

# A Review on Green ICT Solutions for CO<sub>2</sub> Emissions

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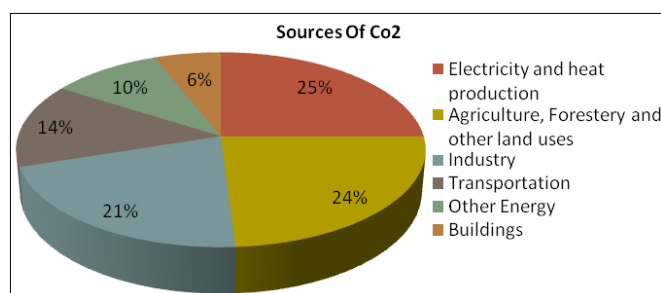
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**Abstract:** *Our world's resources, has been decaying faster than we imagine. The major issues in which most of the countries face now are global economic crisis, energy issues and climate change. The idea of green economy has emerged as a solution for a sustainable development as per UNEP 2011. ICT industry has been identified as one of the key solution for the reduction of green house gas to a certain extent. This paper discusses about the sources of CO<sub>2</sub>, the impacts due to tremendous increase in CO<sub>2</sub> and a green solution for the reduction of CO<sub>2</sub> with the help of ICT.*

**Keywords:** UNEP, Green economy, Green solution, ICT.

## 1. Introduction

The rapidly growing population along with increased pressure on natural resources has put tremendous negative impacts on the environment. The top four CO<sub>2</sub> emitting countries which together accounts for almost two thirds (61%) of the total global CO<sub>2</sub> emissions. Those countries include china(30%), the united states(15%), the European Union (EU-28, 10%) and India( 6.5%) as per EDGAR report 2015. The main environmental problems on which most of the countries face now are deforestation, soil erosion, air and water pollution, land degradation (MoEF 2009). Economic recovery and sustainable development are the key challenges that most of the countries face now.(Jing Zhang and Xiong-jian Liang, 2012). The idea of green economy can partly be a solution to both environmental and sustainable development (UNEP, 2011). As per UNEP(United Nations Environment programme ), a green economy is one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. As per global green house gas emission data (EPA 2014) Electricity and heat production contributes(25%), industries(21%) , Agriculture, forestry and other land use(24%), transportation (14%), building (6%) and other energy contributes 10% of global green house gas emissions. Figure 1 given below describes about the global emissions of CO<sub>2</sub> by economic sector (source: IPCC 2014).



**Figure 1:** Global green house gas emissions by economic sectors

### 1.1. Environmental impacts due to CO<sub>2</sub>

CO<sub>2</sub> is considered to be a potential inhalation toxicant and a simple asphyxiate (Aerias 2005, Priestly 2003). It enters the body from the atmosphere through the lungs and is circulated in body through blood and causes acid-base

imbalance, or acidosis, with subsequent. During respiratory acidosis the pH of the blood becomes less than 7.35(Priestly 2003).The symptoms related to exposure of CO<sub>2</sub> is given in Table 1(source: Health risk evaluation of CO<sub>2</sub>).

**Table 1:** Symptoms related to exposure of CO<sub>2</sub>

Percentage co <sub>2</sub>	Symptoms
2 to 3	Shortness of breath, deep breathing
5	Breathing becomes heavy
7.5	Headaches, dizziness, restlessness, breathlessness
10	Impaired hearing, nausea, vomiting, loss of consciousness
30	Coma, convulsions, death

#### 1.1.1 CO<sub>2</sub> emissions due to paper industry

Industries contribute 21% of 2010 global green house gas emissions. CO<sub>2</sub> emissions from industry primarily involve fossil fuels, chemical, metallurgical, mineral transformation etc. During the entire process of producing paper starting from cut of trees, transporting them, cutting them into desired length, stripping bark, grinding wood, and chip screening, CO<sub>2</sub> is emitted either during logging or offsite because of coal used in the generation of electricity or during transport.(Paper and the environment, 2009) Further during chemical pulping, wood is cooked with chemicals which emits air pollutants like formaldehyde , methanol, acetaldehyde and methyl ethyl ketone. Bleaching of pulp, which includes using chlorine and other chemicals and beating of pulp to achieve desired consistency , also involves heavy carbon emissions because of petro chemicals or electricity used.(Encyclopedia for Occupational health and safety). According to a report of steering committee of EPN, harvesting trees , production of pulp and paper and their eventual disposal produces global warming. According to this report the pulp and paper industry is the fourth largest emitter of green house gases among manufacturing industries and contributes 9% of the total CO<sub>2</sub>.Green house gases are emitted even till disposal of paper (Lingbo Kong et al, 2015).

#### 1.1.2 CO<sub>2</sub> emissions due to electricity and heat production

25% of the 2010 global green house emissions comes from electricity and heat production. When we switch on an electric heater, the consequence is that a fossil fuel power station burns a bit more fossil fuel to provide that extra

electricity, and so releases extra CO<sub>2</sub> to the atmosphere (Green Electricity, 2015).

### 1.1.3 CO<sub>2</sub> emissions due to Agriculture and forestry

24% of the 2010 global greenhouse emissions come mostly from agriculture (EPA 2016). Agriculture releases to the atmosphere significant amounts of CO<sub>2</sub>, CH<sub>4</sub> AND N<sub>2</sub>O (Cole et al., 1997; IPCC, 2001; Paustian et al). CO<sub>2</sub> is released largely from microbial decay or burning of plant litter and soil organic matter (Smith, 2004b; Janzen 2004). Use of marginal lands increase the risk of soil erosion and degradation, with highly uncertain consequences for CO<sub>2</sub> emissions (Lal, 2004a).

### 1.1.4 CO<sub>2</sub> emissions due to transport

14% of 2010 global greenhouse gas emissions come from transport. Greenhouse gas from this sector primarily involve fossil fuels burned for road, rail, air and marine transportation (EPA 2016). Globalization and liberalization policies of the Government in 90's have increased the number of road vehicles nearly 92.6% from 1980-1981 to 2003-2004. These vehicles mainly consume non-renewable fossil fuels and are a major contributor of green house gases particularly CO<sub>2</sub> emissions. Intensities and the level of CO<sub>2</sub> emissions from different modes of transport is given in Table 2. (source: BAU scenario).

**Table 2:** Intensities and the level of CO<sub>2</sub> emissions from different modes of transport

Mode of transport	2000-01			2020-21		
	BPKm	CO <sub>2</sub> intensity (grams of carbon equivalent per PKm)	CO <sub>2</sub> emission (million metric tones of carbon equivalent)	BPKm	CO <sub>2</sub> intensity (grams of carbon equivalent per PKm)	CO <sub>2</sub> emission (million metric tones of carbon equivalent)
Private and Para-transit modes	749	10.05	7.53	6247	10.05	62.78
Bus	2330	4.19	9.76	5662	4.19	23.72
Rail	457	5.50	2.51	1078	6.29	6.78
Total	3536	5.60	19.80	12987	7.18	93.25

### 1.1.5 CO<sub>2</sub> emissions due to buildings

As per IPCC 2014, 6% global greenhouse gas emissions comes from buildings. Greenhouse gas emissions from this sector arise from on-site energy generation and burning fuels for heat in buildings or cooking in homes. As per UNEP buildings are responsible for more than 40 percent of global energy use. (T.V Ramachandra and Shwetmala, 2009).

### 1.1.6 CO<sub>2</sub> emissions due to other energy

Other energy which is about 10% includes greenhouse gas emissions from the energy sector which are not directly associated with electricity and heat generation, such as fuel extraction, refining, processing and transportation. (EPA 2016).

## 2. Literature Review

Jing Zhang and Xiong – Jian Liang has proposed a comprehensive understanding of green ICT from the perspective of green innovation and develops an analytical frame work based on innovation system approaches. Uwe Clausen et al, 2012 aims at promoting an environmentally sound development of the European goods transport. This paper describes which role a smarter use of ICTs thereby can play. Kavitha Suryawanshia and Sameer Narkhedeb presents evolution of green ICT and discusses the barriers in implementation of green ICT at higher education institutes based on survey conducted in India. Yun Zhang et al, 2015 aims to review and identify the ICT based information dissemination models in china and to share the knowledge and experience in applying emerging ICTs in disseminating agriculture information to farmers and farm communities to improve productivity and economic, social and environmental sustainability. It reviewed and analyzed the development stages of china's agricultural information dissemination systems and different mechanisms for agricultural information service development and operations.

T.V Ramachandra and Shwetmala focuses on the state wise road transport emissions (CO<sub>2</sub>, CH<sub>4</sub>, CO, NOX, N<sub>2</sub>O, SO<sub>2</sub>, PM and HC), using region specific mass emission factors for each type of vehicle.

## 3. Methodology/Approach

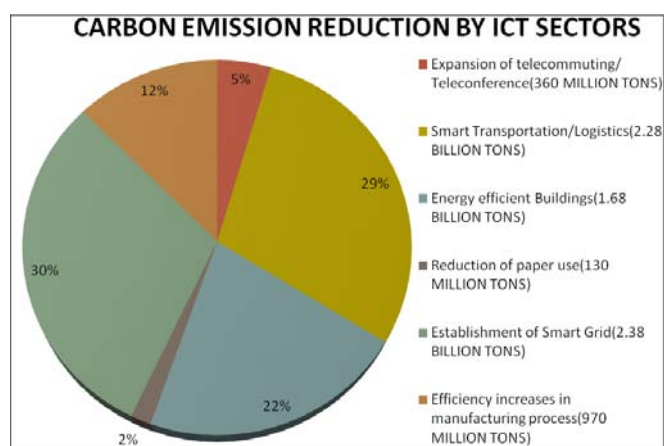
This descriptive type article is purely based on review of literatures. The data collected for this review article consisted of secondary data through literature survey. Literatures are collected to study the hazardous effect due to tremendous increase in CO<sub>2</sub> and the CO<sub>2</sub> reduction techniques adopted presently and tables were drawn highlighting the salient features. From the literature survey it is clearly noted that ICT can reduce carbon to a certain extent, even though it creates its own carbon foot print. There is a growing need to find a solution for tremendous increase in green house gas. As per garner report 2012, pollution directly by ICT is only 2 percentage, but ICT can green the environment through many other means. India is the fourth green house gas emitter all over the world. (Times of India June 25, 2015). It is key time to find a solution to decrease the green house gas production and to protect the environment.

### 3.1 What is green ICT?

Green ICT (Information and communication technology) is the concept that aims to eliminate ICT related Environmental problems and drive positive externalities, is embarrassed by both the ICT industry and national policy makers (Jing Zhang and Xiong-jian Liang, 2012). Green ICT is a pioneering way of using ICT that consists of practices and policies which deal with environment sustainability by minimizing carbon foot print ICT waste and by optimizing energy consumption and by conserving natural resources for cost effectiveness, sustenance of ICT and to save the planet.

### 3.2 Need of green ICT

As per garner report 2012 pollution directly by ICT accounts only 2% of the total worldwide emission but they can help to reduce green house gas emissions by 15%. There are two main approaches for green ICT (i) Green of ICT (ii) Green by ICT. Green of ICT is to reduce the burden of ICT on the environment and green by ICT is to reduce the burden on the environment by improving the efficiency through the use of ICT(Jing Zhang and Xiong-jian Liang, 2012). As per GeSI 2008, carbon emission can be reduced by, energy efficient building(up to 22%), establishment of smart grid(up to 30%), smart transportation(up to 29%), efficiency increase in manufacturing process(12%), expansion of telecommuting (5%), reduction of paper (2%). Carbon emissions reduction by green ICT is shown in Figure 2. Source: GeSI 2008.



**Figure 2:** Carbon emissions reduction by green ICT

## 4. Results and Discussions

### 4.1 ICT Solutions for energy savings in IT industry

The following factors may considered for saving energy such as turning off the computer when it is not in use or plug the computer in surge protector with a master control outlet, which automatically senses when the computer is not in use. Try to reuse and repair ICT equipment before replacing. Use backgrounds for screen display since bright colour consumes more power. Laptop models use much energy less than desktop units. Using multifunctional equipments for tasks such as printing, faxing, copying and scanning as multi-functional equipments save upto 50% in space and 20% in energy. Try to make use of inks which are made from renewable resources such as vegetable and non-petroleum products. Cloud computing which is rapidly emerging as a technology trend almost every industry that provides or consumes software.(Tomasz Lis and Bajdor Paula). It has raised from a large growth of the internet and the increasing number of e-commerce transactions, carried out all around the world. It can save more energy than personal computers.

#### 4.1.1 E-Waste management

It is noted that recycling E-Waste can save up to 70% on the energy required on mine and process new materials. Electronic waste is often comprised of precious metals, like gold silver and platinum as well as valuable copper,

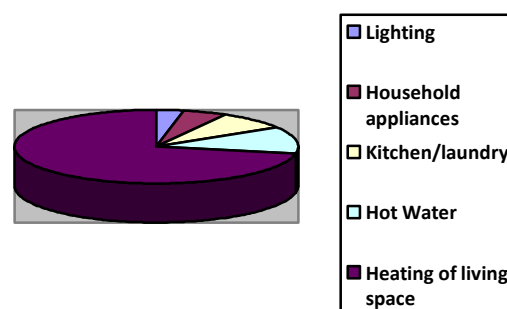
aluminum and iron. These metals are denoted as precious and valuable. Reuse of E-Waste can save non-renewable resources to a certain extent.( M-Chrysovalantou et al., 2013, D.Sinha-Khetriwal et al., 2005).

### 4.2 ICT solutions for paper industry

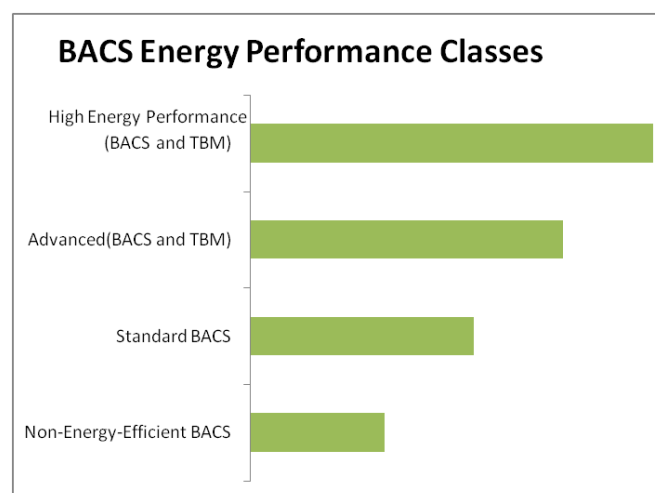
ICT contributes paperless communication through e-form, blog, media server, e-book, e-learning, mobile phones, video conferencing technologies and remote collaboration tools are used to reduce the need for physical business travel. e-Business, e-Government, e-Commerce can help reduce the usage of paper (OECD 2009).

### 4.3 ICT solutions for building industry

Effective usage of ICT in buildings can contribute a system which automatically turns off all the lights and reduces the room temperature. High energy performance can be maintained by the combination of BACS(Building Automation and Control System) and TBM(Technical Building Management System) which is shown in Figure:4. ICT can contribute 72% energy savings in heating of living space, 12% energy savings in hot water, 8% in kitchen, 5% in household appliances and 3% in lighting. Energy consumption in private house holds, 2006 is shown in Figure 3 (source: UVEK, 2008).



**Figure 3:** Energy consumption in private household buildings



**Figure 4:** BACS Energy Performance Classes-EN 15232

#### 4.4 ICT solutions for Transportation

Video Conference reduces travel time. Information and Communication Technologies (ICT) can potentially be a powerful driver to promote change, namely by ICT applied to vehicles through on board user aid devices for educating the driver, improving efficiency, reducing costs and environmental impacts of urban mobility (Patrica C. Baptista et al, 2012).

#### 4.5 ICT solutions for electricity and heat

About 20% of the world electricity is used for lightening. Changing to energy efficient light bulb could half today's energy consumption for lightening by 2025 (European Union 2009). Smart grid technologies were the largest opportunity found in the study and could globally reduce 2.03 CO<sub>2</sub>.

### 5. Conclusions

ICT Provides economic growth, sustainable environment to a certain extent. Even though ICT contributes 2% of global green house gas emissions, it can reduce green house gas to 15%. Cloud computing can save more energy than personal computers. Reuse of E-Waste can save non-renewable resources to a certain extent. ICT contributes paperless communication thereby it reduces CO<sub>2</sub> production. Video Conference reduces CO<sub>2</sub> emission due to transportation. Changing to energy efficient light bulb could half today's energy consumption for lightening by 2025.

### 6. Future Scope

Green ICT is a concept which requires more academic research. In order to get a pollution free environment we need to reduce the emission of CO<sub>2</sub>. Green ICT can be one of the solution to reduce the amount of carbon dioxide to a certain extent. Even though ICT contributes a certain solution for the reduction of CO<sub>2</sub>, it can further develop more to have a green economy.

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