Back to Green

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Abstract

Eco-friendly, i.e., green is of high importance today not only from the perspective of health of our planet but also from the point of view of business. In this paper we present an overview of worldwide activities in the field of green Information and Communication Technology (ICT). Together with the overview we present technical means to make ICT green and usage of ICT to make a green world. We also capture some of the issues and activities in India regarding green ICT – notably that of Global ICT Standardisation Forum for India (GISFI). This because India continues to grow and her energy needs is putting a huge challenge for everybody.

Keywords: ICT, GHG, green, GISFI.

1 Introduction

Technology enhancement usually leads to easier and convenient life for mankind but it has not always been positive for Mother Nature – our planet. Last few decades have seen huge technological development along with leapfrog increase in consumption as the two most populous countries of the world join the bandwagon. Earlier with consumption confined to few select countries, emission and other side effects, though harmful was causing slow-poisoning.

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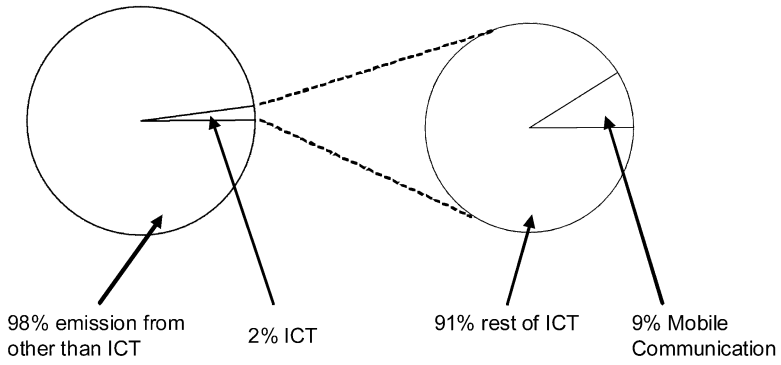


Figure 1 Green House Gas (GHG) emission [2–8].

But the needs of this new club of users from China, India, Brazil and many other so called emerging economies are overwhelming Mother Nature particularly her capabilities to sustain the overall Green House Gas (GHG) emission. This in essence has sped the obvious side effects – like increase in average global temperature, irregular weather pattern, changing wind pattern, elevation of sea level, impacting plant and animal kingdom. The impact on the nature of our planet has brought us to the junction where future needs to be considered carefully, to sustain and make our planet green again, so as to prevent a catastrophe from happening.

While Information and Communication Technology (ICT) is one of the greenest technologies, at global scale of penetration and perpetual usage, the side effect is not negligible. A rough estimate of Carbon Dioxide (CO_2) emission, a part of GHG, from ICT and especially mobile communications is depicted in Figure 1 [1–8].

Impact on green starts from the decision of material to use for a given technology or product to usage and finally decommissioning of the product, i.e., the product ends its useful lifetime. Nature is further impacted by policy, rules and regulations in place and their enforcement to check the harm done by a given product at all stages of its lifecycle. Today the problem is wide spread beyond the GHG emission but ICT can enable controlling the problems – like sound pollution, water scarcity and air pollution.

In this paper we focus on the GHG emission during the product usage. We divide our discussions in two main parts – in first part we focus on opportunity to make ICT further green and in second we focus on leveraging ICT to make other industry green.

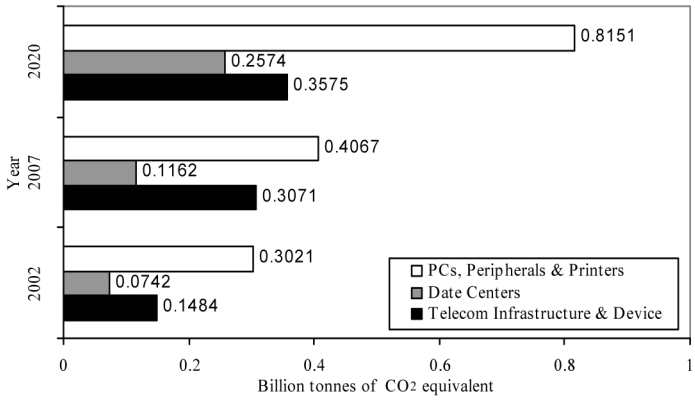


Figure 2 Global ICT footprint by sector [32].

We start the paper in Section 2 with a discussion on emission of GHG by ICT. In Section 3 we provide a literature survey of known solutions to reducing GHG in ICT, or using ICT to reduce GHG. After this, in Section 4, we pay special attention to specific technologies for reducing GHG. Finally, we present a discussion on GHG emission related issues in India and standardization activity on Green ICT at the Global ICT Standardisation Forum for India (GISFI) in Section 5. We conclude the paper in Section 6.

2 Impact of ICT on GHG Emissions

In this section we present a brief overview of GHG emission from ICT. We first present an overview of emission and in subsequent sub-sections give further details regarding emission from telecom sector, data centers and end-user devices respectively.

2.1 Overall

The ICT sector has grown at an extraordinary pace over the last two decades – transforming society and economy. ICT impacts business, lifestyle and family relationships unlike never before. As the ICT sector grows, GHG emission from the ICT sector will continue to grow. Below are a few examples of the explosive growth of ICT:

- The number of computers connected to the Internet is expected to cross 3 billion by 2011 [25]. According to some projections, by 2020 the

number of devices connected to the Internet will be around 50 billion. Today there are more than 1.5 billion users of Internet. As more and more users from developing nations start using Internet, this number will see a significant increase over the years. Many of these users from developing nations will access Internet via their mobile phones.

- Global mobile phone penetration is already reaching 50% while the number of mobile phone users in India as of May 2010 has already crossed 617 million with an annual growth of close to 50% [26].
- For most economies, the share of Gross Domestic Product (GDP) attributable to the ICT sector is already quite significant and is increasing each year. In India, ICT sector contributed about 5.8% of the national GDP in Fiscal Year 2009. Share of GDP attributable to ICT sector in developed economies such as United Kingdom is close to 7% [27].

As of 2007, the ICT sector was responsible for about 2% of total Carbon emissions at over 0.8 billion tones of CO_2 equivalent [32]. With the kind of growth happening in the ICT sector, total emissions from this sector is estimated to rise to about 1.4 billion tones of emission by 2020. Segment wise contribution towards the total carbon footprint of the ICT sector is shown in Figure 2.

2.2 Telecom Infrastructure and Devices

Since 2007, 37% of all ICT emission is due to telecom infrastructure and devices [32]. This includes emission caused by mobile network infrastructure, mobile devices, and fixed broadband and narrowband devices. Increasingly as more and more people get access to mobile telephony, the total emissions from mobile devices and infrastructure will increase correspondingly. By the year 2020, as much as 25% of the total ICT Carbon footprint will be from telecom devices and infrastructure. This amounts to almost 349 million tons of CO_2 equivalent. Figure 3 shows the break up of the same into various segments. We can see that over half of the contribution would come from mobile networks alone.

Mobile network equipment is operated nonstop round the clock and 365 days a year. As the number of mobile subscribers increase, more number of cell sites are added to the network and the energy bill for maintaining the network continues to soar. Almost 80% of a mobile operator's energy consumption is due to radio base station equipment. The remaining energy is consumed in core networks. Sub-optimal network design leads to significant inefficiencies with respect to energy consumption and therefore carbon

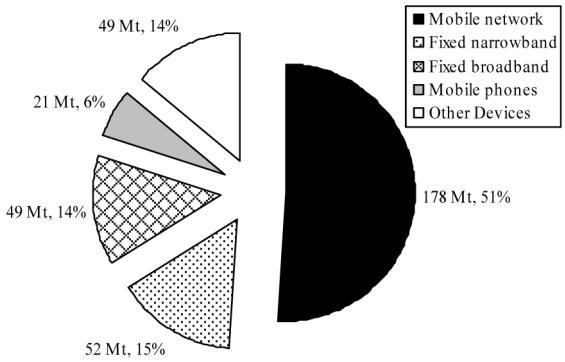


Figure 3 CO_2 footprint of telecom devices and infrastructure by 2020 [32] (Mt: Million tons).

footprint [38]. Within the radio base stations site and equipment, significant opportunities exist to improve energy efficiency of radio equipment, signal processing and associated circuitry, power amplifiers, power supply and air conditioning [39, 40].

2.3 Data Centers

Data Centers are the fastest growing segment of ICT and are major contributors of carbon emission [32]. Rapid growth in use of Internet, web applications, online services, Voice Over Internet Protocol (VOIP), IP Television (IPTV) and enterprise Information Technology (IT) needs has resulted in proliferation of data centers . Web services providers are building cavernous warehouse scaled data centers to meet their growing needs. As of 2007, 14% of all ICT emission is caused by Data Centers. This includes both corporate data centers and as the Internet data centers where large scale consumer facing web applications such as search engines and social networking sites are hosted. Roughly 50% of the emission due to data centers is due to power system losses and cooling loads. Of the remaining, the bulk of the emission is caused by the energy consumed to power up low cost commodity servers that now dominate most data centers.

2.4 End User Devices

By far the largest contribution to CO_2 emissions in the ICT sector is from end user devices such Personal Computers (PCs) and peripherals [32]. This because there are already more than a billion PCs worldwide and the number

is expected to touch 4 billion by 2020. PCs alone will be the single largest contributor to ICT emissions responsible for almost 42% of all ICT emissions. By 2020, two major technological changes are expected to take place: (1) desktop PCs will be largely replaced by the more energy efficient laptops, (2) almost all Cathode Ray Tube displays will be replaced by energy efficient Liquid Crystal Displays. Both will bring significant efficiencies; however the increase in number of PCs will mean that the total CO_2 footprint in 2020 will be three times that of 2002 levels.

3 Standards, Industry Activities and Recommendations

At the global level, international standards in Green ICT is driven by international organizations such as International Electorotechnical Commission (IEC), International Telecommunications Union (ITU), European Telecommunications Standards Institute (ETSI), Electronics and Telecommunications Research Institute (ETRI), Institute of Electrical and Electronic Engineers (IEEE) and GISFI. In addition to these organizations, standardization activities of organizations such as Intergovernmental Panel on Climate Change (IPCC), United Nations Framework Convention on Climate Change (UNFCCC), International Organization for Standardization (ISO) and GHG Protocol Initiative have indirect relationship to Green ICT. There are also several industry activities and recommendations.

ITU study on ICTs and Climate Change [2] categorizes the worldwide initiative for Green ICT as (1) policies, (2) indicators and statistics, (3) data collection, (4) environmental management (5) corporate reporting, (6) energy efficiency of equipment, (7) energy efficiency of networks, (8) energy efficiency of data centers, (9) electronic wastes, and (10) equipment labeling. In this section we use the ITU categorization to give an overview of some of the activities regarding green ICT and present the open issues. Note that a few of the mentioned activities might fall under multiple categories.

3.1 Corporate Reporting

Greenhouse Gas Protocol: This is the standard and accounting tool for understanding, quantifying and managing GHG emissions. It has come out with two important standards – namely the "A Corporate Accounting and Reporting Standard" and "The GHG Protocol for Project Accounting."

ISO/IEC JTC 1: ISO IEC JTC 1 has established a Study Groups on Green ICT and Energy Efficiency of Data Centers. It also has a Special Working Group on Smart Grids.

3.2 Environmental Management

UNFCC Clean Development Mechanism (CDM) methodologies: The UNFCC maintains baseline and monitoring methodologies for CDM project activities [29]. The CDM allows GHG emission-reduction (or removal) projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one ton of CO_2. These credits can be traded and sold. The ICT Sector is not directly covered.

ISO TC 207: This covers standardization in the field of environmental management tools and systems. The ISO TCS 207 consists of a set of standards that provide a general framework for environmental management. These standards are industry neutral and have ICT sector specific rules, requirements and guidelines for use in ICT.

ISO Project Committee 242: This committee aims to establish the ISO 50001 standards. This standard would establish a framework for managing energy usages for various types of organizations such as industrial, commercial, institutional, large residential, and transportation sectors.

IPCC Guidelines: IPCC has three guidelines [28]. Volume 1 provides step-by-step directions for compiling, documenting and transmitting GHG Inventory reports. Volume 2 of the guideline is a workbook that provides step-by-step instructions for calculation emissions of GHG gases like carbon dioxide and methane. Volume 3 is a technical reference manual that provides detailed technical information about methods of estimation of emission.

Global e-Sustainability Initiative (GeSI): GeSi's purpose is to further the cause of sustainable economy using innovative use of ICT. In 2008 GeSI published the Smart 2020 Report [32] on use of ICT for creating a Low Carbon economy. GeSI's activities include development of standards, methodologies, best practices and promotion of good conduct in the areas of Climate Change, Energy Efficiency, E-waste and Supply Chains. It also works with policy makers to promote the use of ICT for sustainable development.

3.3 Energy Efficiency

In this section we cover activities regarding energy efficiency of networks, equipments and data centers.

ITU-T: Study Group 5 (SG 5) on Environment and Climate Change (CC) is the lead SG to advance standardization efforts in the area of Green ICT [31]. The Work Programme 3 (WP 3) of SG 5 study group has started work in areas such as:

- Coordination and planning of ICT standardization related to climate change.
- Methodology for environmental impact assessment for ICT.
- Energy efficient power feeder/supplies for ICT devices.
- Methodology for data collection related to ICT energy efficiency.
- Environmental protection and recycling of ICT equipment and facilities.

In addition to ITU-T SG 5, a Joint Coordination Activity on ICTs and climate change (JCA-ICT&CC) has been established in 2009 by the ITU-T Telecommunication Standardization Advisory Group (TSAG). The JCA-ICT&CC coordinates ITU-T ICT&CC work amongst the various ITUT Study Groups and liaises with the ITU-R and ITU-D Sectors. Relevant ITU-T Study Groups are SG-13 that works on standards for Next Generation Networks (NGN), SG-15 that works on Digital Subscriber Line (DSL) standards and SG-16 that works on Multimedia terminals, systems and applications.

The Green Grid: Green Grid's charter includes defining meaningful, user-centric models and metrics for data center efficiency. It also promotes the adoption of energy efficient standards, processes, measurement methods and technologies. The Green Grid is best known for publishing the Power Usage Effectiveness (PUE)/Data Center infrastructure Efficiency (DCiE) and Data Center Productivity (DCP) metrics for data centers [33].

Alliance for Telecommunications Industry Solutions (ATIS): In March 2009, the Network Interface, Power, and Protection (NIPP) committee of ATIS published three specifications of telecommunication systems [35]. The specifications describe a methodology for measurement and reporting of energy efficiency. One of the documents describes the general requirements and serves as the base requirements. The other two describe the requirements for servers and transport. ATIS specifications define a metric for energy efficiency – namely the Telecommunications Energy Efficiency Ratio (TEER) that is defined as the ratio of Useful Work to Power. Useful Work depends on the equipment in question and examples include performance measures like Data Rate, Throughput, Processes/sec, etc. Power is the actual measured equipment power in watts.

Climate Savers Computing Initiative (CSCI): The focus of CSCI is on energy efficient PC and servers. CSCI promotes the development, deployment

and adoption of energy efficient technologies for PC power delivery and use of power down states for reducing the idle state energy consumption. The stated goal of CSCI is to move industry toward a 50% reduction in power consumption by computers by 2010.

3.4 Equipment Labeling

Energy Star: This is an initiative of the US Environmental Protection Agency (EPA) and Department of Energy. The Energy Star program for computers aims to generate awareness of energy saving capabilities and accelerate the market penetration of more energy-efficient technologies. In July 2009, Energy Star released Version 5 of its specifications for PCs, Laptops, Power Supplies, Displays, Workstations and Thin Clients [34].

3.5 Open Issues

The ISO/IEC JTC 1 in its report [30] has identified many gaps in the existing standards with respect to needs of the ICT sector. Some of the important gaps identified are as follows:

- There is a need to define GHG accounting standards for the ICT sector. Standards defined by IPCC, GHG Protocol Initiative and ISO TC 207 need to be tailored/customized for use by the ICT sector.
- There is no UNFCC CDM methodology for ICT sector and it needs to be developed.
- There is a need to develop specific standards of environment labeling to promote low carbon ICT products. Also, standards for Life Cycle Analysis and carbon foot-printing methodologies for ICT hardware need to be developed.

Radio-communication and spectrum issues also have an impact on climate change efforts. There is a need to look at standardization of new radio technologies like digital modulation, compression and error correcting codes that will enable radio equipment to lower their energy requirements.

Energy efficiency is needed in all layers of the Open Systems Interconnection (OSI) Reference Model and therefore every standardization activity needs to consider these.

With respect to Green Data Centers, while organizations such as The Green Grid have come out with guidelines and best practices, there are no international standards yet. There is a need for standards for Data Center energy efficiency methodologies and metrics.

Significant standardization effort is also required in Smart Grid technology – including specific topics like Smart Grids interoperability, Smart Metering, Home Area Networks and communication interfaces.

4 Green Technologies

In this section we dive deeper into the topics that have or will have huge impact on GHG emission reduction. We start with analyzing three fundamental needs for energy efficient system: (1) consolidation, (2) energy proportionality, and (3) energy efficient algorithm. We then introduce virtualization and cloud computing to show how these new technologies are helping us in achieving greener ICT. Next we give some examples on the utilization of ICT to make other technologies greener with a specific focus on transportation.

4.1 Consolidation

Overall, system level inefficiencies must be eliminated in order to achieve reduction of GHG emission. Systems must be operated such that utilization is maximized while maintaining desired service levels. Consolidation is a proven method that increases utilization of infrastructure and helps reduce energy consumption substantially. Put simply, consolidation involves deploying multiple applications/services on a common shared virtualized resource pool. Consolidation improves energy efficiency since it enables infrastructure to be used at higher levels of utilization. It also reduces space usage and the embodied carbon footprint.

The problem of low utilization levels is especially prevalent in typical enterprise IT environments where unplanned and ad-hoc growth combined with shortage of CAPEX leads to too many varieties of servers with widely different hardware, OS running many different applications. The overall environment is inefficient in terms of energy and space usage leaving huge scope of consolidation.

A similar case of consolidation is possible in telecom network as well. In the telecom context, the consolidation can happen through sharing of passive elements (towers, etc.) and active elements (antenna, radio elements, switches, etc.) or resources (spectrum). Examples of passive sharing of towers are already seen in many countries, including India.

Another example of consolidation is the usage of flexible base stations that allow multiple services to be run on the same hardware, such as both GSM/EDGE and/or WCDMA/HSPA.

4.2 Energy Proportional Design

Energy Proportional Design principle implies that a device should use negligible power when it is powered on but doing no work. As the load of system increases, the power consumption should increase in proportion. However as Table 1 shows, in reality almost all common device devices consume substantial power even at zero load. For example, a typical server consumes almost 50% of the maximum rated power consumption when running at no load Some of these components exhibit very low dynamic range of peak power consumption versus idle power consumption [36, 37].

Non-proportional behavior exists in all data center equipment such as switching, storage, power supplies, UPS, air conditioning and air handling systems.

While ideal proportional behavior is difficult to achieve there are efforts towards making standby/sleep/hibernation mode more energy efficient in almost every product through research and standardization. New technological advancement like Multi-core Central Processing Units (CPUs) is plausible candidate in helping this goal. Theoretically a system with many cores can show better proportionality of consumption and throughput [45].

4.3 Energy Efficient Algorithm

Apart from the categories given in previous two sub-sections, another long-term and much more subtle technological development is needed, which is energy efficient algorithm, or computing to make complete system energy efficient. We must remember that till now algorithms were designed to be (1) time/speed efficient and (2) memory efficient. Energy efficiency was not the primary goal [47]. In the context of power constraint environment like sensor network, etc., energy efficient algorithms starts from design of energy efficient protocols [48].

4.4 State of Affair of Greener ICT: Virtualization and Cloud Computing

In the previous sections we have discussed means of enabling greener ICT, in this section we present well known solutions and show how they are helping to make a greener ICT. One of the major enabler for consolidation in data centers or IT back-end environment is virtualization technologies. The other mode of consolidation is happening through cloud computing.

Table 1 Power consumption in different mode of operations showing highly non-proportional behavior [44].

Product/Mode	Average (W)	Min (W)	Max (W)	Count
Modem, DSL				
Off	1.37	0.33	2.02	16
On	5.37	3.38	8.22	20
Charger, mobile phone				
On, charged	2.24	0.75	4.11	4
On, charging	3.68	0.27	7.5	23
Power supply only	0.26	0.02	1	32
Computer Display, LCD				
Off	1.13	0.31	3.5	32
On	27.61	1.9	55.48	31
Sleep	1.38	0.37	7.8	30
Computer, desktop				
On, idle	73.97	27.5	180.83	63
Off	2.84	0	9.21	64
Sleep	21.13	1.1	83.3	52
Computer, notebook				
Fully on, charged	29.48	14.95	73.1	13
Fully on, charging	44.28	27.38	66.9	8
Off	8.9	0.47	50	19
Power supply only	4.42	0.15	26.4	19
Sleep	15.77	0.82	54.8	16

Computer virtualization refers to the abstraction of computer resources, such as the process of running two or more logical computer systems on one set of physical hardware [41–43] with any combination of common OS and hardware available in market [46].

In this way, many of poorly utilized machines can be replaced by a few high-end servers: a typical, virtualized server runs at 65–85% capacity compared with average server usages of 7–20%. Given the fact that a server that is in idle state consumes around 50% of the rated power, the overall saving from this consolidation is obvious [23, 41–43, 46].

Current servers are highly non-proportional in energy efficiency; running server for personal application for one's own use may not be energy efficient. This is further true when applications need bigger servers. If such servers are running continuously at very low utilization, it is obviously highly energy inefficient. The alternative is to run such application on the cloud which allows scaling as and when needed. As the cloud is always shared with many users, resource utilization is much better than a personal server at lower capacity [19–21].

Along with the virtualization techniques, a single server in the cloud data center can provide multiple services to its users. Servers in the cloud data centers may also have the ability to migrate their workloads to other data centers [20]. These characteristics allow the data centers to cut the number of servers and realizes efficient power consumption.

The configurable resources mentioned above can be pooled to serve multiple users using a multi-tenant model [19]. This enables the centralization into large scale data centers where high power usage effectiveness (PUE) can be achieved. These data centers often have PUEs around 1.2 [21]. It is difficult to achieve such PUE in a small scale data center placed in a local office building.

4.5 Smart ICT – Towards Emission Reduction

As we mentioned earlier that emission from ICT is not a major contributor compared to other larger industry like energy, transportation, manufacturing, mining etc. That is good news. But most importantly ICT is visualized as the agent of change for all the other industries toward energy, cost and other efficiency improvement. Some of the means to utilize ICT are given in [15].

While we can go into details of many of the technologies to see how ICT can help each of them, to start with we capture some of the generic benefit that ICT brings:

- Pervasive Awareness: One of the basic things about GHG emission is awareness of people regarding their impact on the nature. Simple applications on mobile phones can be used to give information to the users regarding their impact on the environment. Alerts could be provided to highly enthusiasts on reaching their GHG emission threshold (person emission of GHG or PEG) for the day – something similar to calorie meters today with a difference that PEG could also reduce when a person does eco-friendly things like walking or cycling.
- Accurate Real time Measurement: Using embedded communication modules in any of the components of the system one can collect accurate measurement of states of choice through appropriate sensors. If one can measure one can control leading to a stable and optimally controled system which can be highly energy efficient.
- End-to-End Quality Check: Sensor solutions using machine-to-machine (M2M) communication over the mobile network can also be used to observe the condition in areas with high risk of, for example, oil spill,

chemical spill etc. This will allow timely warning for maintenance and repair, as prevention, and an early warning to avoid any accident.

Having described the generic value that ICT brings we will now focus on specific example of technology domain and see how ICT helps the goal of reduction of GHG emission. We specifically probe Transportation industry and show how ICT is being utilized and how it can bring novel ideas into reality in near future.

4.6 ICT for Transportation

Transportation System will be major benefactor of ICT and the impact would be substantial not only from reduction of GHG emission but also for better user experience and financial benefit to all stakeholders.

While benefit of ICT in mass transportation system is already well known through ticketing, routing and traffic optimization, accident reduction, these are just some early value of ICT and many more dimensional values will be generated in near future. It is very important that each of the new technology opportunities is compared using a single parameters like GHG emission per person per km of travel over a longer period of time and region. Failure to measure such parameter will not lead to the final goal of reduction of GHG emission. Below we highlight a few thoughts on leveraging ICT for greener transportation solution.

Synchronous Multi Modal Transportation System: Mass transportation remains awfully short of coverage thus a large population in every country has to depend on personal mobility means. Potential solution to the issue is a synchronous system where personal mobility system works in sync with different types of public transportation. This is a huge challenge for ICT but with obvious gain for reducing the GHG emission.

Synchronous Traffic Signal: Synchronizing of traffic signals leading to fewer stops for vehicles can be very beneficial in terms of GHG emission but locally optimal solution may not bring enough value. Therefore next generation ICT enabled large scale synchronous traffic signaling system is required. Such ICT enabled synchronous system can be designed so that at the entry point of arterial system, vehicles are kept waiting till appropriate time. In a holistic design, these entry points can even be pushed to individual home/office. In essence, this means that people do not start from home or office unless time is ripe. Albeit once again this is a huge challenge to find a globally (e.g. at a large city level) optimized system with a focus to impact the overall emission reduction.

Pay-as-You-Drive: Assuming that one can measure in real time the actual driving hours and emission produced by the vehicle together with pollution level along the path and time of driving, a pay-as-as-you-drive model can be introduced which will enable responsible driving by discouraging unnecessary driving, or by avoiding peak hours as well as crowded places. Enabling such an infrastructure is practically possible and can be done using current ICT technologies.

ICT Enabled Social Sensing: Equipping a fraction of vehicle on the road with road condition sensing capabilities (potholes, ice, roughness, water, etc.) and allowing these data to be aggregated either in centralized fashion using vehicle to infrastructure communication or in peer-to-peer (P2P) manner using vehicle to vehicle communication can bring a system of collaborative sensing. This can allow better navigation of the vehicles allowing potentially safer and low emission driving. The next stage of this sensing technology can leverage vehicle to vehicle communication for collaborative driving.

4.7 Protection against Unsolicited Communication

Unsolicited communication (UC) is the terminology used for spam or other similar attacks on network/users [9, 10]. The Internet is plagued with UC and slowly the mobile world is also being attacked. Issue in mobile communications will become worse as the terminals become always-on and IP is truly going end-to-end as in Internet. There is tremendous growth of attacks especially due to botnets [9] that can also be rented for use.

Increase in traffic due to UC has direct impact on green ICT because (1) bandwidth is used for unwanted traffic most of the time, in case of mobile communications this is a even bigger issue, (2) servers are used for unnecessary purpose, thus all the benefits from techniques discussed earlier in the paper lead to nothing, and (3) end devices will use most of their power for processing unwanted traffic thus leading to higher power consumption. Although some solutions for UC exists, e.g. for e-mails, there is still lack of solution for all forms of UC.

Third generation partnership project (3GPP), the global mobile communications standardization body, is working on a solution for prevention against unsolicited communication in IMS (PUCI) [10]. The way to prevent UC in mobile communications is to use the Identification, Marking and Reacting (IMR) solution discussed in [10]. This is a flexible solution capable even of countering new type of UC. Identification, marking and reaction of

UC can be handled in many places, in the network or terminal. Moreover, different steps can be centralized or distributed.

5 Green ICT Standardization in INDIA – GISFI

Since 2009 India started the Global ICT Standardisation Forum for India (GISFI) [11] where one of the initial topics for standardization is Green Energy [12]. The Green Energy technical working group of GISFI, that started activities from June 2010, is looking into Indian requirements and solutions for making ICT green and using ICT to reduce GHG [12]. Although fulfillment of Indian requirements is the focus of GISFI, it is fair to say that these requirements are valid for several other economies. In this section we give point wise background of India together with the impact these points have on green ICT.

- India has the world's second largest population of 1.2 billion people, about 17% of world population, with a median age of 25.3 years and about 70% living in rural areas [16]. The young median age means that there is a huge population that is ready for new or any technology acceptance. While the high percentage in rural areas means that there is a large population where the technology impact, in general, has not reached. Thus one can expect a huge rise in GHG emission as the economy improves and technology penetrates all sectors of the market.
- Today India has the fastest growth rate of mobile subscribers [17] with one of the lowest average revenue per user (ARPU) [2]. Thus leading to a necessity to reach out to as many customers as possible to reach profitability for the operators. This equates to faster deployment of mobile network and thus increase in GHG emission.
- The power supply in India is not only erratic but also below (about 12%) demand, this is even more pronounced in the rural area [13,14]. The government has set requirements on mobile operators to provide coverage in rural India [18]. In India there are about 500,000 base-stations which is growing at the rate of 3,000+ per month [13]. Due to unpredictable nature of power supply, every base-station is equipped with a diesel generator so as to fulfill the mobile operator's service level agreement (SLA) regarding availability and working temperature thus leading to higher GHG emission. Altogether the energy and energy related cost is about 50–60% of a base-station's operating expense (OPEX) for a mobile operator [13]. Providing coverage in rural India will mean that

the cost for mobile operator will increase further together with the GHG emission while the ARPU is decreasing.

- In addition to the above, India has granted spectrum license for broadband wireless access (BWA) that will lead to deployment of newer mobile communication technologies. It is a well known fact that energy consumption, and thus GHG emission, of a new mobile communications technology is far higher in the beginning.
- With the fast pace of deployment, network optimization has not been considered yet – as in any network deployment it is a thing for later. This non-optimized deployment is leading to huge wastage of energy and thus GHG emission.

The Indian government has committed to reduce carbon intensity by 20–25% by 2020 compared to 2005 level [13]. This should be done by fuel efficiency standards. Thus there is a strong economical interest and regulatory pressure on Indian mobile communications industry to identify a cheaper and greener source of energy. Indian mobile operators have already taken several steps towards greener solution examples are in the form of using cooling from ground, external air usage, usage of specific material to maintain indoor temperature, etc.

As for the network deployment, solution certainly is optimized network design and deployment but the other solution is to develop small low energy/energy efficient base-stations. The biggest part of deployment in India is in highly dense areas that do not require powerful base-stations with big coverage, thus efficient low energy using base-station providing coverage for such densely populated areas can do the job. Such efficient deployment will lead to huge savings for operators and also decrease the overall GHG emission.

Besides the mobile communications industry, most Indian enterprises are committed to GHG reduction and are looking at means for green business [22]. Being green to enterprises does not always have to go with increased cost. Solutions like secure thin-clients in association with cloud computing can bring down total cost of ownership for IT by 40% and energy usage can be reduced by about 60% [23]. Combining thin-client as remote desktop solution with mobile broadband communications (allowing remote office or home-office) enterprises can see much higher reduction in cost and energy usage equating to lower GHG emission.

With GISFI standardization activity on Green Energy – focusing on Green ICT – India has almost closed the circle, i.e., Indian government, industry and

standardisation have all joined hands to make green India happen. The circle is closed completely with the Indian research and development activities in academia that has started under the umbrella of The International Institute for Innovation in Information Communication Technology (I4CT) [24].

6 Conclusions

Green House Gas (GHG) emission is a major issue to our environment today. The topic of reducing GHG has become of high importance recently therefore several research, standardization and industrial activities are happening. In this paper we have presented a brief overview of the activities taking place worldwide with the focus on Information and Communication Technology (ICT). Furthermore we have also presented an overview of usage of ICT for decreasing GHG elsewhere.

Reduction of GHG from ICT should start from the very beginning, i.e., from the time of decision to make the product, design of the product, material choice, usage to decommissioning of the product. The focus in this paper was on the GHG emission due to usage. The reduction of GHG in existing system can be done by reducing CPU speed, putting to sleep or shut-down of system when load is low. New systems or evolution of existing system with green in mind will be far more effective.

Using ICT for reduction of GHG is probably as important as reducing GHG in ICT if not more. In this paper we have shown usage of ICT in several markets including vehicular and healthcare. A lot still remains to be done but one thing is for sure, ICT will play a major role in reducing the GHG emission.

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