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Energy Efficient Clean and Green IT: Concepts and Approaches

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Abstract

Green IT practice is essential to minimize electricity bill. We have done our analysis on power consumption of computer. We have stated different management policies for reduction in energy consumption. Energy Star (ES) programme of the United States promotes energy efficiency in electronics products that provides an exceptional productivity as compared to the old or traditional systems. Energy Star program has been adopted by many countries to make a move towards Clean and Green environment. ES labels can be easily found on electronic appliances at homes, offices, buildings and many other places. Depending upon the devices, using these policies can result between 30%-90% of less power consumption. In our analysis, we got a reduction of 40% less power consumption in computers after implementing management policies. In this work, we are estimating power bill, and analyzing its economical feasibility along with that we are proposing a plan to reduce power consumption of academia and Institute. We have also discussed about management policies for disposal of e-waste.

Keywords: *Green IT, electronics, Energy Star (ES), Energy Efficient Techniques, Environment Friendly Design, Eco-Friendly Approach, Low Power Product, e-waste disposal*

1. Introduction

Although computers play a pivotal role in life of human. Whereas, exponential growth of computers, Smartphone, laptop, and Personal Digital Assistant (PDA) used for personal or official purposes by individuals and organizations for a very long period of time almost over one decade has positive as well as negative effects on the environment. Benefits of these devices have helped us to store a huge amount of information though computer without even compromising our natural resources (*e.g.*, paper). Along with positive ecological benefits, technology has made harmful footprint on the environment. Organizational green motivations behind green Information Technology (IT) policies are main guiding factor behind Green IT investments [1]. Energy Star (ES) programme of the United States promotes energy efficiency in electronics products that deliver better services than traditional equipment without the Energy Star label [2]. Along with manipulating FPGA resource, LVCMOS IO standard, Voltage Scaling, Frequency Scaling, Clock Gating, and Adaptive Voltage Scaling (AVS) are also energy efficient techniques that are in use of energy efficient design of ALU [3], Mobile Battery Charge Controller Sensor (MBCCS) [4-5], state-of-the-art VLSI designs in 40 and 65 nm processes [6].

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1.1. Hazardous e-waste

Table 1. Hazardous Chemical Presents in E-waste

Cadmium	Beryllium
Lead	Mercury

Hazardous e-waste such as Cadmium, Lead, Mercury or Beryllium available in equipmemnt like electronic circuit boards, CRTs (Cathode ray tubes), processed and unprocessed CRT glass, power storing batteries, lamps and other electronic devices. These equipments, when become unworkable are classified as e-waste. Developed countries take proper care of disposal of non-working equipment, electronic devices that are exported for reuse and repair. This policy of developed country helps them to maintain their hazardous garbage dump.

1.2. Issues and Economics

IT and electronics industries have played a great role in helping or providing opportunities for those organizations which are focusing their work on green or sustainable business development practices. In a survey, it was found that these advanced systems helps to reduce cost, energy, environmental and travel-related issues from ongoing consumption of resources.

The issues which are leading industries or organizations towards adopting these Green IT movement or energy efficient systems/techniques are stated below:

1.2.1. Rise in demand of energy with increased unit cost and availability of limited resources.

1.2.2. Improper Management and disposal of e-waste (Hazardous electronic waste).

1.3. Program

These days many IT and electronics, industries and organizations are moving towards Green techniques and programs to achieve objectives that focuses on energy efficient designs, power management techniques, reduction in the hardware and maintenance cost and alternatives for reducing e-waste. The three major areas where this topic is focusing on are stated below:

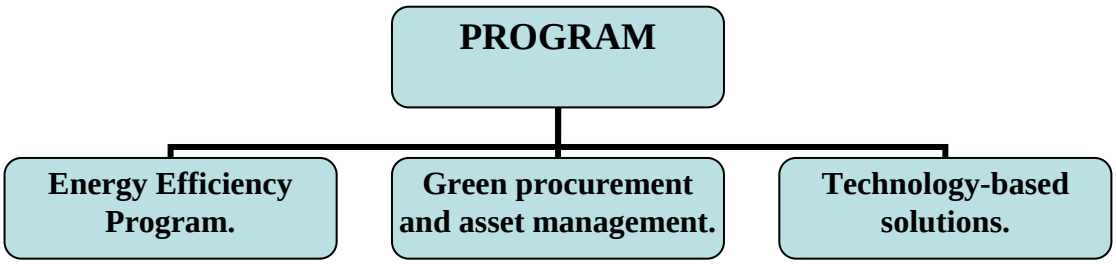

Figure 1. Smart Art Design for Different Program for Green IT

1.3.1. Energy Efficiency Program

The main objective of these programs is to maximize the energy yield and computing efficiency in the electronics and IT sectors, reduction of energy consumption in data center levels, reducing the electric utility costs which is affordable to the consumer and minimizing the impacts of global greenhouse gas on environment. Efficiency strategies that will make a real impact on balance sheet and environmental record are more

elaborate than simply replacing bulbs. Network level energy management software helps us to centralize the management of power of PCs and Visual Display Unit (VDU), which ensures that our network is configured to efficiently respond the rise in power demands of electronics and IT industries.

A key role which a consumer can play in investing energy efficiency takes place at the time of purchasing optimized electronic devices such as monitors, lightening devices, cooling devices, drives and machines which approved and certified by Energy star Program.

Green Procurement and Asset Management Program is an initiative that focuses on purchasing electronics equipments that are more efficient in terms of energy and are Eco-friendly. The technology should focus on 3 R's while designing electronic equipments: Reduce, Reuse and Recycle.
This program also includes extended life cycle of the products, reduction of hazardous materials in product manufacturing, packaging and industry/factory waste management programs.

Technology-Based Solutions.

This category includes designing of equipments or technology that will help to reduce travel, commuting and real estate costs along with the environmental impacts of jobs related to people movement. Technologies such as teleconferencing and web-based meeting play a great role in these solutions. Other options are such as web access, file sharing and emails using software's. Calling, Internet access, messaging and emails on personal mobile phones. Software products such as Microsoft office which are used for management of work without even compromising the natural resources for paper sheets. These are green computing techniques [7]. Due to presence of hazardous and toxic components in the circuits of devices, the proper disposal of these components ensures that we are following the environmental regulations of the society and protecting interest of our future generations. Formalizing a recycling mandate within company provides added value to new and existing customers, as this concern is first priority nowadays. Green computing challenges [8].

2. Analysis

2.1. Asset Disposal

According to an analysis done by Silicon Valley Toxics Coalition, have shown that "e-waste" is the 2% of all waste contributions of USA. Throughout the world in different countries the electronics and IT industries are seeing trends towards legislation that will help to regulate the laws for the disposal of e-waste. Moreover customers are also playing an active role by inquiring about the recycling mandates and policies of electronic and IT companies. Charity organizations are great outlets for extending the lifecycle of our equipment.

2.2. Indian Energy Scenario

Table 2. Indian Energy Scenario

S.N.	Sector	MW	%
1	State Sector	78,378.14	52.5
2	Center Sector	50,522.63	34.0
3	Private Sector	28,328.71	13.5
	Total	**1,57,229.48**	

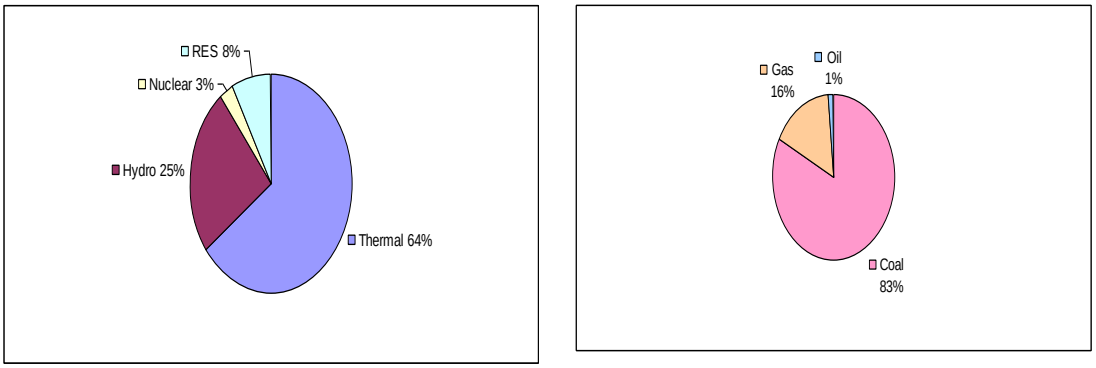

Figure 2. Indian Energy Scenario

3. Management of Energy at Home and Work Place

3.1. Turing of Monitor of computer when not in use because monitors consume more than half the system's energy.

3.2 Turning the laptops or computers in sleep-mode helps when not in use helps to reduce electricity cost by approximately 40%.

3.3 Plugged in battery chargers draw power which is of no use unless connected to charging device. Pull the plug and save the energy.

3.4 Turning On and off does not consume much energy. In fact, shutting computers down, when your work is finished actually reduces system wear and saves energy.

4. Calculations and Results

Case Study on Computers

Total number of computers with servers: 220
Average energy consumption by a computer/hour: 200 Watt.
Total number of working hours/day: 6
Total working days in a year: 219

We are substituting short forms for the table below:
Number of Computers = A
Average energy Consumption per hour = B
Total number of working hours per day = C
Total number of working days in a year = D
Total Consumption in Watt per hour = E
4.1. Calculation of Energy Consumption

Table 3. Energy Consumed by a Computer in a Year

A	B	C	D	E
1	200	6	219	262800

Total consumption of energy by 1 computer is 1*200*6*219 = 262800 W/h. Energy consumed by 220 computers in a year (working days) = 220*262800 = 57816000 W/h.

4.2. Calculation of Energy Cost.

Tariff per Unit = T
Cost of Energy per Computer per year = X
Cost of energy per year for 220 Computers = Y

Table 4. Cost of Energy per Computer in a Year

T	X	Y
Rs 7.5	Rs 1971	Rs 433620

Tariff per unit is Rs.7.5 (For industrial line).

Cost of energy per computer per year is 262800 W (Total consumption of energy by 1 computer)*7.5 (Tariff per unit)/1000(W/KW) = Rs 1971.00

Cost of energy per year for 220 computers is 220*262800 = 57816000 W (Total consumption of energy by 220 computers) * 7.5(Tariff per unit)/1000(W/KW) = Rs. 433620.00

4.3. Energy and Cost Savings

We are substituting short forms for the table below:

Number of Computers = 220 = P
New Average energy Consumption per hour = 120 = Q
Total number of working hours per day = 6 = R
Total number of working days in a year = 219 = S
Total Consumption in Watt per hour = Z

Using power management policies, 40 % energy consumption may be reduced.

Earlier the consumption of computer was 200 W but after implementing policies it reduced to 120 W only.

Table 5. Power after Implementing Management Policies

A	**B**	**C**	**D**	**E**
1	120	6	219	157680

Total consumption of energy by 1 computer is 1*120*6*219 = 157680 W/h. Energy consumed by 220 computers in a year (working days) = 220*157680 = 34689600 W/h.

Table 6. Energy Consumption Analysis after and before Implementing Policies

Energy Consumed in a year before implementing Policies	57816000 W/h
Energy Consumed in a year after implementing Policies	34689600 W/h
Total Energy saved after implementing Policies	23126400 W/h

Saving in energy consumption= (57816000-34689600) W/h = 23126400 W/h as shown in Table 6 and Figure 1.

4.4. Effect of Efficient Energy on Environment

4.4.1. 0.75 Kg Carbon dioxide generated for producing 1kW power by thermal plant.

4.4.2. Reduction in Carbon dioxide due to implementing power management policies =23126.4 kW * 0.75 kg of CO_2 = 17344.8 Kg of CO_2

Power management software's and policies can make IT sector cost effective as well as clean and green

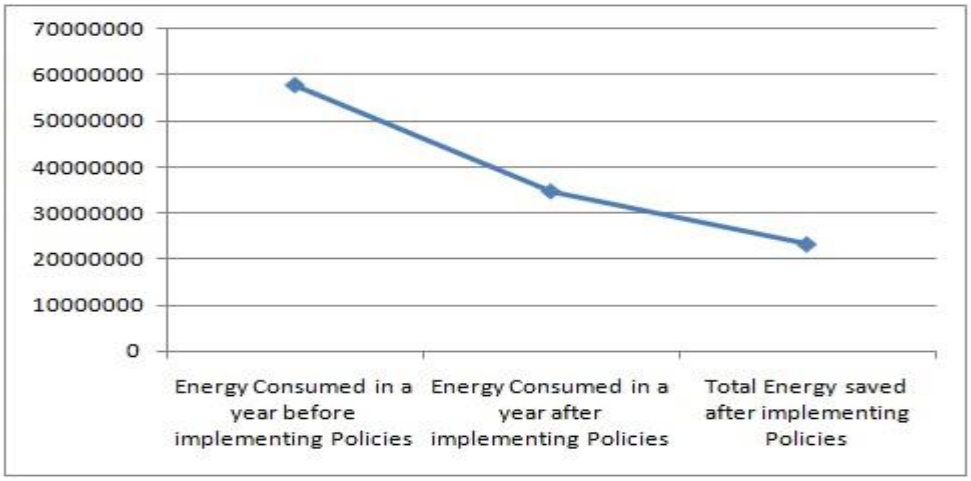

Figure 3. Reduction in Energy Consumption after Green IT Policies

5. Conclusion

Any steps taken for green computing is not only research but also a service toward humanity. This approach is also a service of society because that is also applicable for saving of money and energy both. In this work, we are achieving financial and ecological gain with only one measure. In future, there is scope to go ahead with implementation of multiple approaches of green computing.

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