



Green Computing and Sustainability: Legislature's Perspective

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ABSTRACT

Climate change is a serious concern for all living beings and states. The Right to life and the Right to development are both integral for human beings. Development in technology is a necessity but it also raises concerns for its impact on the environment. Handling, recycling, and reusing e-waste has been promoted over the last few years at different levels worldwide. However, we still need to find more solutions to reduce the waste generated by the development of technologies and its consequences. From this arises the concept of sustainable computing also termed Green technology or green IT. Green computing focuses on the use of technology keeping in mind its impact on the environment and thus Sustainability comes into the picture. This paper analyzes the concept of Green computing, its impact on the environment, and green computing implementation in India, challenges, regulations, and suggestions.

Keywords: Green Computing, Electronic Waste, Environment Sustainability

1 Introduction

The Sustainable use of resources considering the environmental impact of industry processes or IT operations is considered Green IT. In simple terms, it is using technology in an energy-efficient and eco-friendly way to reduce resource consumption. This can be achieved through energy-efficient technology and designs, proper disposal of computers or servers, and electronic waste (e-waste).

EPA ('Environmental Protection Agency') is an agency to protect the environment in the U.S. It introduced a controlled label system in 1992 known as the Energy Star, promoting and recognizing energy-efficient products, which later led to the adoption of energy-saving features like sleep mode in electronic devices. [1]

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Green IT is the design, manufacture, use, and disposal of computers, chips, and other technology components that limit the harmful impact on the environment, which include:-

- I. choosing sustainably sourced raw materials to reduce e-waste, carbon emissions, energy consumption, and
- II. Promoting sustainability and renewable resources.

It focuses on reducing power consumption through the use and manufacturing of Energy Star-rated devices or power-saving software mechanisms, promotes the use of renewable resources of energy, designs like cooling systems, power distribution, proper management, disposal, and recycling of electronic waste and hazardous components to prevent contamination of the environment and reducing the need for physical travel and carbon footprint. [2]

Green computing technologies include:

- I. **Virtualization:** It is a combination of virtual machines on a server, with less hardware and expenditure to improve resource utilization. This reduces the active server as per requirement and thus saves energy.
- II. **Power Management:** One method of power management is putting inactive servers in sleep mode, which disconnects network resources and decreases energy usage.
- III. **Data Storage:** Data storage in IT systems requires power for business transactions, phone records, etc which can be reduced by Green computing.
- IV. **Display:** Monitors use light-emitting diodes (LEDs) which reduces energy consumption. [1]

The Industrial Revolution gave the concept of sustainability with technological advancement, and raw materials utilization on a global scale. The ‘Our Common Future Report 1987’ by the ‘UN Brundtland Commission’ popularized the term ‘sustainable development’:

“Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

In 1997, UNFCCC brought the Kyoto Protocol to limit greenhouse gasses but it failed [3].

The environmental impact of Green computing can be reduced by:

1. Implementing monitoring tools to track energy consumption and greenhouse gas emissions.
2. Setting clear goals through frameworks and standards.
3. Embracing hybrid and remote work to reduce carbon emissions through lesser employee commutation and the energy demands of powering large buildings.

4. Virtualization allows a single physical server to consolidate multiple virtual machines which reduces energy consumption.
5. Proper disposal of Electronic waste and recycling electronic devices.
6. Utilizing built-in power management features for IT components, such as hard drives, displays, and other peripherals allows these devices to automatically enter sleep mode or power down completely when not in use.
7. Data centers rely on renewable energy sources like geothermal cooling, wind power, and hydroelectric power that offer a significantly greener approach and reduce their environmental footprint. [3]

2. Implementing green computing

2.1 Practices adopted for implementation

Green Computing is responsible use of devices and their disposal in a manner to least harm the environment. The main focus must be on the safe use and disposal stage of any electronic device. Google search-powered search engine “Blackle” can save 750 MW each year. It is based on the theory that different colors on monitor displays consume different amounts of energy. [1]

Intel's 2030 strategy demonstrated internal action and a collaborative approach to environmental challenges focused on achieving 100% renewable energy and zero landfill waste in manufacturing, prioritizing environmental responsibility with technology. It also aims to expand digital literacy for a sustainable future. [3]

2.2 Challenges in implementing Green Computing

India has potential for energy conservation. The first challenge is lack of awareness of the reasonable use and safe disposal of the technology. Awareness among all users, organizations, manufactures, and other stakeholders involved in commuting devices. Lack of uniform policy on green computing regarding disposal, funding for resource allocation, skilled labor for adopting the practices of disposal, design and development of technology are the main concerns in India while adopting green computing. Another challenge is the authenticity of the product claimed as environment friendly. To make profit, many companies claim use of materials or their product to be environmentally friendly and deceive the consumers [4].

Other challenges include a lack of concern, prioritizing rapid changes in technological advancements, and most importantly the capital investment required for the configuration of green setup in any institution [2].

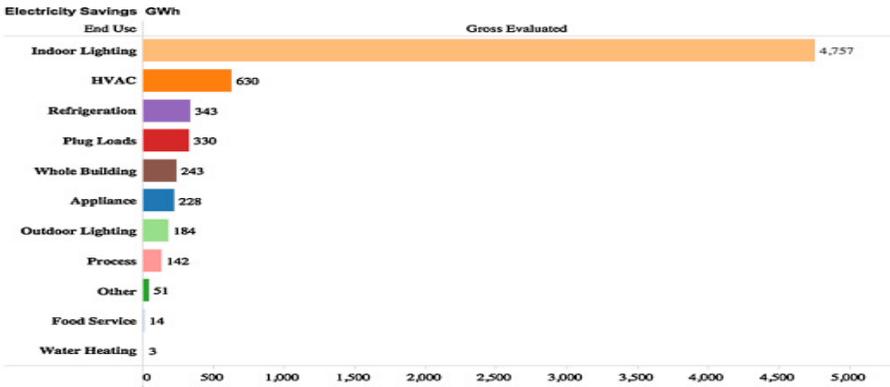


Fig. 1 Electricity saving

Figure 1 shows Electricity savings reported by the California investor-owned utilities (IOUs) for their 2010–2012 residential and commercial efficiency programs [Note: California Energy Efficiency Statistics. This figure is derived from IOU evaluated numbers; the numbers are presented based on gross EE savings from the IOUs’ commercial and residential programs].

3. GREEN COMPUTING IN INDIA

India has been an active participant in green IT. Business owners, investors, and technology specialists are adopting green IT and sustainability solutions in policy framing in India. ‘National Action Plan on Climate Change’ (NAPCC) lays out the strategy of the country to manage emissions of GHGs and ‘12th Five Year Plan (2012-2017)’ provides for Green IT concerns.

One of the great initiatives that is also adopted by the city of Indore (Madhya Pradesh) is the separate handling and recycling of e-waste which further reduces water and electricity usage which is used in the production of new products. It also minimizes the quantity of toxins that are going into landfills.

The ‘E-waste awareness program’ created awareness at various levels of society bringing together the public, industry, and government for sustainable practices [5].

4. REGULATION OF GREEN COMPUTING

4.1 Global Scenario

The use of electronic equipment and its recycling were regulated by the EU legislation in 2003 through ('Directive 2002/95/EC') and ('Directive 2002/96/EC') respectively. Revised Directives 2002/95/EC (RoHS) provided for schemes to promote the reduction, reuse, and recycling of hazardous substances, and substitution by safer alternatives. [6] To tackle the increasing volume of e-waste, the 'European Commission' revised the directives in 2008 followed by countries like China, South Korea, Japan, Australia, Canada, Brazil, etc. [7]

A global consortium 'Green Grid' was founded in February 2007 by 'Dell, HP, IBM, Intel, Microsoft, Sun Microsystems, etc.' to improve data center efficiency. [8]

Table 1 shows Green Computing Rules under the Environment (Protection) Act, 1986 in India [9].

Table 1 Indian Green computing scenario

Sr. No	Rules	Purpose
1	2008 Rules on Management and Handling of Hazardous Wastes"	Management of e-waste
2	2016 E-Waste Management Rules	Adequate training for the stakeholders in the 'electrical and electronic equipment (EEE) industries for proper compliance.
3	2022 E-Waste Management Rules	'Extended Producer Responsibility (EPR)' which aims to regulate and streamline the e-waste ecosystem.

4.2 Extended Producer Responsibility (EPR)

EPR is the responsibility beyond production for manufacturers and producers, to manage the final disposal of their electronic products as shown in figure 2.



Fig. 2. EPR covering life cycles

Rules 2024 to the Environment (Protection) Act, 1986 added environmental compensation to penalties to include aid and abatement of any violation, ensuring deterrence against non-compliance. Government emphasis on solar technologies and the additional penalties address the emerging challenges in the e-waste domain. The concerns are the role of the informal sector and the potential burden on authorized recyclers [10].

4.3 Enforcement Agencies in India

The GoI is accountable for policy framing, propagating, and coordinating the program related to the environment which includes identifying hazardous in particular e-waste to preserve and protect the environment under MoEF [11]. Some strategies of E-Waste management are Reducing, Reusing, Recycling, and finally proper Disposal [12].

Under the Central Government, the Ministry and Department of IT are taking initiatives to develop technological solutions to manage e-waste by making cost-effective and environment-friendly technology. The main thrust is to minimize land filling and zero emissions to water, land, and air. It aims to recover valuable materials and reuse plastics to make recycling an economically profitable business [13].

5. Conclusion and suggestions

In this article, the concept of Green computing was explained from the perspective of Legislatures. The focus is on the regulation and enforcement of rules on Green

Computing. It is concluded that the legislation is one way to promote energy saving practices among users and different stakeholders. Data centers are the major concern for the energy-efficiency practices which involve resource reduction, re-use computing systems, utilization of renewable energy resources, limiting the carbon footprint of IT operations and limiting the e-waste contribute to sustainability efforts through environmental monitoring and social awareness. [14]

It can help to conserve energy for which steps like sleep mode method, avoid using hazardous materials, to reduce waste in manufacturing components and gadgets, lengthening the lifespan of computing devices, and making devices recyclable on the part of the manufacturer will help.

5.1 Way Forward

5.1.1 User Practices: Users can reduce energy consumption by making sure things are turned off when not in use, by adjusting screen brightness, Central processing units (CPUs), speakers, and printers should be powered down. Replacing devices like Notebooks for laptops and laptops for desktop computers, as the latter consumes less energy, can help in a green environment.

Buying refurbished equipment, Refilling printer cartridges, limiting printing, recycling papers, previewing before printing, printing both sides of paper, using Google Workspace for sharing documents, and safe disposal of electronic equipment improves sustainability. When individuals buy new equipment, 'Energy saving stars' become good guidance.

5.1.2 Deploying technologies: Deploying technology Services such as virtualization technology for servers and desktops promotes sustainability and improves services. To effectively and sustainably manage e-waste in India, a balance between formal and informal recycling channels is required. Adopting Green Computing adds cost to the customers.

5.1.3 Government initiative: The design and installation of the e-waste recycling facilities are expensive, which only can be an initiative on the part of the Government or possibly through a "Public-Private Partnership". Government subsidies can help the consumers adopt the technology best for the environment similar to one provided by the Government in India for green energy generating processes such as solar energy.

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