources-fossil fuels such as coal, oil, and natural gases. These fuels are often termed **non-renewable** energy sources. Although, the available quantity of these fuels are extremely large, they are nevertheless finite and so will in principle 'run out' at some time in the future. Renewable energy sources are essentially *flows* of energy, whereas the fossil and nuclear fuels are, in essence, *stocks* of energy

Renewable energy is energy generated from natural resources such as water, sunlight, wind, rain, tides, fuel cells and biomass sources as energy crops. Renewable energy sources are energy sources that are continually and naturally replenished in a short period of time. In contrast, fuels such as coal, oil, and natural gas are non-renewable. Renewable Energy Technologies (RETs) are those that utilize energy sources in ways that do not deplete the Earth's natural resources and are as environmentally benign as possible. These sources are sustainable in that they can be managed to ensure that they can be used indefinitely without degrading the environment16. By exploiting these energy sources, RETs have great potential to meet the energy needs of rural societies in a sustainable way, albeit most likely in tandem with conventional systems. The decentralized nature of some RETs allows them to be matched with the specific needs of different rural areas (Table)

Renewable Sources and Corresponding RETs

Energy Source	**Energy for Domestic Use**	**Electricity**
Elemental renewables		
Solar	Solar pump, solar cooker	Solar PV
Water (including wave/tidal)		Micro- & Pico-hydroelectric generating plant
Wind	Wind powered pump	Wind turbine generator
Geothermal		Geothermal generating plant
Biological renewables		
Energy Crops		Biomass generating plant
Standard Crops (and by-products)		Biomass generating plant
Forestry and Forestry by-products	Improved cook-stoves	Biomass generating plant
Animal by-products		Biogas generator

Source: Renewable Energy Association 2009

Where sites are beyond the reach of an electricity grid or where the electricity supply is unreliable, and are remote enough to make the regular maintenance and refueling of diesel generators prohibitive, there are several cost-effective alternative energy sources available. The importance of these alternative energy sources is increasing as the costs of expanding into remote areas grow. As radio sites have become more energy-efficient, it has become more economically and technically feasible to use alternative energy sources.

The following approaches have been considered singly or in combination:

- Solar energy
- Wind energy
- Ocean/Tidal energy
- Pico hydro energy
- Biomass energy
- Fuel cell energy

Infrastructure Sharing

Passive site sharing involves components such as the tower, ground based or rooftop, cables, physical site or rooftop, shelter cabinets, power supply, air-conditioning, alarm systems, etc. In addition to capex saving, tower sharing saves utilization of precious natural resources like steel (approximately 10 tonnes), cement, concrete, Zinc (500 litres used for galvanization), land & soil conservation and optimised use of Power. In addition, active sharing of network infrastructure, which involves the sharing of the antennae systems, backhaul transmission systems and the base station equipment itself, will allow operators to save an additional 40% on top of available savings from passive infrastructure sharing. Active sharing could save mobile operators globally about US$60 billion over the next five years.

VI. MOVING TOWARDS GREEN ICT

In the march towards green telecom, the ultimate goal for all stakeholders would be to achieve carbon-neutrality or net zero carbon footprint. This can be achieved by balancing a measured amount of carbon released with an equivalent amount offset. In other words it refers to the practice of balancing carbon dioxide released into the atmosphere from burning fossil fuels, with renewable energy that creates a similar amount of useful energy, so that the carbon emissions are compensated. Alternatively, companies can buy enough carbon credits to make up the difference.

The Kyoto Protocol allows carbon offsets as a way to earn carbon credits from countries or companies that they can then trade on the open market. After reaching carbon neutrality, companies are encouraged to make money by selling their credits to other companies that are not carbon neutral. The World Bank plays a major role in the carbon credit market, and has rolled on the Clean Development Mechanism (CDM) carbon trading6. It allows the developed countries to earn "certified emission reduction units (CERs)".

The CERs can be applied to partially meet their GHG reduction commitments under the Kyoto Protocol whenever they undertake GHG reducing projects that contribute to sustainable development in a listed developing country, where land, technology and labour are less costly, &concomitantly result in real, measurable, verifiable and long-term GHG reductions that are additional to any that would otherwise occur.

The concept of carbon trading came to India in 2002 and since then India has developed an attractive portfolio of CDM market share of nearly 12.6%. The Indian market is extremely receptive to Clean Development Mechanism (CDM). Having cornered more than half of the global total in tradable CERs, India's dominance in carbon trading under the clean development mechanism (CDM) of the UN Convention on Climate Change (UNFCCC) is beginning to influence business dynamics in the country.

Faced with the economic and environmental realities, telecom network operators and their equipment vendors have begun to take new initiatives to improve the energy efficiency of telecom networks and reduce their associated carbon emissions. These efforts include reductions in the electricity required to power network elements, integration of renewable energy sources such as solar and wind, more energy efficient practices for network operations and a greater focus on recycling and reuse of network equipment. Pike Research's analysis indicates that there initiatives are likely to result in a significant reduction in energy-related operating expenses in addition to a dramatic decrease in GHG emissions related to telecom network operations.

Several sources estimate that the Information and Communications Technologies sector contributed 2-2.5% of global greenhouse gas (GHG) emissions in 2007 and that it is increasing. By 2020, with expanding telecom networks and increasing PC penetration, this figure is estimated to double unless actions are taken to change the direction in which the world is moving right now.

At 2% the ICT industry would account for 800 million tonnes of the world's greenhouse gas emissions through burning of fossil fuel. At present the energy component of operational expenses is nearly 25 percent of the total network operating costs. A typical communications company may spend nearly 1% of its revenues on energy which for large operators can amount to hundreds of crores of rupees. A redeeming factor is that compared to other sectors such as travel and transport, buildings and energy production, the ICT sector is relatively energy-lean (with telecom representing just0.7 percent or about 280 million tonnes).

Global Iniative:

Some of the initiatives taken by telecom players globally include:

- China Mobile has one of the world's largest deployments of green technologies to power its base stations. China Mobile had 2,135 base station powered by alternative energy in 2008. Of these 1,615 were powered by alternative solar energy, 515 by solar and wind energy and 5 by other alternative sources. According to a study low-carbon telecommunications solutions saved China 48.5 million metric tons of direct carbon dioxide emissions in 2008 and 58.2 million metric tons in 2009 and projected to deliver as much as 615 tons in carbon savings by the year 2020.

Across the world, some more initiatives have been launched to green the telecom sector. A few such initiatives are listed below:

- The **'Green Touch'** is a global consortium organised by Bell Labs whose goal is to create the technologies needed to make communications networks 1000 times more energy efficient than they are today.
- **British Telecom** have indicated that they have reduced carbon emissions by 60% compared to 1996, and plan to reduce the same by 80% by the year 2020.
- **GeSI (Global e-Sustainability Initiative)** based in Belgium, with 30 members, brings together leading ICT companies – including telecommunications service providers and manufacturers as well as industry associations – and non-governmental organisations committed to achieving sustainability objectives through innovative technology.
- The **Green Grid** is a non-profit open industry consortium of end-users policymakers, technology providers, facility architects and utility companies collaborating to improve the resource efficiency of data centers and computing ecosystems. With more than 175 member companies around the world, the Green Grid initiative based in Oregon, USA seeks to unite global industry efforts, create a common set of metrics and to develop technical resources and educational tools in quest of its goals.

- The European Commission's Code of Conduct on Data Centres' Energy Efficiency comprises a series of voluntary, light-touch measures, expected to form the basis of more stringent legislation in the future, laying out a set of minimum standards for compliance. The move to introduce the code of conduct at the end of last year was a recognition by the EC that data centres are heavy and often inefficient consumers of energy.
- Telefonica, having presence in 25 countries, has created a climate change office and is committed to reducing its consumption of network electricity by 30% by the year 2015.

Indian Initiatives:

The Indian telecom sector has also taken some steps towards reducing carbon footprints and working on a number of initiatives to develop energy efficient networks and energy efficient handsets. Some efforts that have been reported are:

- Launch of green shelter concept to save energy consumption by Airtel.
- Idea Cellular currently has many sites running on biodiesel in India. The biodiesel for these base stations comes from used cooking oils from restaurants.
- Bharti Infratel has set a target of deploying 2000 renewable energy sites by the financial year 2010-11. This initiative is expected toresult in estimated savings of US$16.67 million per year. The project is also expected to result in an estimated reduction of 58,170 tonnes of CO2 emissions per year.
- BSNL has taken up pilot projects for 10KW solar plants at 14 sites and Wind power project at 6 USO funded sites in Rajasthan, Gujarat, Tamil Nadu, Karnataka and Maharashtra.

In India too, various service providers have made numerous efforts towards green initiative. Some of their recent efforts to reduce the carbon footprint of the Indian telecom industry are as follows:

- The launch of the "green shelter" concept to save energy consumption by a telecom service provider. This is expected to reduce air conditioning costs at BTS locations.
- The use of renewable energy and bio diesel for running cellular sites by some service providers.
- The initiation of pilot projects for solar/ fuel powered cell sites at selected locals by some service providers. The installation of fuel catalysts in the fuel pipeline of Diesel Generators sets. The installation of Free Cooling Units (FCU) at some BTS sites by certain service providers. The initiation of pilot projects for bio-diesel powered cell sites at a few locals. Various technology solutions are available for powering telecom towers, but success of each of the available technology depends on multiple factors like capital expenditure, operating cost, reliability etc.
- While there are complex technologies like fuel cells available, viability in Indian context becomes a question. In India, solar and wind have been widely used in various distributed generation applications and have been successful in the past.
- Telecom towers companies are increasingly looking at renewable energy as an intermediate solution which could help reduce dependence on liquid fuel. Some tower sites have successfully combined conventional and alternate energy to overcome the load shedding issues.

VII. PROMOTING R&D FOR GREEN TELECOM

Globally a number of manufacturers of telecom equipment have committed funds to R&D in green telecom equipment. In January 2010, Green Touch, a global consortium was launched by Bell Labs whose goal is to create the technologies needed to make communications networks 1000 times more energy efficient than they are today. A thousand-fold reduction is roughly equivalent to being able to power the world's communications networks, including the Internet, for three years using the same amount of energy that it currently takes to run them for a single day. To support its objectives the Green Touch Initiative will deliver — within five years — a reference network architecture and demonstrations of the key components required to realize this improvement. This initiative also offers the potential to generate new technologies and new areas of industry.

In India by and large the telecom equipment is imported. The IPR of even those that are manufactured in India are held by foreign companies. This results in the financial benefit of the growth of infrastructure accruing largely to foreign companies. In the domain of green telecom there have only been some scattered efforts for carrying out R&D in green telecommunications equipment. Some private operators in India have developed microcellular systems run by solar power. There are also reports of energy-efficient engine alternators being developed for rural areas. Lightweight base station arrays have been designed for rural applications.

Confederation of Indian Industries state on their website that global research and development in low-carbon technologies should be initiated in collaborative mode involving public and private sector both from developed and developing countries. Businesses from developing countries can commit to accelerate deployment of clean energy technologies, build capacity to access and internalise cutting-edge technologies and contribute to the international R&D initiatives. Development of new technologies in consortia mode should also be accompanied by appropriate sharing of IPRs. It is suggested for having the following for boosting R&D in India:

- In addition to direct investment in R&D by both operators and vendors; there are consortiums to address challenges in green telecoms via networking and knowledge sharing.
- Subsides from USOF or other sources are necessary to fund R&D in green telecom.

VIII. CSR AND COMMUNITY SERVICE

Energy consumption is one of the leading drivers of operating expenses for both fixed and mobile telecom network operators. Reliable access to electricity is limited in many developing countries that are currently the high-growth markets for telecommunications. At the same time, many operators have adopted corporate social responsibility initiatives with a goal of reducing their networks' carbon footprints, and network infrastructure vendors are striving to gain competitive advantage by reducing the power requirements of their equipment. According to a report from Pike Research, all of these factors will continue to converge over the next several years, and "green" network equipment will grow to represent 46% of the $277 billion global telecom infrastructure market by 2013. Some of the telecom operators and equipment vendors leading the charge to create greener networks include China Mobile, Cisco, Huawei, Juniper Networks, Nokia Siemens Networks, Telstra, and Vodafone. According to a survey by IBM, CEOs from around the world and across diverse industries plan to increase corporate social responsibility (CSR) investments significantly over the next three years**.** According to the survey, CEOs plan to increase investment in corporate social responsibility initiatives by 25% over the next three years to better understand the demands of increasingly "socially-minded" customers.

It is now generally agreed that customer expectations around corporate social responsibility are increasing, and that CSR will play an important role in differentiating an enterprise in the future. Customers are coalescing around organizations' CSR profile – including "green" initiatives and are increasingly demanding socially-minded products, services, and even supply chains. It has been reported that £2 billion in customer contracts that British Telecom has won could be attributed in part to the operator's differentiation on CSR, of which a key part is Green ICT. BT won those contracts through its 'ethical reputation and its Green ICT credentials,' which include its CO2 emission reduction target, and its investment in low-carbon energy sources.

The CSR adopted by telecom service providers and manufacturers generally revolves around reducing energy consumption and greenhouse gas (GHG) emissions with more energy-efficient products and operations, managing materials and waste responsibly through a sustainable supply chain and strengthen communities where the companies are located. It would be worthwhile to see whether excess power generated through renewable sources can be distributed to communities or whether the water flowing out of the pico hydro power can be distributed to rural farms through tube-wells.

IX. GOVERNMENT OF INDIA'S ROLE

- Green Telecom India 2009 - International Conference
- Green Telecom India 2010 - International Conference
- Green Telecom India 2011
- National Telecom Summit 2013
- Green Summit 2014
- Green India Energy Summit 2015

Government directives:

Following directions has been issued to the licensees:

- At least 50% of the rural towers and 20% of the urban towers are to be powered by hybrid power (Renewable Energy Technologies (RET) + grid power) by 2015, while 75% of rural towers and 33% of urban towers are to powered by hybrid power by 2020.
- All telecom products, equipments and services in the telecom network should be energy and performance assessed and certified 'Green Passport [GP]' utilizing the ECR's Rating and energy 'passport' determined by the year 2015.
- TEC shall be the nodal center that will certify the telecom products, equipment and services on the basis of ECR rating. TEC may either appoint independent certifying agencies under its guidance or shall certify the same through their Quality Assurance teams. TEC shall prepare and bring out the 'ECR Document' delineating the specifics of the test procedures and the measurement methodology to be utilized.
- All service providers should declare to TRAI, the carbon footprint of their network operations in the format prescribed by TRAI. This declaration should be undertaken after adopting the formulae and procedures prescribed by TRAI. The declaration of the carbon footprints should be done twice a year i.e. half-yearly report for the period ending September to be submitted by 15th of November and the succeeding half yearly report for the period ending March to be submitted by 15th of May each year.
- Service providers should adopt a Voluntary Code of Practice and encompassing energy efficient Network Planning, infra-sharing, deployment of energy efficient technologies and adaptation of Renewable Energy Technology (RET) including the following elements:
- The network operators should progressively induct carefully designed and optimized energy efficient radio networks that reduce overall power and energy consumption.
- Service providers should endeavor to ensure that the total power consumption of each BTS will not exceed 500W by the year 2020 for 2+2+2 configuration of BTS. TEC shall regularly standardize and prescribe specifications for Telecom equipments of different technologies with respect to power consumption levels.

Service providers should adhere to the TEC specifications in order to reduce the total power consumption of BTS.

- A phased program should be put in place by the telecom service providers to have their cell sites, particularly in rural areas, powered by hybrid renewable sources including wind energy, solar energy, fuel cells or a combination thereof. The eventual goal under this phased program is to ensure that around 50% of all towers in the rural areas are powered by hybrid renewable sources by the year 2015.
- Service providers through their associations should consensually evolve the voluntary code of practice and submit the same to TRAI within three months from the date of issue of this letter.
- Service providers should evolve a 'Carbon Credit Policy' in line with carbon credit norms with the ultimate objective of achieving a maximum of 50% over the carbon footprint levels of the base year in rural areas and achieving a maximum of 66% over the carbon footprint levels of the base year in urban areas by the year 2020. The base year for calculating all existing carbon footprints would be 2011, with an implementation period of one year. Hence the first year of carbon reduction would be the 2012.
- Based on the details of footprints declared by all service providers, service providers should aim at carbon emission reduction targets for the mobile network at 5% by the year 2012-13, 8% by the year 2014-15, 12% by 2016-17 and 17% by 2018-19.

X. CONCLUSION

- India is the second largest and fastest growing mobile telephone market in the world. On an average, more than ten million new subscriptions are added every month, the market grows by 23% each year and has now crossed 800 million. But telecom is also the second largest energy consumer in India after the Railways.
- Almost all of this consumption is unseen – small diesel generators running for hours to power transceivers on each Cellphone tower and run air-conditioning units to keep equipment shelters cool. Generators are used because mobile operators are able to meet only 40% of their power requirements from grid electricity.
- TRAI suggests that in the next five years, at least 50% of rural towers and 33% of urban towers should be powered by hybrid energy (renewable energy technologies and grid power), while all rural towers and 50% of urban towers are to be powered by hybrid energy by 2020.
- The industry should place all its bets on alternative energy and wait till it becomes affordable to make for a viable solution. Until that happens, operators can focus on energy savings through efficient equipment and infrastructure.
- **Energy efficient equipment:** New generation equipment is not only more energy and space efficient but also has features that can cut down energy usage. Uninor's sites, for instance, have advanced functionalities like automatic shutdown of inactive transceivers. This saves energy when there is no activity on the network.
- **Enhancing infrastructure efficiency:** Most measures the industry can undertake today fall in this category. Some of these include:
- **Infrastructure sharing:** Passive sharing involves sharing of towers, shelter cabinets, power supply unit, air-conditioning unit alarm systems etc. Just this can lead to significant energy savings. Active sharing would involve sharing of network infrastructure such as antennae systems, backhaul transmission systems, and base station equipment.
- **Better cooling solutions:** A large part of energy consumption at a tower comes from the use of air-conditioning to cool down shelters that house equipment. A lot can be done here.
- For starters, many of the 'indoor' transceivers (kept in air-conditioned shelters) can be converted to outdoor sites. New generation equipment with better temperature tolerance allows for this. For sheltered sites, green shelters can be deployed. These have better insulation resulting in lower solar gain and therefore lower air-conditioning needs. Similarly, Free Cooling Units, which utilise ambient temperature to cool down equipment, reduce dependence on air-conditioning. Uninor has conducted a pilot at 7,500 sites that shows up to a 30% reduction in energy consumption with the deployment of Free Cooling Units.
- Uninor is also exploring a unique concept of underground heat exchangers. These channelize the lower temperature of soil below the surface to cool down equipment at the top. This reduces power requirement at a site by 25-30Kw per day.
- **Optimisation on diesel generator operation:** It involves deployment of fuel catalyst to improve the efficiency of the combustion process. Together with its partner Viom, Uninor installed fuel catalysts at 4,500 pilot sites and proved energy savings of 8 to 10%.
- Substituting conventional diesel generators with DC direct generators sets removes the inefficiencies of converting AC to DC power and hence reduces overall fuel consumption.
- The big measure next is to deploy renewable energy – initially to complement conventional diesel, and gradually to become the main power source to run telecom networks.
- Solar is one of the most adoptable options. Though it has high investment costs, the energy savings make it a compelling option. From the pilot that Uninor has implemented, it is evident that solar panels reduce fuel costs by almost 30%. For adoption of greener technologies and energy sources, measures such as tax holidays, accelerated depreciation and targetted subsidies will encourage early adoption and scale.

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