Consultation Paper No 3/2011

TELECOM REGULATORY AUTHORITY OF INDIA

Consultation Paper

On

Green Telecommunications

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Mahanagar Doorsanchar Bhawan

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New Delhi-110002

Preface

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 telecommunications 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.

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 is in this regard that TRAI believes that this is an opportune time to discuss the related issues and is therefore issuing this consultation paper for consideration and comments by the stakeholders. The inputs received will enable the Authority to take further action and take or recommend suitable measures.

Written comments on the issues raised in this consultation paper are invited from the stakeholders by 7th March, 2011 and counter-comments on the comments by 21st March, 2011. The comments and counter-comments may be sent, preferably in electronic form, to Mr Lav Gupta,

Principal Advisor (TD) on the e-mail address: tdra@trai.gov.in or tdra.trai@gmail.com. The fax number of TRAI is 011-23230056. Comments and counter-comments will be posted on the TRAI's website.

Dr. J.S. Sarma
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INTRODUCTION

1. Climate change is one of the most compelling global challenges of our time. There has been a considerable increase in the average temperature of the earth in the past century. This rise in temperature is attributed to the effects of global warming brought about by the accumulation of greenhouse gases (GHG) in the atmosphere. The reason for increased GHG, mainly Carbon Dioxide (CO_2), is because of the increased energy consumption which results in emission of pollutants. Natural calamities like typhoons, floods and changes in the sea levels are attributed to the CO_2 fuelled greenhouse effect. It is estimated that during the last 30 years the CO_2 emissions have gone up by 73%. India is ranked 5th amongst the countries in the list of global GHG emission, with USA and China contributing about 4 times emission than that of India[1]. The Kyoto Protocol of 1997, which was signed by over 160 countries, including India, calls on all countries to reduce their emissions of greenhouse gasses by 5%, from the 1990 level, by the year 2012. Many governments around the world, including India has taken steps to reduce energy consumption and emissions. India is committed to reduce carbon intensity by 20-25% between 2005 and 2020.

2. The information and communications technology (ICT) industry alone accounts for about 2% or 860 million tonnes of the world's greenhouse gas emissions[2]. The main contributing sectors within the ICT industry include the energy requirements of PCs and monitors (40%), data centres about 23% and fixed and mobile telecommunications contribute about 24% of the total emissions. Compared to the other sectors such as travel and transport, construction and energy production, the ICT sector is relatively energy-lean with telecommunications contributing just 0.7 percent or about 230 million tones of green house gas emissions. The challenge for the telecom service providers, telecom equipment

[1] India: Greenhouse Gas Emissions 2007, Ministry of Environment and Forests, Govt. of India, May 2010
[2] Gartner (2009), www.gartner.com/it

manufacturers and the government is to pursue growth in telecom networks, while ensuring that the 2 percent of global emissions does not significantly increase over the coming years.

3. 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.

4. 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[3] which for large operators may amount to hundreds of crores of rupees.

5. 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

[3] Telecom's green future by Dawn Bushaus, NXTcomm daily news, 18th June 2008

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.

6. 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 powering servers, data centers, networks, etc, it can leverage a reduction or avoidance of up to 9 tonnes across the economy[4].

7. This consultation paper has been issued by TRAI, *suo-motu,* to engage the industry in evolving mechanisms to assess and control carbon footprint and deliberate on the need and form of carbon credit policy for the telecom sector. Chapter I of this Consultation paper brings out the factors contributing to the carbon footprint and the need for carbon credit policy. Chapter II deals with methods to reduce carbon footprint and Chapter III gives the summary of the issues for consultation.

[4] http://www.mckinseyquarterly.com/How_IT_can_cut_carbon_emissions_2221

CHAPTER I

CARBON FOOTPRINT OF TELECOMMUNICATIONS INDUSTRY

A - What is Green Telecom?

1.1 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 green house 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:

(i) 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.

(ii) 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.

(iii) Design of green central office buildings: optimization of energy power consumption and thermal emission, minimization of green house gas emission

(iv) 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.

B- What are Green House Gasses and Carbon footprint?

1.2 Greenhouse gases (GHG) are gases in the atmosphere that absorb and emit radiation within the thermal infrared range. These gases prevent heat from escaping from the atmosphere and make the earth warmer. This process is the fundamental cause of the greenhouse effect. The main greenhouse gases in the earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, ozone and chlorofluorocarbons. Human activities add significantly to the level of naturally occurring GHG. Carbon dioxide is released into the atmosphere by the burning of solid waste, wood and wood products, and fossil fuels (oil, natural gas, and coal). Nitrous oxide emissions occur during various agricultural and industrial processes, and when solid waste or fossil fuels are burned. Methane is emitted when organic waste decomposes, whether in landfills or in connection with livestock farming. Methane emissions also occur during the production and transport of fossil fuels. Some gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6) result exclusively from human industrial processes. Greenhouse gases vary in their ability to absorb and hold heat in the atmosphere. HFCs and PFCs are the most heat-absorbent. Nitrous oxide absorbs 270 times more heat per molecule than carbon dioxide, and methane absorbs 21 times more heat per molecule than carbon dioxide.

1.3 Carbon footprint is the total set of GHG emissions caused by an organization, event or product through burning fossil fuels for electricity. For simplicity of reporting, it is often expressed in terms of the amount of carbon dioxide (CO_2) or its equivalent of other GHGs, emitted. It is expressed in equivalent tonnes of carbon dioxide ie CO_2e. A carbon

footprint is a measure of the impact our activities have on the environment, and in particular climate change. Carbon footprints can be classified into primary and secondary footprints:

- The primary footprint is a measure of the direct emissions of CO_2 from the burning of fossil fuels for the activities of the entity being carbon footprinted. For a telecom service provider it would include, for example, network operational cost, building lighting and cooling or heating and transportation. The service provider would have direct control over these.

- The secondary footprint is a measure of the indirect CO_2 emissions associated with the manufacture and eventual breakdown during the whole lifecycle of the products that are used. Energy consumed in the manufacture of equipment like BTS causes secondary footprint for the service provider who uses it.

C- Motivations for Green Telecom

1.4 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:

(i) Need to reduce the cost of operations of the telecom network by reducing energy cost.
(ii) Need to expand network into rural areas where power availability is poor.

(iii) Renewable energy technology becoming available at increasingly reducing cost.
(iv) Confluence of socio-political trends towards environmental responsibility, pressure groups against global warming
(v) 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.
(vi) International treaties like Kyoto Protocol

D- Estimating carbon footprint

1.5 Mobile subscriber base crossed 5 billion mark in July 2010 and is expected to cross 8 billion by 2020. With increasing demand for telecom services, the energy consumption has also grown significantly and poses an environment challenge in terms of larger carbon emission footprint of the telecommunication industry. The total global carbon footprint of the ICT industry as a whole is in the order of 860 million tonnes CO_2 which is approximately two percent of the global emissions. Of this, the contribution from global telecommunication systems-mobile, fixed and communication devices are around 230 million tons CO_2 or approximately 0.7% of global emissions.

1.6 How does one arrive at the carbon footprint of an activity? One can understand this by looking at one's own carbon footprint. One's carbon footprint is the sum of all emissions of CO_2, induced by one's activities over a period of one year. A common way to calculate CO_2 emissions is to base it on the fuel consumption. This can be simplified by taking fuel consumption. One litre of petrol is equivalent to 2.3 kgs of carbon while one litre of diesel is equivalent to 2.7 kgs of carbon dioxide. The following activities add 1 kg of CO_2 to one's carbon footprint: Travelling by public transportation a distance of 10 to 12 km., driving on your car for a distance of 6 km, flying on a plane a distance of 2.2 km, operating computer for 32 hours, producing 5 plastic bags or 2 plastic bottles.

1.7 To understand the contributory factors to the telecom carbon foot print one needs to understand the architecture of the telecom network, particularly the wireless telecom network. At the top level we have the telecom network and the rest of the assets like administrative offices. A telecom wireless network consists of the Radio Access Network and the Core network. Access mainly consists of the towers, antenna, BTS or Node B and BSC or RNC. When we refer to telecom towers, we generally refer to the towers and associated equipment like antenna, power system, BTSs, backhaul equipment etc. The core network mainly consists of MSC, SMSC, HLR, SGSN and GGSN. For any telecom operator the network uses 86% of the energy. The tower sites use 65% and the core network 21%. As compared to this all vehicles use just 1% and the corporate office 12%.

1.8 India has around 3,10,000 telecom towers of which about 70% are in rural areas. Presently 40% power requirements are met by grid electricity and 60% by diesel generators. The diesel generators are of 10-15 KVA capacity and consume about 2 liters of diesel per hour and produce 2.63 kg of CO_2 per liter. The total consumption is 2 billion litres of diesel and 5.3 million litres of CO_2 is produced. For every KWH of grid electricity consumed 0.84 Kg of CO_2 is emitted. Total CO_2 emission is around 5 million tones of CO_2 due to diesel consumption and around 8 million tons due to power grid per annum.

The following issues emerge for consultation:

1. **How should the carbon footprint of Indian telecom industry be estimated?**

2. **What is your estimate of the carbon foot print of the fixed, mobile and broadband networks?**

3. **In case of mobile what would be the individual footprints of the radio access network and the core network? How are these likely to change with 3G and 4G technologies?**

Carbon Credit Policy for telecom industry

1.9 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.

1.10 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 green house 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.

1.11 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 CO_2 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.

1.12 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 World Bank estimates that in 2006 approximately US $5 billion worth of CER were sold. The CER for December 2008 delivery was trading at about US $30 (EU €21) on September 1, 2008 on the European Climate Exchange. Current rate of the Carbon Credit is US$ 14.

1.13 The Indian government has approved more than 1,400 projects as part of the Clean Development Mechanism (CDM) that could attract around $6 billion(Rs 28,000 crore) into the country by 2012 through sale of Certified Emission Reduction (CER) certificates[5]. A 6.5-megawatt (MW)

[5] Business Standard, Leslie D'Monte / New Delhi Dec 11, 2009, 00:44

wind energy project in the state of Madhya Pradesh was issued 10,413 CER for offsetting green house gas emissions over a 13-month period.

1.14 India currently has more than 3,10,000 cell phone towers, which consume about 2 billion litres of diesel per year. The move from diesel to solar and other alternate sources of energy will result in a reduction of 5 million tons of CO_2 emissions as well as a savings of $1.4 billion in operating expenses for telecom tower companies. 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.

1.15 With regard to carbon credit policy for the telecom sectors the main comments given by the stakeholders' comments are as follows:

- A carbon credit policy would incentivize move towards renewable energy sources.
- To promote environment friendly telecom infrastructure, TRAI may propose to give carbon credits to operators for using eco-friendly fuels to power their exchanges and mobile base stations.
- The energy solutions companies are innovating on technologies that can reduce GHG emissions drastically. Also many sites are working on green energy. Both of these activities can earn carbon credits.
- As the carbon trading is a premature concept, government/TRAI needs to formulate a comprehensive frame work for carbon credit trading for Telecom companies.
- A clear Policy should be mandated with detailed modalities of how the carbon credit can be used /exchanged in the telecom market place. What benefit the telcos can enjoy if they reduce the carbon emission or alternatively what price they need to pay in case they fail to achieve the benchmarked figure of permissible CO_2 emissions.

- Prior to initiating or enabling any carbon credit policy, a comprehensive assessment within the Indian Telecom sector is critical to qualify the potential for mitigation within the sector, segregated further as high and low cost mitigations. The framework should ensure that Indian companies are demonstrably taking real action, with offsetting not hampering Indian company's potential / inclination to mitigate.

Comments are invited on the following issues relating to carbon credit policy:

4. **How should the carbon credit policy for Indian telecom sector be evolved? What should be the timeframe for implementing such a policy?**
5. **What should be the framework for the carbon credit policy?**
6. **What should be the metric to ensure success of the carbon credit policy in reducing the carbon footprint of the telecom industry?**

CHAPTER II

MOVING TOWARDS GREEN TELECOM

2.1 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 trading[6]. 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 labor 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%[7]. The Indian market is extremely receptive to Clean Development Mechanism (CDM). Having cornered more than half of the global total

[6] www.worldbank.com

[7] CDM Projects India, http://indscanblog.com/cdm-knowledge-base/carbon-credits-indian-scenario/

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.

2.2 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 these 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.

2.3 Several sources[8] 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,

[8] Sources: Gartner 2007; ITU 2007; SMART-2020, 2008

the ICT sector is relatively energy-lean (with telecom representing just 0.7 percent or about 280 million tonnes).

2.4 India has 12% power shortage[9]. In the five years to 2007, the country added 20,950MW of capacity, against a target of 41,110MW. It had an installed capacity of 1,50,000 MW in 2009. While 80 percent of Indian villages have at least an electricity line, less than 52.5% of rural households have access to electricity. In urban areas, the access to electricity was 93.1% in 2008. In 2009 the overall electrification rate in India was 66.3% while 403.7 million people were without access to electricity.[10] Due to the precarious power situation about 40% of the telecom towers have grid/Electricity Board power availability of less than 12 hours. Table 3.1 shows availability of power in different types of cell site locations.

Table 2.1 Power Availability for Tower Sites

Cell Sites	EB Availability	Description
10%	>20 hrs	Mainly metro cities of Mumbai, Kolkota, Chennai, some cities of Gujarat, State of Chattisgarh, some cities of Punjab
20%	16-20 hrs	Covers most other major cities and towns in the rest of the country
30%	12-16 hrs	All semi-urban and small uran 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

2.5 Deficient grid power makes it imperative to use non-grid sources, the most common being diesel gensets. The telecommunications industry in India uses about 2 billion liters of diesel fuel each year which results in 5 million tonnes of CO_2. This consumption would only increase as more new operators roll out their services existing operators expand their network further and launch 3G service BWA services. As per

[9] LiveMint.com May 5, 2009
[10] International Energy Agency, World Energy Outlook, 2010 new Electricity access Database

estimates[11] almost Rs 300 cr (US $ 67 million) is being spent every month by the telecom operators on running diesel generators in remote locations where the grid power remains cut off for long hours.

2.6 Given that the international supply and demand gap is resulting in increase in the price of diesel which would result in increase in the operational cost associated with managing networks, this may affect the profitability of operators, some of whom are already seeing profit erosion because of competition. To reduce costs, operators worldwide are trying to use innovative technologies that consume less energy and also making use of renewable energy sources and are increasingly opting for sharing. There are governments that subsidise use of renewable energy technology and regulators who have allowed active infrastructure sharing. Manufacturers of telecom equipment and handsets are also contributing. **The following issues arise in relation to availability of power:**

7. **What proportion of tower infrastructure is in rural areas? Please comment on the grid/electricity board power availability to these towers.**
8. **To what extent can active sharing reduce the carbon footprint and operational expenses?**

A - Domestic efforts for reduction of carbon footprint

2.7 India's deficient energy generation hampers its industrial and economic progress while making it heavily dependent on fossil fuels for its energy needs. Most of the power generation is carried out by coal and mineral oil-based power plants which contribute heavily to greenhouse gases emission. It is, therefore, essential to tackle the energy crisis through judicious utilization of abundant renewable energy resources, such as

[11] MAZAR & CMAI report "Role of renewable energy in telecom"

biomass energy, solar energy, wind energy and geothermal energy. Apart from augmenting the energy supply, renewable resources will help India in mitigating climate change. India is the world's fifth largest producer of wind power after Denmark, Germany, Spain, and the USA. There is a significant potential in India for generation of power from other renewable energy sources like small hydro, biomass, and solar energy. Greater reliance on renewable energy sources offers enormous economic, social, and environmental benefits.

2.8 While the Indian government is concerned that the rich nations are trying to shift a disproportionate burden of handling the climate crisis to the developing world, many companies in India have intensified the effort to reduce their carbon intensity[12]. At least a few large domestic corporations claim to have voluntarily developed technology road maps for cutting their carbon footprint. Some experts feel that these efforts are meager given the enormity of the task in hand. These experts think a lot more needs to be done with a sense of urgency in the areas of fuel switching and reduction of carbon consumption in manufacturing processes.

2.9 During the run-up to the UNFCC meet in Copenhagen in December 2009, where the international community strove to come up with a comprehensive agreement to combat climate change, India made a significant announcement that it intends to reduce 20% to 25% of its carbon intensity by 2020 against a 2005 baseline. India has a relatively low carbon footprint and a steadily declining carbon intensity over the last decade, and this voluntary target will further India's contribution. Even though India has a low-carbon per capita footprint, it has had some success in reducing its carbon intensity, being one of the few nations whose carbon intensity declined in 10 years preceding 2006. According to a World Bank study[13], the carbon intensity of the five sectors the five sectors that account for 75% of the CO_2 emission(power

[12] Adapted from Financial exp 19 Jan 2011

[13] Energy Intensive Sectors of the Indian Economy: Options for Low Carbon Development

generation, energy-intensive industries, road transportation, commercial buildings and residential housing) is set to improve by 33 percent between 2005 and 2031 (19 percent by 2020) with existing plans, but could improve by as much as 45 percent by 2031 (and 30 percent by 2020) with an all-out effort on the technical, financial and institutional fronts to reduce carbon emissions. The study said that the rate of decline will be determined by, among other initiatives, the timing of investments to maximize domestic sources of renewable energy and enhance energy efficiency.

2.10 India's current renewable energy base is 13,250 MW (7.7% of total installed base). Indian Wind Energy Association has estimated the 'on-shore' potential for utilisation of wind energy for electricity generation is of the order of 65,000 MW. In wind power, India's total installed capacity is planned to at least double by 2022 and the nation is emerging as an important manufacturing base for the global wind industry. In July 2009, India unveiled a $19 billion plan, Jawaharlal Nehru National Solar Mission, to produce 20,000 MW of solar power by 2020. India's National Solar Mission aims to see solar energy achieve grid parity with the cheapest coalfired capacity by 2030 and establish the country as a global leader in the field. Other major renewable technologies are on the agenda too, making India one of the world's most important markets for the clean energy sector[14].

2.11 The Indian telecom sector has also taken some steps towards reducing carbon footprints and are 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.

[14] http://www.renewableenergyworldindia.com/index.html

- 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 to result 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.

The following issues in relation to domestic efforts in reducing carbon footprint may be commented upon:

9. **What proportion of non-grid power supply to towers in rural areas can be anticipated to be through renewable sources of energy in India in the next 5 years?**

10. **How much saving accrues per tower if supply is through a renewable source instead of diesel for towers that do not get grid power for 12 hours or more?**

11. **How can migration to renewable sources be expedited?**

12. **If you are a service provider, what steps has your company taken towards use of renewable sources of energy? Have the gains from this move been quantified?**

B- Global efforts for reduction of carbon footprint

2.12 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.
- Active sharing agreements have been entered into by T-mobile and 3 Group in UK, Telstra and 3 Group, as well as Vodafone and Optus, in Australia, Tele 2 and Telia in Sweden.
- Swisscom has successfully implemented its "Mistral Mobile" cooling system at 30 of its BTS, leading to a reduction of up to 80% in the energy needed for cooling mobile network equipment.
- Nokia has launched a recycling initiative in many countries(including India) by placing kiosks at public places. The Kiosks are used to collect old phones to be recycled and used. Nokia plants a tree for every phone dropped and provides the customer with a unique URL and instructions with which to view their tree through Google Earth.
- Alcatel-Lucent's Bell Labs and partners such as China Mobile, Telefonica and AT&T, have formed a new consortium called Green Touch that vows to develop networking equipment that can cut energy consumption by a factor of 1,000, reducing emissions in the process.

- Ericsson has installed more than 200 photovoltaic 'Sunsites' (solar-powered base stations) in Morocco, Mexico and Ethiopia, among many other countries.
- Indonesian operator PT Telekomunikasi Selular (Telkomsel) is using latest generation low power consumption RBSs which are powered by Solar technology from Ericsson to provide macro coverage in Sumatra and rural areas of Indonesia.
- Village Solar Chargers have been deployed in all Millennium Villages in the ten countries in sub-Sahara Africa where Ericsson is working.
- Bell Canada, BT, Nippon Telegraph & Telephone and other European telcos have calculated and published their carbon footprints and have set goals for reducing them. These companies have publicly reported their emissions in corporate social responsibility reports and through the Carbon Disclosure Project, an independent organization that requests carbon disclosures from the world's largest companies.
- As part of a commitment to going green, AT&T has invested about $14 million to take specific actions to improve efficiencies based on the results of comprehensive energy audits of the company's highest energy-consuming facilities
- Sprint has indicated that 75% of the energy used at Sprint's 200-acre headquarters facility in Overland Park, Kan., is generated by wind. That makes Sprint the 15th-largest purchaser of renewable energy in the U.S.
- Globally, BT gets credit for being one of the most aggressive in reducing its carbon footprint. The company's 2006 CO_2 footprint measurement in the United Kingdom was .64 million metric tons of carbon emissions — a reduction of 60% from its 1996 total of 1.6 million metric tons. BT has pledged an 80% reduction of its 1996 total by 2016. In the U.K., nearly all of BT's electricity now comes from renewable sources and combined heat and power plants.

C- Methods of reducing carbon footprint

2.13 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 airconditioning 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 life cycle emission could be reduced through recycling.

2.14 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 following issues relate to metric for certification of products and services:

13. **What should be the metric for certifying a product green?**
14. **Who should be the metric for certifying a network or service as green?**

Measures for reducing telecom carbon footprint

2.15 We would examine the measures that can be undertaken to reduce the telecom sector footprint under the following categories:

(i) Adoption of energy efficient equipment and innovative technologies

(ii) Use of Renewable sources of energy

(iii) Infrastructure Sharing

(iv) Improvement of grid supply

(v) Waste Management

(vi) Better network planning: more outdoor BTS, less BTS, less airconditioning requirement to cool sites

(vii) Standardization of equipment, test and certification

(viii) Manufacturing process

(ix) Monitoring and reporting

(x) Government support – subsidies, taxes & levies

(i) Adoption of energy efficient equipment and innovative technologies

2.16 Telecom service providers and others in the ICT industry can bring into play an expansive array of technologies and services that will substantially improve the environmental footprint of commercial enterprises as well as that of consumers. It is important to understand that the technologies underlying a green communication initiative are largely currently available. What is required is to organize these into green ICT solutions that can be effectively marketed and used.

2.17 Energy costs account for more than half of a mobile operators' operating expenses and about 65% of this is for the tower site equipment. Therefore, radio network solutions that improve energy-efficiency are not only good for the environment, they also make commercial sense for operators and support sustainable, profitable business. A way to compare energy efficiency of products is to assess annual CO_2 emission during the life time operation of products. This would involve the subscriber instrument and what was required to produce, deliver and operate the network to provide the service. In a study[15] it has been found that the annual CO_2 emissions per average GSM subscriber is now about 25kg down from around 180kg for first-generation networks in 1985. The 25kg CO_2 equates to the same emissions created by driving an average European car on the motorway for around one hour. The average 3G subscriber has a footprint of about 30kg CO_2. As the mobile phone becomes smart subscribers can perform many more services for a reduced CO_2 impact compared with previous generations of mobile devices.

[15] Ericsson Press Release "Energy-saving solutions helping mobile operators meet commercial and sustainability goals worldwide", June 2008

2.18 A key element of the delivery of this CO_2 reduction is the energy-efficiency of radio base station products. A feature that has been introduced is automatic control of BTS Power based on the traffic. This feature reduces energy consumption in mobile networks during low traffic periods by putting the radio resources of the network, that are not being used, into standby mode. This energy-saving feature does not disrupt existing traffic or subscriber experience. Depending on network traffic patterns, the feature can reduce energy consumption by up to 25 percent in the radio access network. In many cases this feature can be introduced through a software upgrade.

2.19 In general, larger equipment have greater energy requirement. Today, such energy – in the region of 10 kilowatt – is being provided by diesel generators, which leave a large carbon footprint. It may be possible to design distributed systems that are spatially separated and together serve a large area and yet requires lesser energy than, say 1 kilowatt at each location.

The following issues with regard to energy efficient technologies may be commented upon:

15. As a manufacturer/service provider have you started producing/using energy efficient telecom equipment? How is energy efficiency achieved? Please explain.

16. How does the cost of energy efficient and the normal equipment compare?

(ii) Use of Renewable Energy Technologies

2.20 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 environment[16]. 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 2.2)

Table 2.2 Renewable Sources and corresponding RETs

	RETs	
Energy source	**Energy for domestic use**	**Electricity**
Elemental renewables		
Solar	Solar pump, solar cooker	Solar PV
Water (including wave/tidal)		Micro- and 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 cookstoves	Biomass generating plant
Animal by-products	Biogas digester, improved cookstoves	Biogas digester

Source: Renewable Energy Association 2009.

2.21 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

[16] Renewable Energy Association, 2009

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

Solar Energy

2.22 Solar power is generated using the photovoltaic properties of semi-conductors to convert light energy into electricity. With the reduced power consumption of modern telecommunications equipment, solar electricity has become an economically and technically attractive alternative to conventional energy sources. Solar power can be used in microwave repeaters, cellular base stations, VSATs, telephone exchanges and satellite earth stations etc. Solar transmission towers and repeater stations can be located in remote locations, even in the most rugged terrain, far from utility lines, allowing for the best placement of the site. Many existing sites that operate 24/7 on diesel fuel can transition to solar to reduce the burden of costly fuel and maintenance of generators. Very often a combination of solar, wind, and generator is used.

2.23 Solar is perhaps the most matured amongst all alternative energy technologies. The main advantages are that it is clean and causes no direct production of GHG, it has no moving parts so minimal maintenance cost, has a lifetime of about 20 years, it is easy to manage and is more reliable than diesel generator powered systems. New generation power efficient base stations for a macro coverage site only requires much smaller solar panels making them easier to install and manage. There are some concerns, though. Although sunlight is free, solar cells and the equipment needed to convert their direct-current

output to alternating current for use in a house is expensive. Electricity generated by solar cells is still more than twice as expensive as electricity from fossil fuels. The arrays can be target for theft or vandalism. The solar cell itself may be non-polluting but the production of collectors and storage devices is not pollution free.

2.24 Often a site is too large for a purely solar power solution to be viable, so alternative solutions are needed to improve energy-efficiency and cut running costs. Hybrid solar and diesel solutions can lead to 50 percent reduction in energy-related costs.

2.25 Besides the network equipment some mobile companies have developed solar mobile phone charges for rural areas. These can charge a number of mobile batteries per day and many mobile phones simultaneously.

Wind energy

2.26 In recent years, wind has become an increasingly attractive source of renewable energy and, according to some sources, the world's fastest-growing energy technology. To generate power, a wind turbine attached to an electrical generator converts wind power to electrical energy. Wind turbines placed at sites with strong, steady winds can economically generate electricity without producing pollutants. The source is free, clean and green. Smaller systems can be mounted on existing radio-masts, reducing costs. Site–selection must be carefully done for deployment of wind–turbines (ISO–20 wind maps must be studied before deploying wind turbines). However, the cost per kW of electricity is currently higher than solar or diesel. Wind velocity is often erratic, thus we need a very efficient charge controller and a sink for excess power. Sink for excess power can be a tube-well for example

Ocean/Tidal

2.27 The world's oceans have potential of becoming an important energy source but right now there are very few ocean energy power plants and most are fairly small. There are three basic ways to tap the ocean for its energy. We can use the ocean's waves, we can use the ocean's high and low tides, or we can use temperature differences in the water.

2.28 Wave Energy: Kinetic energy exists in the moving waves of the ocean. This energy can be used to power a turbine. Waves can be used to cause air movement in a special chamber which spins a turbine which can turn a generator. Alternatively, up and down motion of the wave can be used to power a piston that moves up and down inside a cylinder and can turn a generator. Most wave-energy systems are very small.

2.29 Tidal Energy: Another form of ocean energy is called tidal energy. When tides come onto the shore, they can be trapped in reservoirs behind dams. Then when the tide drops, the water behind the dam can be let out just like in a regular hydroelectric power plant. In order for this source to be effective, tides should be large. An increase of 16 feet between low tide and high tide is usually needed. There are only a few places where this tide change occurs around the earth. Tidal plant in La Rance, France makes enough energy from tides to power 240,000 homes.

2.30 Ocean Thermal Energy Conversion (OTEC): The third ocean energy idea uses temperature differences in the ocean. Power plants can be built that use this difference in temperature to make energy. A difference of at least 38 degrees Fahrenheit is needed between the warmer surface water and the colder deep ocean water.

Pico Hydro Energy

2.31 The term pico hydro refers to very small hydro systems. Hydro systems provide constant energy during times of normal rainfall. Today, the primary use of pico hydro is for lighting and basic electrical needs in remote areas. However, areas with high rainfall, steep flowing streams and rivers provide an ideal source of power for wireless communication network base stations, allowing the low cost, low maintenance deployment of wireless communications to emerging markets. The potential energy stored in the elevated water supply flows through a pipe called a penstock, to drive a turbine which drives a generator which converts the mechanical energy to electrical power. Typical energy efficiency in such a system is 40-50%[17]. Successful trials have been carried out but Pico hydro as a commercial alternative power solution is very much in its early stages. Commercially, governments and action groups are supporting hydro power.

Biomass Energy

2.32 Biomass power is obtained from the energy in plants and plant-derived materials, such as food crops, grassy and woody plants, residues from agriculture or forestry and the organic component of municipal and industrial wastes. Biomass power is not only a source of renewable energy but also helps in waste management. The energy crops, coupled with high-efficiency conversion technologies, can help respond to global climate change concerns. Electricity generated from biomass is also called biopower. Biopower facilities use many different technologies; the most common is burning of wood or other biomass feedstock to produce steam which then is used to drive turbines and produce electricity. Some generators use a mix of biomass and fossil fuels to generate electricity, while others burn methane, a product of the natural decay of organic materials. Biomass power is close to a carbon-

[17] Motorola white paper on "Alternatives for Powering Telecommunications Base Stations, Motorola

neutral electric power generation option as biomass absorbs carbon dioxide from the atmosphere during its growth and then emits an equal amount of carbon dioxide when it is processed to generate electricity. Thus, biomass fuels "recycle" atmospheric carbon, and may reduce global warming impacts. Biofuels are liquid fuels produced from plants. The two most common types of biofuels are ethanol and biodiesel.

2.33 While biomass is a renewable energy resource, it can have both negative and positive environmental impacts. It may reduce emissions and pollutants, but factory farming of biomass crops can reduce biodiversity and negatively impact wildlife habitat. Safe disposal of ash/residue is also important. Municipal solid waste may contain toxins which could cause pollution if it is used as a biomass feedstock. As with other renewable resources, use of appropriate technology will promote the most positive environmental impacts. The DG which is part of the previous hybrid solution can be made to use biomass instead of costly and polluting fossil fuel. It reduces the dependence on diesel. In India some operators are deploying base stations powered by biofuels in rural areas that have not previously had access to a mobile network and are located in areas with unreliable power supply. In the long term, it is expected that locally produced jatropha oil will be used, as soon as this is available in sufficient quantities.

Fuel cell

2.34 Fuel cells that electrochemically combine hydrogen and oxygen to produce electricity and heat offer the promise of making hydrogen an ideal universal fuel. Hydrogen also can be found in many organic compounds, as well as water. It's the most abundant element on the Earth but does not occur naturally as a gas. It's always combined with other elements, such as with oxygen to make water. Once separated from another element, hydrogen can be burned as a fuel or converted into electricity

2.35 Fuel cells are emerging as a strong alternative power source candidate. The technology has matured in recent years and has many benefits compared to generators, such as fuel efficiency, climate resistance, reliable start-up, and being very compact (fits in a 19" rack). Having reached volume manufacturing and with prices falling, they will challenge conventional engine driven generators in terms of cost and reliability. There are, however, some concerns like availability of hydrogen on continuous basis at identified locations, requirement of covered storage space for hydrogen storage and safety & security issues with hydrogen cylinders.

The following arises with respect to use of renewable energy sources:

17. What are the most promising renewable energy sources for powering telecom network in India? How can their production and use be encouraged?

(iii) Infrastructure Sharing

2.36 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[18]. **The following issues regarding infrastructure sharing becomes important:**

18. What is the potential of infrastructure sharing in reduction of energy consumption?

(iv) Improvement of grid supply

2.37 The total installed power capacity(as on 30-11-2010) is 1,67,077.36 MW out of which power from renewable energy sources is 16,786.98 MW or 7.7 %. The Ministry of Power has set a goal of power for all by 2012. A comprehensive blueprint has been prepared encompassing an integrated strategy for the sector development with the objective of sufficient power to achieve GDP growth rate of 8%. It aims to give reliable and good quality power at optimum cost. With the increase in availability of grid power in rural and remote areas consumption of diesel for telecom tower sites would reduce resulting in reduction of carbon footprint. As more and more energy comes from renewable sources, the footprint would reduce further.

[18] "Charting the future of mobile infrastructure"; www.greentelecomlive.com

(v) Waste Management

2.38 Rapid industrial development has led to the generation of huge quantities of hazardous wastes, which have further aggravated the environmental problems in the country by depleting and polluting natural resources. Therefore, rational and sustainable utilization of natural resources and its protection from toxic releases is vital for sustainable socio-economic development. Hazardous waste management is a new concept for most of the Asian countries including India. The lack of technical and financial resources and the regulatory control for the management of hazardous wastes in the past had led to the unscientific disposal of hazardous wastes which posed serious risks to human, animal and plant life. In order to manage hazardous waste, MoEF, Government of India notified the Hazardous Waste (Management & Handling) Rules (HWM Rules) on July 28, 1989 under the provisions of the Environment (Protection) Act, 1986 and was further amended in the year 2000 & 2003. India is also a party to the Basel Convention on transboundary movement of hazardous wastes. The basic objectives of the Basel Convention are for the control and reduction of transboundary movements of hazardous and other wastes subject to the Convention, prevention and minimization of their generation, environmentally sound management of such wastes and for active promotion of the transfer and use of cleaner technologies. As a party to the Convention, India is obliged to regulate and minimise the import of hazardous waste or other wastes for disposal or re-cycling and also to prohibit export of waste to parties, which have prohibited the import of such wastes. Further, hazardous waste generated in the country is also required to be managed in an environmentally sound manner.

2.39 The hazardous waste generated in the country per annum is estimated to be around 4.4 million tonne. Out of this, 38.3% is recyclable, 4.3% is incinerable and the remaining 57.4% is disposable in secured landfills. The amount of hazardous waste generated in this country is quite small in comparison to that of the USA, where as much as 275 million tonnes

of hazardous waste was generated annually. Nevertheless, considering the fragile ecosystem that India has even this low quantum of hazardous wastes can cause considerable damage to natural resources if untreated before releases.

2.40 Some countries are imposing strict regulation on disposal of electronic waste that consists of network equipment as well as handstes. Recycling is on the increase driven by increasingly strict regulation. One example is the Waste Electrical and Electronic Equipment Directive (WEEE Directive) of the European Community imposing responsibility for the disposal of waste electrical and electronic equipment on the manufacturers of such equipment which became European law in February 2003. This has substantially changed the way equipment recycling is handled, mainly by equipment vendors but also responsible operators. Mobile phone recycling is reducing the environmental impact of the telecom industry not only by reducing CO2 emissions, but also by limiting the release of toxic elements into the environment. With more than 3 billion mobile phone users globally, it is estimated that over 500 million tons of mobile phones have been retired worldwide so far[19][20]. These devices contain numerous toxic elements, like arsenic, beryllium and lead, which risk being disposed of in landfills.

Stakeholders are invited to comment on the following issues relating to waste management:

19. What is the current procedure for storing, disposing and recycling telecom waste by the service providers and manufacturers?

20. How can waste management be made more green?

[19] Source: GRC Wireless Recycling 2009
[20] Taking the temperature on green telecom, White paper, www.northstream.com

(vi) Better network planning

2.41 Network planners can help reduce the carbon footprint in a number of ways. New network design methodologies, radio techniques and site technologies have been developed to reduce energy consumption across the board: from radio equipment, through climate and power systems to radio access networks with a focus on improving both new network roll-out, as well as the operation of existing networks. Energy consumption can be reduced if network solutions and services can be designed to use fewer sites and to reduce energy consumption. It is not difficult to see that energy is not only required to power the equipment and make it work. When equipment, like base stations, operate they dissipate some power as heat which raises the ambient temperature of the equipment. If the equipment is not cooled, by bringing the ambient temperature within the operational range, then the equipment may malfunction or breakdown. The chambers were equipment is housed are therefore airconditioned. Airconditioning needs energy for operation. It therefore follows that energy demand and therefore the carbon footprint can be reduced if planners use energy efficient equipment that need less energy to work and also dissipate lesser power as heat. Equipment that allow control of power based on the user traffic can also be used. Planners can also serve the cause of green telecom and bring savings to their companies by judiciously using a mix of micro and macro sites and also home-based femto cells. The core network can also be planned with technologies with sleep mode and energy efficient elements like routers. Backhaul may be designed for sharing using adaptive Ethernet transmission rate switching depending on traffic load. There are techniques like MIMO(Multiple Input Multiple Output), HARQ(Hybrid Automatic Repeat Request), beam forming, wireless mess networks, distributed equipment that would be more energy efficient. Innovative methods like using telecom towers as wind towers and solar panels as shelter roofs can also deliver some benefits. Software based power management systems can be used by telecom service providers

to do a real-time monitoring and management of energy consumption in their facilities. Properly planned systems can save them 15% to 35% on energy costs. **This discussion gives rise to the following issue:**

21. What steps can be taken by the service providers in planning green networks?

(vii) Standardization of equipment, test and certification

2.42 There are some existing global standards for green telecom that telecom equipment should conform to e.g. ISO 14001:2004, OHSAS 18001:1999 and EuP. The EuP is a new regulation that sets eco-design requirements for energy-using products. The international standards WRI/WBCSD GHG Protocol and the ISO 14067 standard "Carbon Footprint of Products" are moving closer to completion. Furthermore, significant developments are taking place in different countries that will shape the practical implementation of product carbon footprinting in the future. In TRAI pre-consultation the stakeholders have suggested the following:

- International standards stimulate large production of standard equipment and help vendors to exploit economies of scale. Standards if adopted internationally can help larger adoption of green technologies. However, there are conflicts between defining standards and technology neutrality and therefore while defining any standards, it should always be borne in mind that no technology is preferred over the other.

- Universal mobile phone charger and a common base station for dual technology should be considered for use. A common base stations for dual technology can also be considered.

- The market is still innovating rapidly, therefore forcing standardisation may reduce innovation/advances.

- Base stations, and their locations/markets are very different to each other and therefore very difficult to select 'one size fits all' solutions. By selecting/promoting specific designs/products the procurement decisions shift away from the people that know best i.e. the MNOs /tower companies. However, it is possible to make recommendations that operators/tower companies move towards standardised designs.

- Use of smarter equipment that may lead to less number of towers

- BEE(Bureau of Energy Efficiency) is working out star ratings for industrial equipments. TRAI could insist on star ratings or equivalent rating systems on products being used by telecom operators.

- Publicly Available Specification (PAS 2050) developed by British Standards Institution is widely accepted global standard for product footprint. It provides a method for assessing the GHG emissions arising from products across their life cycle, from initial sourcing of raw materials through manufacture, transport, use and ultimately recycling or waste.

- To further improve the penetration of Green Energy solution Standards need to be formed by Government in terms of defining the total energy used/Carbon emission for every type of sites. Strict enforcement of these regulations can bring in substantial improvement in Carbon emission.

The following issues relating to standardization, testing and certification may be commented upon:

22. What standards do you propose to be followed in Indian telecom network for reducing the carbon footprint?

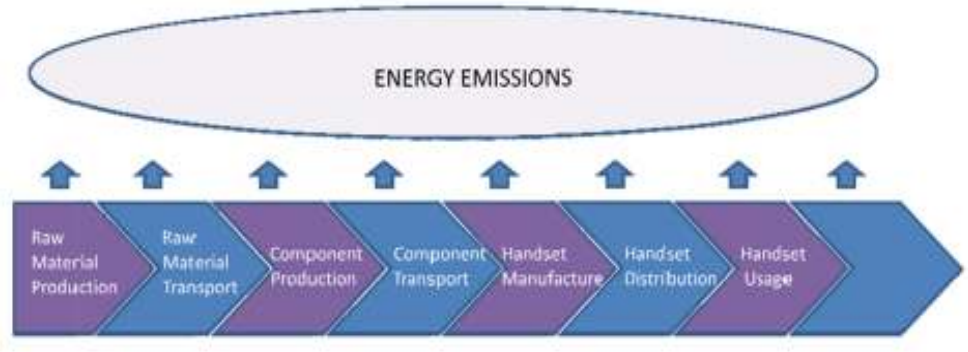
23. Who should handle the testing and certification of green equipment and networks?

(viii) Manufacturing process

2.43 A green product development initiative is often about responding to market interest in environmentally friendly products. For telecom equipment manufacturers the case is no different. The value of a green product for these companies isn't just about environmental goodwill. It's often also about the lowered operating costs their products boast from improved energy efficiency. Developing these products often come with high investment and research costs of green or new requirements that can be difficult to understand. However, finding ways to overcome these challenges is crucial for manufacturers intent on transforming market differentiation into product profitability.

2.44 The pressure on businesses to develop strategies which embrace environmetal sustainability has increased dramatically in recent years. Given both governmental and consumer pressure, many companies have become more proactive in their attempts to deliver products and services which do not adversely impact the environment. The mobile industry is seeking to develop its own environmentally sustainable businesses. With regard to mobile handsets, vendors and operators must analyse emissions across the life cycle of the handset from raw material extraction to end-of-life and then put in place policies to reduce direct and indirect emission. (Figure 2.1)

Figure 2.1 Mobile Handset Lifecycle



Source: Juniper Research

2.45 The following list highlights a number of key means whereby opportunities exist to address direct or indirect CO_2 emissions:

- Increasing energy efficiency in the handset
- Increasing energy efficiency of the charger
- Seeking to utilize solar-power handsets or solar-powered chargers
- Reducing transport emissions
- Ensuring that handsets are manufactured using materials sourced from companies with green credentials
- Reducing packaging
- Encouraging hand recycling

2.46 Telecom equipment manufacturers need to carry out research and development of environment friendly equipment which minimize emission from conceptualisation to product delivery. The design should promote environmental conservation, quality enhancement and efficient use of resources. The equipment should be designed to lower operational costs by effectively reducing the cost of leasing, electricity, air-conditioning, and manpower. The manufacturer should use renewable materials to manufacture products and recycled materials for packaging as far as possible. The telecom equipment should conform to global standards for green telecom. The impact on the environment will be considered at every stage of the product life cycle and assessed in the aspects of resource and energy consumption, waste, recycling, etc., so as to ensure product quality and environmental protection**. The following issues, therefore, becomes important and needs to be considered:**

24. How can manufacturers help in reducing GHG across the complete product life-cycle?

(ix) Monitoring and Reporting

2.47 It is important to devise mechanisms for telecom industry to have a good monitoring system for the carbon emission and ensuring carbon footprint reduction. Carbon footprint of all the activities needs to be measured and documented. Compliance to international standards and domestic regulations must be continuously verified. It may also be useful to mandate suitable reporting requirement to ensure that standards and regulations are being complied to. The stakeholders have suggested the following during the pre-consultation:

- Comprehensive guidelines may be framed in consultation with Industry to estimate and report Carbon Foot print.
- Framework for monitoring carbon emission and corrective action for telecom sector
- The model guidelines/methodologies being practiced internationally should be carefully examined and further discussions should be held to arrive at a monitoring mechanism which is best suited for the Indian environment.

2.48 The energy efficiency rating is used to measure efficiency of an energy system or a device. The higher the rating better is the energy efficiency. To be able to rate telecom devices and networks there is a need to have an energy efficiency rating mechanism undertaken by an accredited energy assessor. The energy efficiency of any network would largely depend on how the network is designed and the elements used. Owing to a large number of telecom devices and equipment having a universal rating standard for telecom industry would be challenging task. The Alliance for Telecommunications Industry Solutions (ATIS) has developed three standards for measuring the energy efficiency of telecommunication equipment. The standards are designed to determine 'network-element efficiency,' through a 'comprehensive methodology' that measures and reports energy consumption and

uniformly quantifies a network component's ratio of 'work performed' to energy consumed.

2.49 In India, Bureau of Energy Efficiency (BEE) is implementing a National Energy Labelling Programme to provide the consumers an informed choice about energy saving and cost saving potential of various home appliances like air conditioners, refrigerators, distribution transformers, etc. Besides, there is also a programme relating to energy audit for buildings. The Energy Conservation Building Code (ECBC) is also in vogue on voluntary basis. The ECBC sets minimum energy standards for new commercial buildings having a connected load of 500 KW or contracted demand of 600 KVA. The Energy Conservation Act, 2001 inter-alia contains provisions for accredited energy auditors as well as the manner and intervals of time in which the energy audit shall be conducted. **In view of the above, the following issues needs to be considered**:

25. **What should be the rating standards for measuring the energy efficiency in telecom sector?**
26. **Please give suggestions on feasibility of having energy audit in the telecom sector on the lines of energy audit of buildings.**
27. **What should the monitoring mechanism for implementation of green telecom?**
28. **Who should be the monitoring agency?**
29. **What type of reports can be mandated and what should be the frequency of such reports?**

(x) Incentives for green telecom

2.50 Adoption of green telecom has its own costs and offsets. R&D of energy efficient equipment or those that work on alternate sources of energy requires funds. There is a general feeling that the alternate sources of energy are more expensive as compared to the grid electricity or even

that obtained through diesel gensets. When incentive schemes are considered necessary, there could be a number of ways in which they could be worked out:

(i) Incentives can be given for equipment working on the principle of energy conservation. Energy requirement for equipment or a part of the network can be worked out as a function of traffic or based on cooling requirements, ability to function in all weather conditions or on sleep mode functionality. The equipment that outperforms the threshold set may be given incentive.

(ii) Equipment that uses renewable energy sources may be given subsidy.

(iii) Equipment that is spectrum efficient and is able to provide more data rate with minimum bandwidth and equipment which is able to provide radiations of more signal strength with less power consumption can be given incentive.

(iv) The operators who utilize non-hazardous materials in telecom as per Kyoto Protocol be given incentives. The telecom industry having adequate arrangement for the hazardous waste reduction should be considered for incentives.

(v) There could be incentive plans for operators who implement equipment recycling program.

(vi) There could be non-financial incentives to operators/tower companies in the form of technical assistance provided by experts of bodies like GSMA, specifically for feasibility studies.

2.51 During the pre-consultation stage stakeholders have suggested the following ways in which incentives can be given:

- Duty reliefs and industry-recognized 'Gold/Silver/Bronze' status for companies implementing green initiatives
- Institution of Government Awards and Recognition mechanism for companies that do outstanding work in use of equipment with lower energy ratings similar to the BEE star ratings.
- Common options are: Tax incentives, Pilot grants, CAPEX subsidies, Allocation of USO funds to renewable energy cell towers in rural/remote regions.
- The support of the Government towards Viability Gap Funding (VGF) for such initiatives by the service providers is necessary
- The MNRE has currently proposed a very positive scheme for Central Financial Assistance for adoption of alternative energy for telecom. In order to encourage maximum conversions, these schemes should be valid for at least 5 years. It will take that time considering the fact that there are over 3 lacs tower installations in the country. Only long term players with large volume rollout plans should be encouraged to ensure that incentives are put to good use for long term benefits of the nation.
- Subsidy on tariff/Equipments for the generation of alternate energy, Import duty exemption on import of equipment for RE generation
- Depreciation benefits on all or part of infrastructure
- Subsidy on running costs of alternative energy equipment
- Subsidy on costs of replacing equipment with higher carbon emission with more environmentally acceptable technologies.
- Subsidies, from Universal Service Fund (USOF) or other sources could also be considered for tower companies to help fund a systematic replacement of carbon emitting fuels by cleaner ones over an agreed timeframe. Another way of subsidizing the costs of telecom players would be through waivers or reimbursement of fees or applicable taxes.
- The investment on the site will depend on the kind of power supply a BTS is dependent on. Since USO Fund is committed to take care of

three-fourth of the investments, it may not end-up to be a huge burden.

- TRAI may recommend of giving financial incentives in terms of lower revenue share to operators deploying non-conventional sources of energy such as solar and wind energy wherever possible.
- A domestic incentive mechanism must be evolved to support incremental efforts and smaller initiatives which tend to be excluded under the Kyoto protocol. Many more activites and agencies are part of the telecom ecosystem and must be supported if India is to achieve the goals of Green Telecom. These agencies include manufacturers, service providers, vendors and decision makers etc involved in energy generation, energy usage, energy distribution. The support could be in the form of waiver or reduction of licence fees or explicit support from the Universal Service Obligation Fund.

The following issue emerges for consultation:

30. What financial and non-financial incentives can be useful in supporting the manufacturers and service providers in reducing the carbon footprint?

D - Promoting R&D for green telecom

2.52 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.

2.53 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.

2.54 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. During the pre-consultation the stakeholders have suggested 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.

The following issues emerge for consultation:

31. What R&D efforts are currently underway for energy efficient and renewable energy telecom equipment?

32. How can domestic R&D and IPR generation be promoted?

E- CSR and community service

2.54 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.

2.55 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 CO_2 emission reduction target, and its investment in low-carbon energy sources.

2.56 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 tubewells.

The following issue needs consideration and comments:

33. Would it be a good idea for TRAI to evolve a best practices document through a process of consultation with the stakeholders?

CHAPTER III

ISSUES FOR CONSULTATION

Carbon Footprint

3.1 How should the carbon footprint of Indian telecom industry be estimated?

3.2 What is your estimate of the carbon foot print of the fixed, mobile and broadband networks?

3.3 In case of mobile was would be the individual footprints of the radio access network and the core network? How are these likely to change with 3G and 4G technologies?

Carbon Credit Policy

3.4 How should the carbon credit policy for Indian telecom sector be evolved? What should be the timeframe for implementing such a policy?

3.5 What should be the framework for the carbon credit policy?

3.6 What should be the metric to ensure success of the carbon credit policy in reducing the carbon footprint of the telecom industry?

Availability of Power

3.7 What proportion of tower infrastructure is in rural areas? Please comment on the grid/electricity board power availability to these towers.

3.8 To what extent can active sharing reduce the carbon footprint and operational expenses?

Domestic Efforts for Reduction of Carbon Footprint

3.9 What proportion of non-grid power supply to towers in rural areas can be anticipated to be through renewable sources of energy in India in the next 5 years?

3.10 How much saving accrues per tower if supply is through a renewable source instead of diesel for towers that do not get grid power for 12 hours or more?

3.11 How can migration to renewable sources be expedited?

3.12 If you are a service provider what steps has your company taken towards use of renewable sources of energy? Have the gains from this move been quantified?

Methods for Reducing Carbon Footprint

Metrics for Certification of Product and Services

3.13 What should be the metric for certifying a product green?

3.14 Who should be the metric for certifying a network or service as green?

Adoption of Energy Efficient Technologies

3.15 As a manufacturer/service provider have you started producing/using energy efficient telecom equipment? How is energy efficiency achieved? Please explain.

3.16 How does the cost of energy efficient and the normal equipment compare?

Use of Renewable Energy Technologies

3.17 What are the most promising renewable energy sources for powering telecom network in India? How can their production and use be encouraged?

Infrastructure Sharing

3.18 What is the potential of infrastructure sharing in reduction of energy consumption?

Waste Management

3.19 What is the current procedure for storing, disposing and recycling telecom waste by the service providers and manufacturers?

3.20 How can waste management be made more green?

Better Network Planning

3.21 What steps can be taken by the service providers in planning green networks?

Standardisation of Equipment

3.22 What standards do you propose to be followed in Indian telecom network for reducing the carbon footprint?

3.23 Who should handle the testing and certification of green equipment and networks?

Manufacturing Process

3.24 How can manufacturers help in reducing GHG across the complete product life-cycle?

Monitoring and Reporting

3.25 What should be the rating standards for measuring the energy efficiency in telecom sector?

3.26 Please give suggestions on feasibility of having energy audit in the telecom sector on the lines of energy audit of buildings.

3.27 What should the monitoring mechanism for implementation of green telecom?

3.28 Who should be the monitoring agency?

3.29 What type of reports can be mandated and what should be the frequency of such reports?

Incentives for Green Telecom

3.30 What financial and non-financial incentives can be useful in supporting the manufacturers and service providers in reducing the carbon footprint?

Promoting R&D for Green Telecom

3.31 What R&D efforts are currently underway for energy efficient and renewable energy telecom equipment?

3.32 How can domestic R&D and IPR generation be promoted?

CSR and Community Service

3.33 Would it be a good idea for TRAI to evolve a best practices document through a process of consultation with the stakeholders?

List of Acronyms

Sl No.	Acronyms	Expansion
1	3G	3rd Generation
2	ATIS	Alliance for Telecommunications Industry Solutions
3	BEE	Bureau of Energy Efficiency
4	CDM	Clean Development Mechanism
5	CER	Certified Emission Reductions
6	CO_2	Carbon Dioxide
7	CSR	Corporate Social Responsibility
8	ECBC	Energy Conservation Building Code
9	EuP	Enterprise Unified Process
10	GDP	Gross domestic products
11	GHG	Green House Gases
12	HFC	Hydrofluorocarbon
13	HARQ	Hybrid Automatic Repeat Request
14	ISO	International Organization for Standardization
15	MW	Megawatt
16	OHSAS	Occupational Health & Safety Advisory Services
17	OTEC	Ocean Thermal Energy Conversion
18	PAS 2050	Publicly Available Specification 2050
19	PFC	Per fluorocarbons
20	RETs	Renewable Energy Technologies
21	SF6	Sulfur Hexafluoride
22	TRAI	Telecom Regulatory Authority of India
23	UNFCCC	United Nations Framework Convention on Climate Change
24	USOF	UN Convention on Climate Change

25	VSAT	Very Small Aperture Terminal
26	VGF	Viability Gap Funding
27	WBCSD	World Business Council for Sustainable Development
28	WEEE	Waste Electrical and Electronic Equipment
29	WRI	World Resources Institute