Using ICTs

TO TACKLE CLIMATE CHANGE

GeSI
GLOBAL e-SUSTAINABILITY INITIATIVE

ABSTRACT

Information & Communications Technologies (ICTs) can be used in a number of ways to meet the requirements of the three main pillars of the Bali Action Plan arising from COP-13 in December 2007: enhanced action on adaptation, cooperative action to reduce greenhouse gas emissions, and actions on mitigation of climate change. ICTs can address these and the problems that all countries (particularly developing countries) face with respect to Climate Change. ICTs can be used to mitigate the impact of other sectors on greenhouse gas (GHG) emissions and to help countries adapt to climate change. These impacts are described in this paper.

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"ICT – DRIVING THE SOLUTION"

The International Telecommunication Union (ITU) comprises 192 Member States and more than 700 Sector Members and Associates. Our three Sectors are Telecommunication Standardization (ITU-T), Radiocommunication (ITU-R) and Development (ITU-D). As the specialized agency of the United Nations responsible for information and communications technologies (ICTs) ITU is committed to working in partnership with other organizations to contribute to the fight against climate change.

Five Symposia on 'ICTs and the Environment & Climate Change', the last held in Cairo in November 2010, have provided vivid examples of ways in which ICTs play an important role in reducing total greenhouse gas (GHG) emissions. These form part of our vision for pervasive action on ICT and climate change and response to the Bali Action Plan calling for: enhanced action on adaptation, taking into account the needs of developing countries that are particularly vulnerable to the adverse effects of climate change, cooperative action to reduce GHG emissions and actions on climate change mitigation.

In response to the UNFCCC recommendations on the need to cap global GHG emissions, the ITU is well placed to provide internationally agreed standards and policies that governments and the ICT industry can apply to tackle climate change. Methodologies are being drafted for the environmental impact assessment of ICT. Every standard developed is now checked for energy efficiency. ICT can be a key part of national commitments to reduce GHG emissions. This paper provides support for the Communiqué "ITU's call to Cancun: ICTs
must be part of the solution. Our Membership urges COP16 delegates to look to the enormous potential of ICT solutions to cut emissions across all sectors".

Malcolm Johnson
Director, ITU Telecommunication
Standardization Bureau

"ICT — A FORCE FOR CHANGE"

The most recent results presented by climate scientists are alarming. The accumulation of GHG in the atmosphere is growing faster than originally predicted. Scientists, economists and policy makers are calling for emission targets of at least 20% below 1990 levels in 2020. In GeSI it has been our objective to estimate the GHG emissions from the information and communications technology (ICT) industries and to develop opportunities for ICT to contribute to a more efficient economy. We have presented the business case for a future-oriented ICT industry focused on responding quickly to the challenge of global warming. We have evidence demonstrating that the ICT industry is a key player in creating a low carbon society. With the right policies, the ICT industry can play even a bigger role in delivering a low carbon society.

To provide technology to enable energy efficiency the ICT sector must act quickly to demonstrate what is possible, get clear messages from policy makers about targets and continue to innovate radically to reduce emissions. Now we must step up our work with organisations in the key opportunity areas – travel/transport, buildings, grids and industry systems – to help turn potential CO_2 reductions into reality. This will include opportunities offered though ICT dematerialization, energy efficiency in all sectors and adaptation to climate change. We must work with UNFCCC delegates to ensure that the right policy frameworks are in place to move us all towards a low carbon economy by including ICT industries in projects, so that ICT's potential to mitigate and/or adapt to climate change is maximised. Then, by involving appropriate partners drawn from the ICT industry, other sectors' industries reporting to UNFCCC, government departments and public utilities, ICTs can be harnessed to their full capability to tackle climate change, both for the developed and the developing world.

Luis Neves
Chairman, Global e-Sustainability
Initiative (GeSI)

1. INTRODUCTION

"We all know that information and communications technologies (ICTs) have revolutionised our world... ICTs are also very vital to confronting the problems we face as a planet: the threat of climate change...Indeed ICTs are part of the solution. Already these technologies are being used to cut emissions and help countries adapt to the effects of climate change...Governments and industries that embrace a strategy of green growth will be environmental champions and economic leaders in the twenty-first century."

BAN KI-MOON, UN Secretary General

Information and communications technologies (ICTs) are a combination of devices and services that capture, transmit and display data and information electronically. These include personal computers (PCs) and peripherals, broadband telecom networks and devices, and data centres[1].

In October 2010, ITU reported that the number of Internet users worldwide had doubled in the past five years and would pass the 2 billion mark in 2010, with the majority of new users coming from developing countries. The number of people with Internet access at home had increased from 1.4 billion in 2009 to 1.6 billion in 2010, but only 13.5 per cent of these came from developing countries. Regional differences are significant: 65 per cent of Europeans are on the Internet, compared to only 9.6 per cent of Africans.

With the rapidly increasing high-bandwidth content and applications on the Internet, there is a growing demand for higher-speed broadband connections as a catalyst for growth. ITU Secretary-General Hamadoun Touré has called broadband "*the next tipping point, the next truly transformational technology*" generating jobs, driving growth and productivity, and underpinning long-term economic competitiveness.

The ITU Plenipotentiary Conference in Guadalajara in October 2010 (PP-10) adopted a new Resolution "The role of Telecommunications/ Information and Communication Technologies on Climate Change and the Protection of the Environment"[2]. The Resolution identifies the need to assist developing countries to use ICTs to tackle climate change and committed the ITU to work with other stakeholders such as GeSI to develop tools to support developing country use of ICT.

Studies such as the recent GeSI SMART 2020[1] clearly show that more effective use of ICTs can deliver tremendous CO_2e (carbon dioxide equivalent) savings.

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ICTs can impact on climate change in three main ways:

- by driving down emissions in the ICT sector itself through the introduction of more efficient equipment and networks;
- by reducing emissions and enabling energy efficiency in other sectors through, for example, substituting for travel and replacing physical objects by electronic ones (dematerialisation); and
- by helping both developed and developing countries adapt to the negative effects of climate change using ICT based systems monitoring weather and the environment worldwide.

2. REQUIREMENTS OF THE BALI ACTION PLAN & ICTs

The Nairobi Framework[3] , adopted in 2006, aims to help developing countries improve their level of participation in the Clean Development Mechanism (CDM) and enhance the CDM's geographical scope. The CDM enables sustainable development projects in developing countries that reduce emissions or enhance sinks, for example through afforestation or reforestation. The ITU is a partner of the Nairobi programme and the ICT sector could greatly assist this.

The Conference of the Parties in December 2007 (COP-13) developed the Bali Action Plan[4]. This calls for:

- enhanced action on adaptation, taking into account the needs of developing countries that are particularly vulnerable to the adverse effects of climate change;
- cooperative action to reduce greenhouse gas (GHG) emissions; and
- actions on mitigation of climate change, including reducing emissions from deforestation and forest degradation in developing countries.

This paper will show how ICTs can assist with each of these actions.

3. ACTIONS ON ADAPTATION TO CLIMATE CHANGE

Adaptation involves taking action to tolerate the effects of climate change on a local or country level. Examples include remote sensing for monitoring of natural disasters such as earthquakes and tidal waves, and improved communications to help deal with natural disasters more effectively.

ICTs in general, and radio-based remote sensors in particular, are already the main tools for environmental observation, climate monitoring and climate change prediction on a global basis. The modern disaster prediction, detection and early warning systems based on the use of ICTs are essential for saving lives and should be proliferated in developing countries. ICTs are making available vital information on the changing environment to the mass population who need information and education to help sustain basic needs such as food and water. Ideally this would be achieved through green technologies such as mobile devices and base stations powered by solar energy.

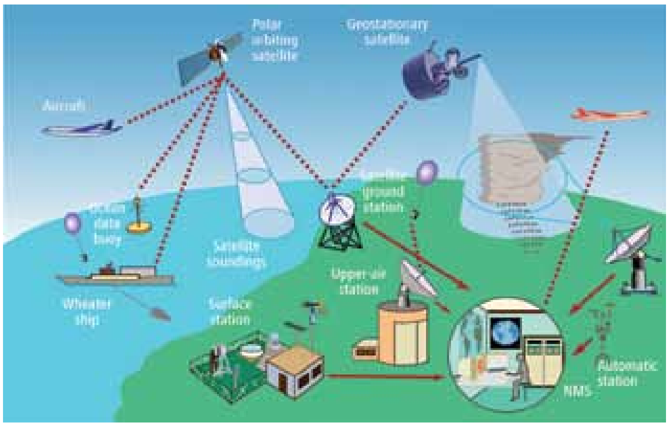
3.1 Using ICTs to monitor the global environment/ecosystem

There will be a predicted rise in average temperature of 1.1-6.4°C[5] during the 21st Century[6]. The results will be uneven in their distribution, with low-lying coastal areas at risk because of rising sea levels and sub-Saharan Africa at risk due to desertification. There will be a growing number of environmental refugees and increased pressure on water sources and vulnerable ecosystems.

ICT systems that are involved in environment and climate monitoring, data dissemination and early warning include:

- Weather satellites that track the progress of hurricanes and typhoons;
- Weather radars that track the progress of tornadoes, thunderstorms, and the effluent from volcanoes and major forest fires;
- Radio-based meteorological aid systems that collect and process weather data, without which the current and planned accuracy of weather predictions would be seriously compromised;
- Earth observation-satellite systems that obtain environmental information such as atmosphere composition (e.g. CO_2, vapour, ozone concentration), ocean parameters (temperature, surface level change), soil moisture, vegetation including forest control, agricultural data and many others;
- Terrestrial and satellite broadcasting sound and television systems and different mobile radiocommunication systems that warn the public of dangerous weather events, and aircraft pilots of storms and turbulence;
- Satellite and terrestrial systems that are also used for dissemination of information concerning different natural and man-made disasters (early warning) as well as in mitigating negative effects of disasters (disaster relief operations).

Figure 1: WMO Global Observing System (GOS)



Source: ITU/WMO Handbook "Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction"[8]

All these systems form the Global Observing System (GOS – shown in Figure 1). GOS is the primary source of technical information on the world's atmosphere, and is a composite system of complex methods, techniques and facilities for measuring meteorological and environmental parameters. It is employed by the majority of countries. The most obvious benefits of GOS are the safeguarding of life and property through the detection, forecasting, and warning of severe weather phenomena such as local storms, tornadoes, hurricanes, or extra-tropical and tropical cyclones. GOS provides in particular observational data for agrometeorology, aeronautical meteorology and climatology, including the study of climate and global change. Data from GOS are also used in support of environmental programmes everywhere.

BOX 1: CASE STUDY ON AN EARLY WARNING SYSTEM FOR MONITORING CLIMATE CONDITIONS IN ECUADOR

In 2008, floods on the Ecuadorian coast resulted in 3,000 million hectares of non-productive land, with economic losses of around 85 million Euros.

An initiative to develop an early warning system to reduce the impact of natural disasters was developed by a leading Latin American Telecommunication Company in conjunction with two institutions involved in monitoring the impact of Niño Phenomena in Ecuador: the National Research Centre of El Niño Phenomena and the Hydrology and Meteorology National Institute. This resulted in the development of a Mobile Information System of Climate Alerts, warning inhabitants of the Ecuadorian coastal region of climate disasters using messages sent to their mobile phones, so they can disseminate this information to their communities.

BOX 2: MOBILE COMMUNICATIONS TO REVOLUTIONISE AFRICAN WEATHER MONITORING

Up to 5,000 automatic weather stations are to be deployed at cellular sites across Africa, where less than 300 are reporting today.

This will increase accuracy of forecasts and provision of weather information via mobile phones to users and communities, including remote farmers and fishermen.

The initial deployment, focuses on the area around Lake Victoria in Kenya, United Republic of Tanzania and Uganda. The first 19 automatic weather stations installed has doubled the weather monitoring capacity of the Lake region[7].

BOX 3: FOOD MONITORING AND EARLY WARNING SYSTEMS[10]

- **GIEWS** – FAO Global Information and Early Warning System[11]
- **FEWS Net** – USAID Famine Early Warning System[12]
- **GMFS** – Global Monitoring for Food security[13]
- **VAM** – World Food Programme Vulnerability Analysis and Mapping[14]
- **MARS FOOD** – Monitoring Agriculture with Remote Sensing (EC/JRC)[15]
- **EARS** – Environmental Analysis and Remote Sensing[16]
- **AP3A** – Alerte Précoce et Prévision des Productions Agricoles (CILSS/Agrhymet – Sahel, only in some African countries)[17]
- **SADC** – Regional South African Early Warning System for Food Security[18]
- **DMC** – Drought Monitoring Centers (SADC/IGAD) in East Central Africa[19]

Source: GMFS, http://www.gmfs.info

Figure 2: A Nitrogen Management Map for Winter Wheat

Source: Solving Precision Farming Challenges[23]

Environmental monitoring systems save thousands of lives each year. WMO and ITU, together with other UN Agencies, administrations and organizations contribute to further develop such systems. Whilst WMO focuses its efforts on meeting the needs for environmental information and the corresponding radio frequency spectrum resources, ITU, as international steward of the spectrum, allocates the necessary radio frequencies and approves standards[9] to allow the interference-free operation of applications and radiocommunication systems (terrestrial and space) used for climate monitoring and prediction.

3.2 Using ICTs to address food security, water transportation and supply

Climate change endangers the quality and availability of water and food. It is causing more frequent and more severe storms, heat waves, droughts and floods, while worsening the quality of our air. The impact will be most severe in poor countries. By 2020, up to a quarter of a billion Africans will experience increased water stress, and crop yields in some African countries are expected to drop by half[20].

The first step to address food security is to systematically monitor world food supplies including the mapping of agricultural production and food shortages.

ICTs that can be used include[9]:

- Machine-to-machine (M2M) connectivity that supports remote sensing infrastructure, with high resolution radiometers and moderate-resolution imaging spectrometers used to monitor food and water resources.
- PCs, mobile devices, servers, mainframes and network databases used for food security analysis, modelling and mapping.
- Communications infrastructure including the Internet to distribute information to farmers and consumers.

Monitoring environmental and soil conditions using ICTs can make farming more profitable and sustainable. Better water management[21] using ICTs can improve the overall efficiency of water use, providing significant savings and a more sustainable use of water resources[22].

Satellite imaging and Global Positioning Systems (GPS) can be used to control the application of water and fertilizer. In the past a complete field would receive the same treatment, whereas precision farming makes it possible to split up the crop into sub-field management areas. Today it is possible to conduct spatial analysis of the crop in blocks as small as 20m by 20m. This allows local soil or climate conditions to be taken into consideration and encourages more efficient fertilizer application[23].

ICT tools used in agricultural and soil monitoring include sensors and telemetry units which measure and transmit parameters such as air temperature, humidity, leaf wetness and soil moisture over mobile networks to global databases.

The deployment of ICTs will enable farmers to better forecast crop yields and production. This data can then be shared to increase the number of farmers profiting from the information.

3.3 Using ICTs to monitor deforestation and forest degradation

The impact of climate change on the rainforest is considered of such magnitude that the issue of deforestation was added as one of the five main topics in the UN negotiations towards a new achievable balanced outcome. Land use and tropical deforestation release annually 1.5 billion tonnes of carbon into the atmosphere, which represents more than 17 per cent of the total of GHG emissions.
For this reason, the protection of forests can be a major element to mitigate climate change.

A recent study by British researchers estimates that a temperature rise of 4 degrees by 2100 would destroy up to 85 per cent of the rainforest. A more modest temperature increase of 2 degrees could kill one-third of the trees over the next 100 years[24]. Since the Amazon is a driver of the world's weather systems, the impact on extreme weather events would be felt world-wide. Higher temperatures can also lessen rainfall in the forest and increase the risk of drought.

Other scientists have noted that "*conserving Amazonian forests both reduces the carbon dioxide flux from deforestation, which contributes up to a fifth of global emissions and also increases the resilience of the forest to climate change.*"[25]

Another study reported in "*Carbon Cycle: Sink in the African jungle*" published in Nature in February 2009[26], shows that "*the lush vegetation of tropical forests is a large and globally significant store of carbon, because tropical forests contain more carbon per unit area than any alternative land cover, cutting them down releases carbon into the atmosphere. For the same reason, growing forests take up carbon from the atmosphere.*" Using data collected in Africa between 1968 and 2007, the authors found that trees have added an average of 0.63 tonnes of carbon per hectare each year. That means that the average rate of carbon accumulation in tropical forests around the globe was 0.49 tonnes of carbon per hectare per year, and estimate that 'old-growth' tropical forests are taking up 1.3×10^8 tonnes of carbon per year worldwide.

It is estimated that reducing tropical deforestation by 50 per cent over the next century would help prevent 500 billion tonnes of carbon from going into the atmosphere per year. This reduction in emissions would account for 12 per cent of the total reductions targeted by the Intergovernmental Panel on Climate Change (IPCC).

Several countries have announced projects to channel millions in funding to tropical countries such as Brazil to help in the protection of vulnerable forests[27]. Tropical countries also have access to funding under a UN plan of extending carbon trading to forests, the Reducing Emissions from Deforestation and Forest Degradation (REDD) initiative.

The Copenhagen Accord (2009) specifies the need to recognize reduced emissions from deforestation and forest degradation through the immediate establishment of a mechanism to enable

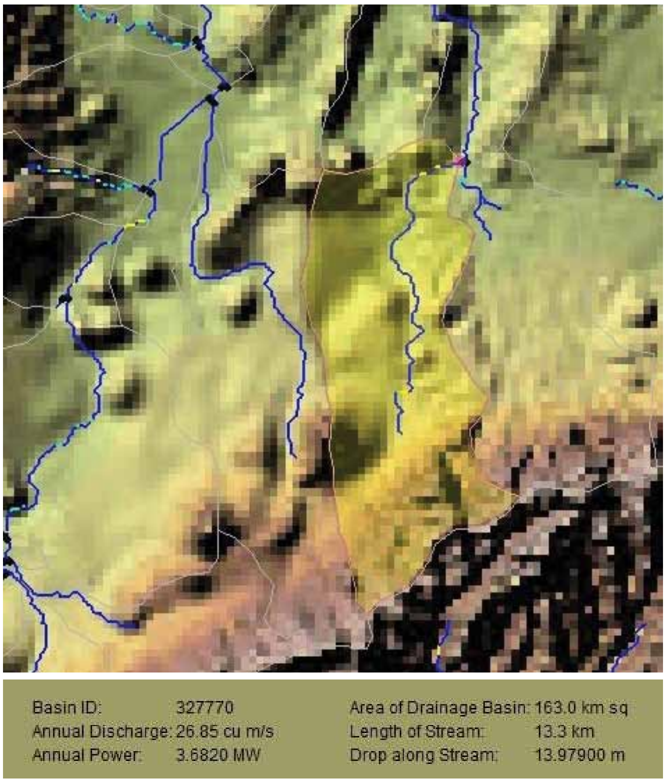
BOX 4: MONITORING DEFORESTATION FROM SPACE

Dense green vegetation gives way to pale fields in these satellite images of deforestation in Brazil's Amazon rainforest. The first image, from the Landsat Thematic Mapper in 1992, shows the beginning of agricultural development in a region of the southwestern state of Mato Grosso.

It dissolves into a released image of the same area in 2006 from the Advanced Spaceborne Thermal Emission Radiometer (ASTER) instrument flying on NASA's Terra satellite.

Source: NASA[28]

Figure 3: Renewable Energy Resource Explorer



Source: SWERA[35]

the mobilization of financial resources from developed countries. This initiative will allow rich nations, which need to meet targets on cuts in emissions, to buy lucrative carbon credits for projects in countries affected by deforestation[30].

ICTs can contribute to this issue, for instance, by developing technological paths to sustainability and protection of tropical forest, as well as to enhance data collection on the condition of the forests. Satellites that are now able to take images through clouds and at night and remote sensing applications are critical for monitoring the health of the world's tropical forests trees and deforestation of these vast forests.

3.4 Waste management with smart ICT

Rapid advances are made in the ICT industry according to Moore's Law. "The number of transistors that can be placed inexpensively on an integrated circuit has doubled approximately every two years[31]" This leads to premature obsolescence and generation of waste. Huge energy savings can be made by recycling ICT hardware, avoiding the need to extract raw materials, especially highly energy intensive materials such as rare earths. Greater use of recycling and the safe disposal of ICT waste can therefore assist in reducing climate change and the release of GHGs, and introduce sustainability of supply to the ICT industry.

A 'cradle to cradle' raw material and recycling approach keeps all the materials in circulation[32]. Design includes easy disassembly and obsolete products are returned to the factory. There is no need for additional mining of raw materials.

ICTs can also play a role in environmental protection, waste management and environmentally-friendly supply chain management. It is now possible to search web sites for places to recycle ICT equipment including mobile phones[33]. ITU together with the ICT industry is developing standards for improved recycling of industrial waste including a recommendation on communication formats for recycling information on rare metals in ICT products and cables.

3.5 Using ICTs to increase energy supply efficiency and maximize the use of renewable sources

ICTs can be used to maximize the efficiency of power systems. Their computing and communications capabilities are essential if power from renewable resources such as geothermal, solar, wind, wave and tidal, and are to be harnessed efficiently and fed into the electricity grid in a smart way. ICTs are required to control the load on the grid by maximizing the utilisation of available solar, wind and tidal power for example.

ICTs are able to model the real-time status of renewable energy systems taking into account local weather stations so that transmission losses are minimized by selecting the shortest route from source to load[34].

Figure 3 shows an ICT system which is able to show the availability of hydro-energy in a user-selected drainage basin collecting mountain run-off in Guatemala. Using this information, turbines located downstream may be switched on to the grid to match demand[35].

3.6 Using ICTs in education and to raise awareness on climate change

There are increased environmental risks caused by climate change, for example, floods causing mass displacement. Among the challenges are the need to gain ICT based infrastructure (internet backbone, electricity, community based information access points, etc.),

BOX 5: UNIVERSAL CHARGER STANDARD – ONE SIZE FITS ALL SOLUTION AIMS TO CUT WASTE AND GHG EMISSIONS

ITU recently developed, together with the ICT industry, a global standard for a universal energy efficient mobile phone charger that will charge all future mobiles[29].

This could save tonnes of redundant chargers a year helping to reduce e-waste and CO_2 emissions.

Source: ITU

especially in vulnerable areas so that localized content can be provided and more specialist knowledge developed where it is most needed[36].

Using ICTs, educational content can be delivered to students in their home communities thus saving travel costs. Radio and television have been used widely as educational tools since the 1920s and the 1950s, respectively in the following areas:

- direct class teaching, where broadcast programming substitutes for teachers on a temporary basis;
- school broadcasting, where broadcast programming provides complementary teaching and learning resources not otherwise available; and
- general educational programming over community, national and international stations which provide general and informal educational opportunities.

Teleconferencing and audio conferencing are now used extensively in education. These involve the live (real-time) exchange of voice messages over a network. Text and images such as graphs, diagrams or pictures can be exchanged along with voice messages. Non-moving visuals are added using a computer keyboard or by drawing/writing on a graphics tablet or whiteboard. Videoconferencing allows the exchange of moving images. Web-based conferencing involves the transmission of text, and graphic, audio and visual media via the Internet.

Teleconferencing is used in both formal and non-formal learning contexts to facilitate teacher-learner and learner-learner discussions, as well as to access experts and other resources remotely. In open and distance learning, teleconferencing is a useful tool for providing direct instruction and learner support, minimizing learner isolation.

Extensive broadband access now allows for educational content to be delivered direct to the students' home thereby eliminating the need for student travel to distant schools when not required or when it is impractical.

3.7 Using ICTs in healthcare

The world is encountering unprecedented changes in the atmosphere and depletion of soil fertility, aquifers, ocean fisheries and biodiversity in general. It is recognised that such changes will affect economic activities and infrastructure and poses risks to human health[37].

Seasonal death rates due to unexpected extremes in temperature are expected to increase and the seasonal pattern of vector borne diseases will change. Standard observational epidemiological methods can illuminate the health consequences of local climatic trends by comparison of data-sets. ICT enhances our capacity to process and share data and subsequently to estimate future impacts.

Figure 4: Teleconferencing Used in Education

Source: Telefónica

ICT improves self-help online education and information dissemination. For those who have internet access it is simple to obtain information about what to do to minimise health and climate risks using online encyclopedias, and then to find more detailed information through search engines.

Use of ICTs in healthcare is known as eHealth (or Health informatics). Healthcare practice supported by electronic processes and communication. ICT tools used in eHealth include not only computers but also clinical guidelines, formal medical terminologies, and information and communication systems. It is applied to the areas of nursing, clinical care, dentistry, pharmacy, public health and (bio) medical research[38].

Remote health monitoring enables individuals to continue to lead independent lives in their own homes. Telemedicine can also provide patients with access to specialists outside their geographic area, using a broadband network. This removes the need for the patient to travel to the doctor's office and so reduces GHG emissions.

BOX 6: TELEMEDICINE IN FLOOD-AFFECTED AREAS OF PAKISTAN

Pakistan floods were the worst ever in living memory. Nearly 20 million were affected and vast tracts of fertile agricultural land had been inundated. In addition, the battle continues with water-borne diseases and malnutrition requires medical attention to displaced populations. In this sense, ITU together with the Pakistan administration has deployed 100 broadband satellite terminals in the flood-affected districts of the country. The satellite terminals are being deployed to restore communications and provide a platform from which telemedicine applications/services will be provided in remote areas that remain difficult to access and where medical attention is a priority in the aftermath of the disaster.

For full text see[39]

BOX 7: GeSI ICT ENABLEMENT METHODOLOGY

In September 2010, GeSI published a report entitled "Evaluating the carbon-reducing impacts of ICT – An assessment methodology".

This was developed in cooperation with the ITU and provides a methodological framework for assessing the enabling effects of ICT, building on existing assessment standards and proposed methodological approaches. Through the commitment of industry leaders and researchers, GeSI has developed a methodology tailored to the needs of the ICT industry and its customers, with a focus on ease of assessment where possible.

Case Studies included in the report:

- Home energy monitoring kit
- HVAC automation system
- Eco-driving software solution
- Telecommuting
- E-health delivery systems
- Telepresence systems

More information can be found on the GeSI web site.[41]

4. ACTIONS TO REDUCE GHG EMISSIONS

Cutting Emissions is important because every 1W saved at the edge of the network (with 1 billion end users) saves one power plant worldwide, as well as reducing CO_2 emissions and other waste products.

Modern fixed and mobile telecommunications networks are efficient and contribute to developing countries' sustainable development. For example, the Next Generation Network (NGN) uses 40% less energy than its predecessors[42]. Another example, being currently implemented is switching from analogue to digital broadcasting. That has resulted in a massive reduction (almost 10 times) in the power consumption of broadcasting transmitters, due to the use of digital modulation instead of analogue. The number of transmitters can also be reduced by transmitting several TV and sound programmes in one frequency channel, instead of transmitting only one TV programme per channel. Taking into account hundreds of thousands of transmitters around the world (some with massive power up to 100-150 kW), the resulting reduction in GHG emissions is very significant.

However the growth of the ICT market demands huge amounts of energy and also requires growth in fixed and mobile telecommunications networks. According to ITU, while high-speed internet is still out of reach of low income countries, mobile telephony is becoming a fundamental service, with access to mobile networks now available to over 90% of the global population. While this is happening, ICT companies are working on energy efficiency practices internally to reduce electricity and fuel consumption in their operations, although many argue that the economic downturn has caused companies to put energy efficiency issues aside.

Smarter ICT can help cut emissions by:

- reducing the power consumption of ICTs themselves;
- turning equipment off when not in use;
- using standby modes;
- requiring low-carbon equipment in procurement specifications; and
- having a longer equipment lifecycle before replacement.

The Telecommunication Standardization Sector (ITU-T) and the ITU Radiocommunication Sector (ITU-R) are developing global voluntary standards[40] in conjunction with ICT-related companies and associations that will put these into practise.

The GHG impact of ICT during the use phase is reported to the UNFCCC via the energy sector. The majority of devices use energy from the grid. The energy companies which provide power to the grid report their CO_2e according to their mix of fossil and non-fossil fuels. ICT is also responsible for emissions during the embodiment phase: extraction of raw materials, manufacturing, etc. These emissions are reported to the UNFCCC in the industry sector. Disposal at end of life is reported under waste control and recycling.

Also of significance is the impact of ICT services on emissions from other sectors. ICT devices are used to improve the efficiency of all other sectors and are pervasive throughout society. ICT services offer global coverage and efficiency gains which greatly enhance economic growth. The challenge is to channel this growth so that it is sustainable and the problems of climate change are eliminated. Our studies have shown that ICT services can have a mitigating effect in other sectors. This can be highly beneficial if the other sectors operate under a remit to reduce emissions as described later in this paper.

Under the Bali Action Plan, ICT is included in the actions to promote technology-based sustainable development including mitigation and adaptation. It calls for consideration of: incentives for, scaling up of the development and transfer of technology to developing country parties in order to promote access to affordable environmentally sound technologies; cooperation on research and development of current, new and innovative technology, including win-win solutions in specific sectors. Because of its pervasiveness and the opportunities for substantial efficiency gains, the impact of ICT should be evaluated in most if not all work programmes.

5. ACTIONS ON MITIGATION OF CLIMATE CHANGE

In addition to reducing the direct effects of the ICT sector on climate change, and the indirect effects through using ICTs for displacement of carbon emissions, ICT-based technologies can also have a systemic impact on other sectors of the economy and of society, and can help in providing a basis for sustainable development. Climate change mitigation involves reductions in the concentrations of GHGs, either by reducing their sources or by increasing their sinks.

5.1 Using ICTs to reduce carbon emissions in other sectors

The GeSI Smart 2020 report[1] provided examples of how the use of ICTs can reduce emissions in other sectors. These include:

- Smart motor systems – through changes to the design of electric motors to allow them to run at speeds optimized to the task.
- Smart logistics – through efficiencies in transport and storage.
- Smart buildings – through better building design, management and automation.
- Smart grids – which would be of most benefit to countries such as India where reductions in emissions could be as high as 30%.

Other examples include reducing emissions from the Healthcare sector through remote diagnosis and treatment, and the application of teleworking and telepresence to a range of sectors.

Environmental load reduction may also come from ICT dematerialization, in particular, by substituting higher carbon products and activities with ICT enabled lower carbon alternatives. These alternatives include:

- Online media
- E-ticketing
- E-commerce
- E-paper
- Videoconferencing
- Teleworking or other remote-participation service

Using ICTs can enhance the efficiency of energy use, enhance the efficiency of and reduce the production and consumption of goods, and reduce the movement of people and goods, achieving the effects listed in Table 1.

5.2 Using smart grids to reduce emissions

A 'smart grid' is a set of software and hardware tools that enable generators to route power more efficiently. This reduces the need for excess capacity and allows two-way, real time information exchange with their customers to permit demand side management (DSM).

Smart grids will help developing countries to monitor how much electricity is generated and how much is delivered. They can then take action to reduce losses (see Box 8[43]). By making the grid more efficient, the investment needed to provide grid electricity to communities for the

Table 1 –Reductions in Environmental Load by Using ICTs

CATEGORIES	EFFECTS
Consumption of materials	By reducing materials consumption (dematerialization), the environmental load related to goods production and disposal as well as waste generation can be reduced.
Power / energy consumption	By enhancing the efficiency of power and energy use to reduce consumption, the environmental load related to power generation, power transmission, etc. can be reduced.
Movement of people	By reducing the movement of people, the environmental load required for transportation can be reduced.
Movement of materials	By reducing the movement of materials, the environmental load required for transportation can be reduced.
Improved efficiency of office space	By using office space efficiently, power consumption for lighting, air conditioning, etc. can be reduced, thus reducing environmental load.
Storage of goods	By reducing storage space of goods, power consumption for lighting, air conditioning, etc. can be reduced, thus reducing environmental load.
Improved work efficiency	By enhancing work efficiency, the environmental load can be reduced.
Waste	By reducing waste emissions, the environmental load required for environmental preservation as well as for waste disposal can be reduced.

Figure 5: Videoconference Equipment

Figure 6: Telepresence Suite

Source: Telefónica

first time in developing countries can be reduced. Countries with an existing grid can seek opportunities to upgrade their system for greater efficiency and reduced emissions when existing equipment becomes obsolete.

Smart grids use demand control signals via smart meters and appliances to reduce peak demands thereby lowering overall energy usage and reducing the need for excess standby generation capacity to meet these peak demands. This system requires a stable and standardized communication backbone to allow each part of the system to send and recognize appropriate signals.

BOX 8: LOST IN TRANSMISSION – SMART ICTs TO AVOID ELECTRICITY LOSSES ACROSS THE GRID

Globally, around 8% of the electricity generated in 2007 was lost before it reached final consumers.

The causes may be simple leaks and inefficiencies, but they also involve fraud and electricity theft. It is estimated that these power losses are responsible for over 600 million tonnes of CO_2 emissions across major global economies (MEF, 2009). In OECD countries, 6% of generated electricity on average is lost between the producer and the final consumer. Shares are higher in non-OECD countries, at around 11%, and can reach over 25%, as in India. Smart grid technologies can help operators reduce the amount of electricity lost during transmission and distribution, e.g. by using sensor-based networks to identify and locate leaks. Applications are not standardised, but must be tailored to suit the country-specific infrastructure conditions and causes of losses.

Source: OECD

5.3 Promoting smart industries to reduce emissions

This makes energy and emissions transparent all along the supply chain through reporting. This information is used to optimize products and services in each innovation cycle. The cost of carbon could then be incorporated into decision making processes to future proof the cost of manufacturing and operating new products and services, in preparation for perhaps having an enforced cost of GHG emission in the future.

Smart motors are electric motors that have been designed to run at different speeds depending on the task, adapting its activity continuously to the real need. They are considered ICT technologies that reduce energy consumption at the level of the motor, the factory, or across the business. Halving the speed of motors, fans and pumps can reduce their energy consumption by up to 75%. Our studies have shown that if applied globally, optimized motors and industrial automation would reduce 0.97 $GtCO_2e$ in 2020, worth $107.2 bn[1].

5.4 Using ICTs to reduce or replace travel

The need for travel can be reduced by using virtual meetings accessible to all users. The most common are web-based conferencing services that require Internet access and web-based software, allowing virtual meetings from different locations, including the sharing and exchanging of documents. Other services include teleconferencing which allows multiple participants in one phone call, and videoconferencing with both audio and video transmission of meeting activities. Both of these can replace or complement face-to-face meetings. Telepresence, used especially by big companies and governmental organizations, provides high definition video, life-sized images, spatial audio, imperceptible latency and easy set up and use. This requires one or more display screens with microphones, speakers and cameras specially designed for the telepresence system.

Our studies have shown that up to 260 $MtCO_2e$ could be saved each year[1]. For example, if up to 30 million people in the US could work from home, emissions would be reduced by 75-100 $MtCO_2e$ in 2030, comparable to possible reductions from other measures such as fuel efficient vehicles.

Conducting meetings online or on the phone, instead of face-to-face, could also reduce emissions. Estimates have suggested that tele- and videoconferencing could replace between 5 and 20% of global business travel. Advanced videoconferencing applications in the early stage of adoption could have a very significant impact on emissions in the transport sector.

5.5 Smart logistics

The potential systemic impact of ICTs is particularly apparent in the transport sector which, according to the Stern report[44], accounts for 14 per cent of total GHG emissions. Through a host of efficiencies in transport and storage, smart logistics in Europe could deliver fuel, electricity and heating savings of 225 $MtCO_2e$. The global emissions savings from smart logistics in 2020 would reach 1.52 $GtCO_2e$, with energy savings worth US$441.7 bn[1].

Although the main focus of Intelligent Transport Systems (ITS) is on the safety, management and efficiency of transport, ITS can also be used to reduce their environmental impact. For example:

- Using GPS for navigation or vehicle dispatch can reduce journey times. Drivers with navigation saw their fuel efficiency increase 12%, with fuel consumption falling from 8.3 to 7.3 l/100kms. This increase in fuel economy translates to a .91 tonnes decrease in carbon dioxide emissions every year per driver, or 24% decrease over the amount that the average non-navigation user emits per year[45].
- Using the 'always turn right rule', or using a mobile phone (or PDA) to inform the driver of the next destination.
- Smart traffic control, where traffic lights send out status signals to warn drivers if they need to slow down or stop.
- Smart parking where vehicles are directed to an empty space so that there is no need to drive around to find a slot. This reduces engine running time.
- Road pricing schemes, such as the congestion charge in London, can encourage greater use of public transport and reduce congestion, thereby reducing journey times.

6. METHODOLOGIES FOR ASSESSING THE ENVIRONMENTAL IMPACT OF ICT

Within the framework of the fight against climate change, the necessity to develop concrete and common methodologies is well recognized, including a unified metric to describe and estimate objectively and transparently the present and future energy consumption of ICTs over their entire life cycles. These methodologies should also cover methods to verify by measurement the assessment of the direct ICT impact and of potential indirect mitigation impacts.

ITU-T Study Group 5, as Lead Study Group on ICT and Climate Change, has developed Recommendation L.1400 "Overview and general principles of methodologies for assessing the environmental impact of ICT"[46]. This presents the general principles on how to assess the environmental impact of ICT (including impact on GHG emissions) and outlines the different methodologies that are being developed by ITU:

- Assessment of the environmental impacts of ICT goods, networks, and services
- Assessment of the environmental impacts of ICT in organizations
- Assessment of the environmental impacts of ICT projects
- Assessment of the environmental impacts of ICT in cities
- Assessment of the environmental impacts of ICT in countries or group of countries

ITU-T Recommendation L.1400 also provides examples of the way ICT can be used to reduce environmental impacts. In order to minimize the negative effects of ICT and maximize the positive effects, ITU-T Study Group 5 develops methodologies that cover both the positive and negative environmental aspects of ICT.

Methodologies are developed within ITU-T SG5 in close cooperation with UNFCCC, GeSI and other standards organizations such as the European Telecommunications Standards Institute (ETSI). Cooperation with UNFCCC is particularly important for the assessment of the environmental impacts of ICT projects and the assessment of the environmental impacts of ICT in countries or groups of countries.

7. CONCLUSIONS

ICTs are becoming ubiquitous throughout society. Telecommunication networks and the Internet ensure that information is available at the touch of a keypad, and with (mobile) phones you can speak instantly to anyone in the world.

The developing world is particularly vulnerable to changing climatic conditions and is not well served with Internet and voice communications. Bridging the digital divide is essential to assist the developing world to plan for adaptation and to enable a rapid and fully informed response to extreme conditions.

We have shown in this paper how the risks due to climate change can be assessed, mitigated or adapted with the help of ICTs and with the cooperation of ICT experts in all sectors.

Therefore we stress the importance of including the carbon reduction benefits of ICT specifically in the negotiating text, along with the adoption of an agreed methodology for assessing the carbon impact of ICT equipment and services. The inclusion of ICTs in national adaptation and mitigation plans would provide an incentive to the ICT industry and its stakeholders to maximize the mitigation capabilities of ICTs.

By accelerating the rollout of ICTs in developing countries the digital divide will be reduced and the most vulnerable populations will have access to the best information available about the changing climate and how to adapt to it.

The recent 'Cairo Roadmap[47]', agreed by the 5th ITU symposium on "ICTs, the Environment and Climate Change" which took place in Cairo from 2-3 November 2010, calls for government policy makers and ICT stakeholders at all levels to create greater understanding of the positive role that ICTs can play in enhancing environmental sustainability. In particular, it calls for governments to integrate ICT, climate, environment and energy policies, and to develop and implement National Green ICT strategies.

A Communiqué from ITU Membership to COP16 in Cancun urges delegates to look to the enormous potential of ICT solutions to cut emissions across all sectors and calls for ICTs to be part of the solution to climate change.

UNFCCC delegates are urged to look to ICTs in the context of their own sectoral emissions to take maximum advantage of the power of ICTs to reduce emissions worldwide and to enhance action on adaptation, taking into account the needs of developing countries.

8. GLOSSARY

CDM	Clean Development Mechanism
CO_2e	Carbon dioxide equivalent – a standardized measure of GHG emissions designed to account for the different global warming potentials of GHGs
COP	Conference of the Parties (to the United Nations Framework Convention on Climate Change)
DSM	Demand Side Management
ETSI	European Telecommunications Standards Institute
GeSI	Global eSustainability Initiative
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GOS	Global Observing System
GPS	Global Positioning System
ICT	Information and Communications Technologies
IPCC	Intergovernmental Panel on Climate Change
ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
M2M	Machine-to-machine is a connection that allows two-way communication of data between machines
NGN	Next Generation Network
REDD	Reducing Emissions from Deforestation and Forest Degradation
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

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ANNEX A

ITU

ITU (www.itu.int/climate) is the UN specialized agency for information and communication technologies (ICTs) including telecommunication issues and its membership includes 192 Member States and more than 700 Sector Members and Associates. ITU offers its unique sectoral competences to play a leading role in developing an integrated approach to the relation between ICTs and climate change, focusing on key elements of the Bali process and negotiation framework, notably technology, environment and climate monitoring, adaptation and mitigation. ITU is working closely with its membership to lead efforts to achieve a climate neutral ICT industry.

Specific ITU initiatives include the following:

- Development and approval international treaty status Radio Regulations facilitating the use of wide range of green wireless ICTs applications and systems providing means and tools for mobile broadband connection at any place and any time.
- ITU in its standards making process is committed to the development of technical standards (Recommendations) that meet environmental sustainability and energy efficiency requirements. ITU-T Study Group 5, which is continuing the previous work of the Focus Group on ICTs and Climate Change, oversees the aspects of standardization related to the environment and climate change.
- ITU through its Joint Coordination Activity on ICT and Climate Change provides a platform to seek co-operation from external bodies including non-ITU member organizations.
- ITU actively participates and provides expertise in the United Nations Framework Convention on Climate Change (UNFCCC) and in the wider UN efforts to combat climate change.
- ITU launched the Dynamic Coalition on Internet and Climate Change (DCICC) in 2007 as an open forum to study ways to moderate the environmental impact of the Internet as well as using it to reduce GHG emissions worldwide.
- ITU plays a key role in promoting the availability of spectrum to enable accurate environment and climate monitoring. As the steward of the global framework for spectrum and through the Radiocommunication Sector and the World Radiocommunication Conference, ITU is mandated to ensure that the necessary spectrum and orbit resources are released to enable better climate monitoring and facilitate better disaster prediction and response systems through ICTs.
- One of the key issues in assisting countries cope with the impact of climate change is adaptation. Small island developing states and low-lying coastal countries suffer as sea levels rise. ITU provides ICT tools that are incorporated into national climate change adaptation platforms. For example ITU designed early warning systems that can play an important role in mitigating disasters, many of today's disasters are a result of climate change.
- ITU support its Member States with a wide range of materials, toolkits and training resources for appropriate ICT development relating to climate change.

GeSI

GeSI (www.gesi.org) is an international strategic partnership of ICT companies and industry associations committed to creating and promoting technologies and practices that foster economic, environmental, and social sustainability and drive economic growth and productivity. Formed in 2001, GeSI fosters global and open cooperation, informs the public of its members' voluntary actions to improve their sustainability performance and promotes technologies that foster sustainable development.

Current members of GeSI are: Alcatel-Lucent, AT&T, Bakrie Telecom, Belgacom, Bell Canada, BT, Cisco, China Telecom, Cosmote, Deutsche Telekom, Ericsson, European Telecommunication Network Operators Association, GSM Association, HP, Huawei, KPN, Motorola, Microsoft, Nokia, Nokia Siemens Networks, Orange/France Telecom, OTE, RIM, Sprint, Telecom Italia, Telefónica, Turk Telekom, Verizon and Vodafone. Associate members are the Carbon Disclosure Project and World Wildlife Fund. It partners with two United Nations organisations: The United Nations Environment Programme (UNEP) and the International Telecommunications Union (ITU) as well as with the World Business Council for Sustainable Development (WBCSD).

GeSI develops its activities through its member engagement in the following main working groups: Climate Change, Supply Chain, E-Waste, Energy Efficiency, Policy and Communications.

The Climate Change Working Group is focusing its activities on:

- Working with public policy makers to ensure that the right regulatory and fiscal frameworks are in place to move us all in the right direction
- Developing and agreeing an industry-wide methodology for the carbon footprinting of ICT products and services, working with the World Resource Institute, the World Business Council for Sustainable Development and the industry-led EU Methodology Consortium
- Working with organisations in the key opportunity areas – transport, buildings, grids and industry systems – to help turn potential CO_2 reductions into reality, and highlight the significant opportunities offered by dematerialization
- Ensuring that energy and climate change matters are fully considered by the organisations that set the technical standards for our industry, including the International Telecommunication Union, the European Telecommunications Standards Institute and the Alliance for Telecom Industry Solutions in the US.
- Emphasising climate issues in our supply chain work to reduce emissions from manufacturing electronic equipment

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