



Green Computing- the Future

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Abstract- Going green is the latest in-thing in almost all human spheres. And IT is not simply left out. Most of the companies try to be green or at least try their best to appear green to show that they are responsible role players. However, relying solely on the IT companies to make a move is not enough. The change must begin from the smallest level. Green Computing facilitates with ways that help in minimizing the deleterious impacts of carbon emissions through industries and other forms on the society. This paper tries to get an insight into how aware the people about green computing actually are and how we still need to work diligently in order to popularize this concept. At the same time, this study also tries to evaluate how facebook leads from the front when it comes to preservation of the environment of the mother earth.

Keywords- Data Center, Green Computing, Open Computing Project, Optimization, Virtualization

I. INTRODUCTION to GREEN COMPUTING

In the world of 21st century, where we are facing tremendous challenges to safeguard and protect the environment from the copious carbon emissions being produced from hundreds of sources, it is a matter of great concern to reach out for solutions that help in arresting the menace. Energy issues will get a serious ring in the coming days, as the debate on global warming and carbon emissions warms up. This being the information age, it is imperative to at least restrict the carbon emissions being produced through computing industries. It has been estimated that Information and Communication Technology sector alone leads to a carbon emission of colossal amount, keeping in view the actual number of sources which lead to pollution. This is where the concept of Green computing comes in to the rescue. Green computing is a step in right direction which deals in minimizing the impacts and undesired adjuncts produced by industries. It pledges to facilitate the society with ways that lay emphasis on creating products that could be recycled, do not result into pollution, thereby taking into consideration all the important aspects that are required to be taken care of. To put across, the role of green computing is to:

- Use fewer environmentally susceptible materials
- Maximize the efficiency of resources used in computing systems
- Promote the recyclability and reusability of defunct products and other type of electronic waste.

Green computing is almost a necessity today because the IT department is one burgeoning department which would account for a lot of energy consumption in the coming years and in turn contribute heavily to the toxic produced in various forms of carbon. Green Computing will benefit the industries and society in more than a single way as it would not only lead to better company performance and higher efficiency but also take care of the financial savings. Green computing focuses on proper disposal of electronic waste. It also puts emphasis on sustaining the future by reducing energy consumption, paper consumption, and adhering to recycling of all computing products. In this way, it helps in developing a green sustainable computing plan. In the present day scenario, Google and Facebook are undoubtedly the two internet super-powers. These two giants receive heavy traffic, since the user base is enormous. To control every bit of the traffic, these two giants have deployed as many servers as possible. It is important to remember that every single server deployed by the company, emits great deal of carbon dioxide and results in global warming. However, both of these companies have efficiently managed to control the amount of heat generated and have set a benchmark for others to follow.

II. SURVEY ANALYSIS

A research, consisting of following questionnaire, was carried out on exactly 200 people working in field of computers. [1] Some of the inferences which could be made out of the green picture of the society are indicated below.

Q1. Are you aware about the term Green Computing?

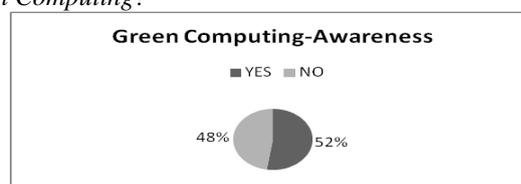


Fig. 1 Result displaying awareness of the concept of Green Computing

The results demonstrate the standing of the society as far as environmental consciousness is concerned. Only 52% of the people admitted to have been aware about Green computing. However, given the fact that the youth are the future decision makers of any society, there is still a lot of scope in the awareness and knowledge enhancement and developing a mature attitude towards the same.

Q2. Are you aware about the carbon emissions generated by computing devices?

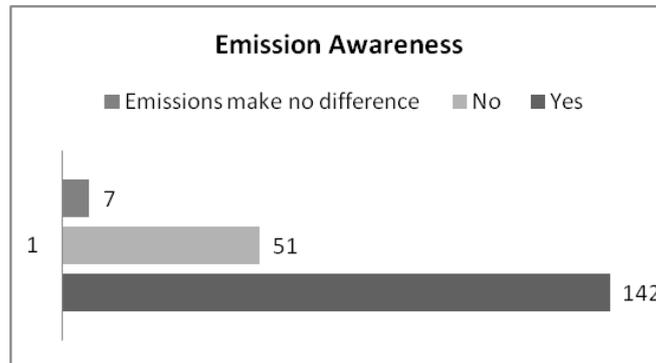


Fig. 2 Result displaying awareness of emissions generated from computing devices

The results give an idea of an aware computing society. Most of the people are aware about the harmful emissions released by computing devices and their adverse consequences which is a good indication.

Q3. Are you aware about energy efficient options provided in the computing equipments?

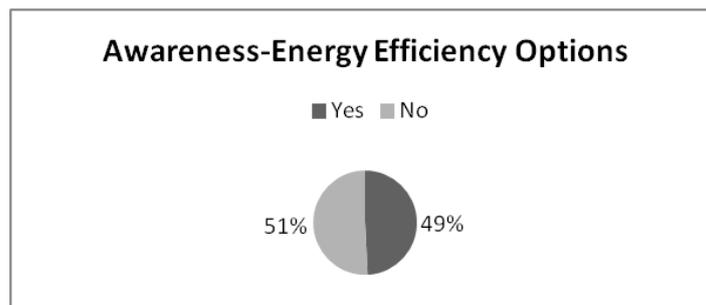


Fig. 3 Result displaying awareness of power saving options in computing devices

According to the survey, almost half of the 21st century's computing society doesn't seem to be much aware about the efficient computing options provided in the devices, for example, sleep mode, hibernation mode and power saver mode which are used for saving energy and in turn arresting emissions to an extent.

As a result, it is not only important for people to be aware about the power utility options but even the computer manufacturing companies must take up few steps through which the users are apprised of the importance of using these facilities. For example, the companies can systemize their products in such a way that notifies the user to turn the device to sleep mode during an inactive period. Another way could be to show tutorial videos of how the energy saving options can be implemented when the computer is used for the first time. Thus, it is imperative to use all the energy efficient options efficiently.

Q4. What type of monitor do you use?

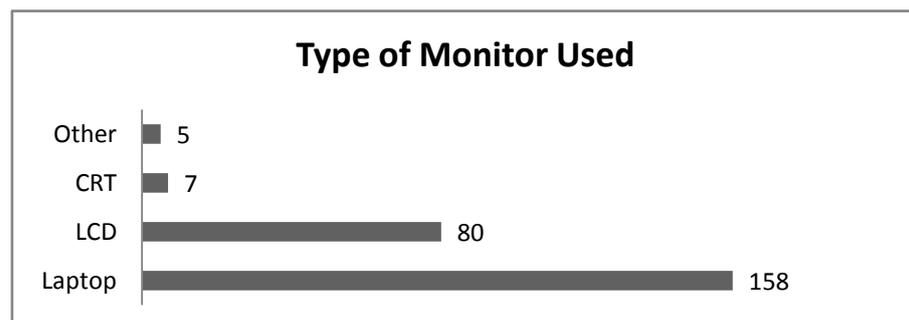


Fig. 4 Result displaying the types of monitor used

As reflected by the data below, a major section of the society uses laptop computers. Laptops are energy efficient and thus this trend might indicate a positively aware attitude towards energy conservation. However, this judgment might also be the victim of faulty reasoning. There is a possibility that laptops are portable and convenient options and thereby the most popular.

Q5. On an average for how much time is your computing device powered on every day?

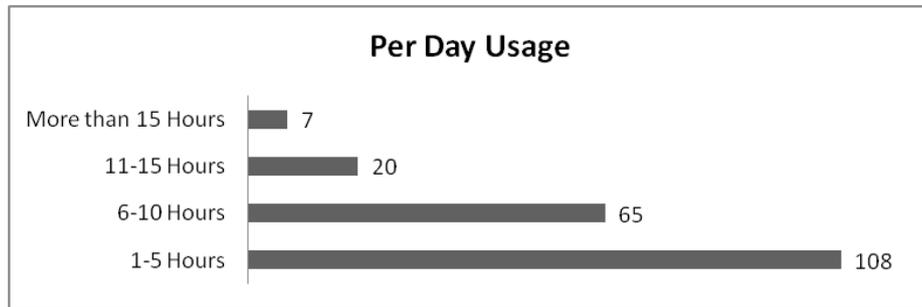


Fig. 5 Result displaying per day usage of computing devices

In accordance to the survey results, a majority of the users use their computing device for 1-5 hours a day. A desktop uses an average of 200 Watt per hour. A computer that is on for eight hours a day uses almost 600 kWh and emits 175 kg of Carbon Dioxide per year. A laptop uses between 50 and 100 Watt per hour. A laptop that is on for eight hours a day uses between 150 and 300 kWh and emits between 44 and 88 kg of Carbon Dioxide per year. In stand-by mode the power consumption of both a desktop and a laptop falls to about a third. [2]

Q6. Do you know about the initiatives taken by various MNCs toward Green computing?

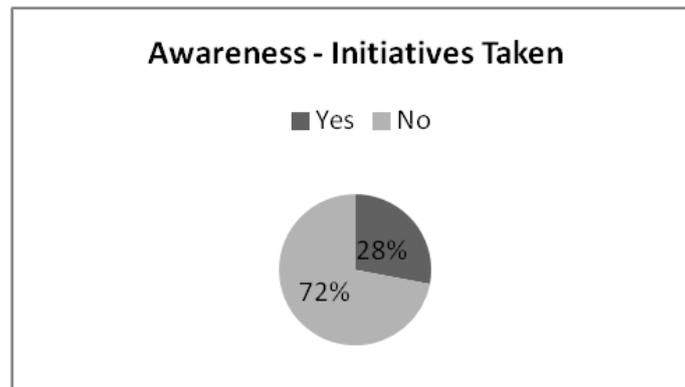


Fig. 6 Result displaying awareness of initiatives taken by MNCs

In reference to the data, it can be inferred that the society is not much aware about the efforts that large-scale MNCs are taking up. Thus, there is a strong need to popularize the concept of green computing amongst the society so that the importance of implementing such an attitude could be understood even by a common man.

Q7. Do you know where to go to recycle electronics in your area?

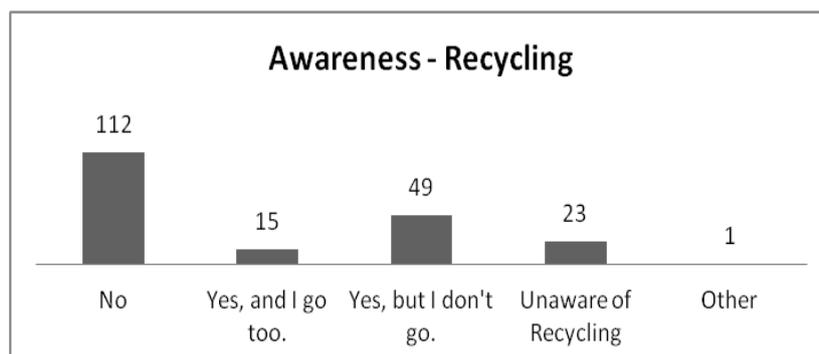


Fig. 7 Result displaying awareness of areas providing recycling facilities

The results imply that majority of the people aren't aware about the places where recycling of the computing devices takes place. This must be looked into with a lot of concern because computers are made up of various different parts that can be safely recycled without damaging the environment. Some of the parts of a computing device may still be used up again and the ones which are completely destroyed can be dismantled up to the level where it would be safe to dispose them. Hence, the need of the hour is to make people a little more aware so that recycling could be practiced at better rates, consequently contributing in the protection of environment.

Q8. Would you recycle the old computing device if you knew where to take it?

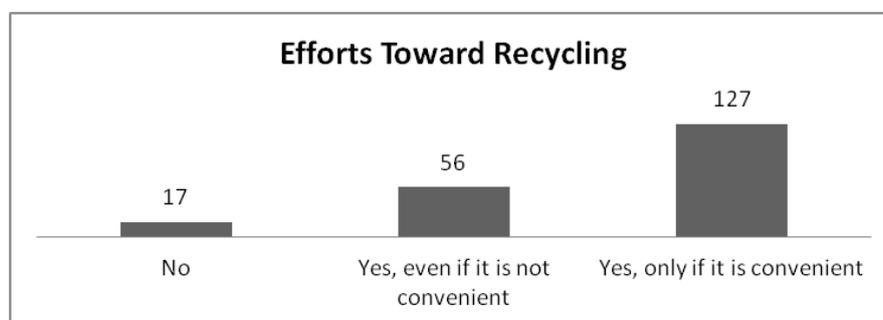


Fig. 8 Result displaying efforts toward recycling

Although there is not much awareness regarding recycling and other international standards pertaining to computing equipments, still the society is keen to make a difference if provided with some important information. It could be even more beneficial if the facility of collecting e-waste is provided at the door-steps.

III. FACEBOOK- THE TRENDSETTER

The internet giant facebook possesses a user base of over 9 million people accounts for a little more than 9% of the whole internet traffic. As a result, this demands for a huge set up of servers at its data centers. Although the exact number of servers still remains a mystery, it is estimated, facebook has deployed hundreds of thousands of servers such that it can deliver the information requested in the blink of an eye. Since the setup is enormous, it is almost a given that it would account for a large amount of carbon emissions and hence affect the environment. But, facebook has been wary of the drastic consequences that might take place if adequate methods are not practiced. According to the results for carbon emissions emitted at data centres revealed by facebook, "From 2011 to 2012, Facebook's per-user carbon footprint changed only slightly, from .000249 metric tonnes of CO₂e – or 249 grams – per monthly active user in 2011 to .000294 MT of CO₂e – or 294 grams – in 2012. Put another way, one person's Facebook use for all of 2012 had the same carbon impact as about three bananas, just as it did in 2011." [3] Also, in 2012, Facebook's total energy use from office space, data centers, and other facilities was approximately 704 million kWh. [3] These results prove that even when the number of users is constantly burgeoning, facebook has been successful enough in maintaining high efficiency of energy and sustainability.

Facebook is also contributing by educating other organizations on the benefits of green computing and its methodologies for the sake of the environment, as well as productivity and overall user experience. For example, facebook came out with Open Compute Project which aimed at helping society in forming highly efficient data centers at lower costs. With the advent of Open Compute Project, Facebook set up its latest data center in Sweden which is unique in its own ways. Facebook proudly admits that the newly set up data center comprises of equipment that run on the locally generated hydro-electricity. It is believed to be 100% renewable and an extremely reliable source of energy. Apart from this, the data center judiciously involves the reuse of rainwater and the naturally accessible frigid winds are used to cool down the servers which emit heat. This heat emitted by the servers is an integral part of the data center functioning since it is used to control the office temperatures. What is even more noteworthy of the data center is its impressive Power Usage Efficiency (PUE) which is just 1.07. [3] In general, the PUE typically determines the measure of effectiveness of the data center in using the input power. So, in facebook's case, the data center only uses 7 percent more power for everything that isn't used on the servers. Such intelligent and diligent use of the resources makes facebook the trend setter in terms of how to look after our mother earth and still be as efficient as it could ever be.

IV. PRACTICING GREEN COMPUTING

There are many factors which result into Greenhouse gas production. The carbon foot-print, which is the measure of emission of greenhouse gases is measured in terms of various types of energy consumed. It can be measured in terms of how many Kilowatt hours of electricity is consumed or it could be metric tonnes of coal and wood consumed. It can also be measured in terms of amount of natural gas and heating oil used. Carbon foot-print must be restricted to the smallest levels and by decreasing the amount of electricity needed for production and limiting the use of coal, wood pellets and propane, it can have aesthetic consequences.

Some of the ways through which Green computing has been and can be implemented are mentioned below-

A. N-Computing:

One possible methodology of reducing energy requirements is by using the energy consumed by a single computer to be used by multiple computers. This would leverage the unused computing power of modern PC's to create an environmentally efficient alternative to traditional desktop computing. Multiple users can work on a single computer by simply attaching up to N monitors, mice and keyboards. This would lead to reduced electronic waste in decent amounts, thereby increased benefits to the society. This methodology is similar to that employed by the renowned company N-computing. [4]

B. IMEC Laptops:

Solar energy is a source of energy which is abundantly available, taking this into consideration Jan Leysens designed a laptop which could be powered just by the use of two solar cells. This concept hasn't got much popular although it is a beautiful prospect because not only does this help in reducing the need of using electricity but also encourages people to understand the importance of solar energy.

C. Using Eco-friendly Desktops:

One of the major problems after buying laptops and other desktop computers is that they would become obsolete at a very early stage with the pace at which technology is advancing. As a result, people might want to switch to newer desktops and laptops, in turn discarding their relatively older computing devices. This would account for a humungous amount of e-waste and will end up polluting the landfills. Thus, it is imperative to use computer systems which don't need to be replaced with newer ones but can be made new with the use of better components. Dell Inc., along with conscious efforts of industrial designer Jocko Chan has worked upon collectively to formulate such a device which is known by the name of Loop. Dell's employees take care of all repair and enhancements. The components which are working in good condition are re-used whereas all other components are taken back for recycling.

D. Buying Carbon Off-sets:

Reducing the carbon foot-print must be the foremost goal for any company's data center. Till the time the company isn't able to find ways to use 100% renewable power sources, it must focus on buying carbon offsets. A carbon offset is an investment in an activity that reduces carbon emissions. "The reduction in carbon emissions is represented by a carbon credit. The credit, usually verified by a third party, signifies that greenhouse gas emissions are lower than they would have been had no one invested in the offset. One credit equals one metric ton of carbon dioxide prevented from entering the atmosphere. The credit purchaser can use the credit for carbon accounting from its data-centre." [5] This methodology is endorsed by Google.

Through this collaboration and investment, global greenhouse gas emissions can be effectively reduced and at the same time companies can contribute to the preservation of environment in which they operate.

E. Virtualization:

According to the dictionary meaning, virtualization means simulating or emulating on a computer using cloud computing. With virtualization, several physical systems could be converted into virtual machines on one single, powerful system, thereby unplugging the original hardware and reducing power and cooling consumption. Virtualization can also assist in distributing work so that servers are either busy or put in a low-power sleep state. [6]

Virtualization also leads to consolidated storage locations, that is, multiple computer systems share a common storage sub-system to function in exactly the same way as it would if it were to have a uniquely dedicated storage location. The implementation of this methodology would not only account for lesser hardware requirement but would also have positive aspects like reduced heat generation, reduced inherent administrative costs due to limited space required and reduced consumption of the electricity.

F. Concept of Optimization:

Optimization of data centers involves improving the efficiency of algorithms on which the servers present in data centers work. This would have a direct impact on resources required for computing functions. For example, use fast search algorithms such as hashed or indexed search algorithms instead of slow linear search algorithms. Cost optimization can be achieved by using algorithms to route the data to data center where electricity is cheaper. In case data center is facing warm weather, traffic could be routed away to cut energy usage, allowing the servers to shut down and avoid using the air conditioning. [7]

G. Miscellaneous:

- EPEAT

It is a tool which focuses on a better and 'greener' type of computing. EPEAT, Electronic Product Environmental Assessment Tool, facilitates the society with economically and ecologically sound purchase decisions. It helps in identifying greener computing devices and also acknowledges manufacturer's efforts of restricted usage of environmentally sensitive materials.

- Recycle and Reuse

Recycling of an electronic or computing device involves dismantling of dangerous substances present in the discarded device. If apposite technology is used to recycle the devices, the value of device after recycling could be much higher.

Thus, once the device is properly recycled, it is fit to be reused again. Reusing is a process which allows the same device to be used again after some modifications. Recycling and reusing help in reducing the volume of e-waste generated by significant amounts.

- Using Energy Star Products

Energy Star is a standard which is not only designated to computing products like laptops or notebooks but also to electronic products like refrigerator, television sets, and air-conditioners. The main purpose to establish this standard was to promote the use of devices which maximize the efficiency while consuming very little power to operate.

Some very basic practices like implementation of power management facilities provided in the computing system must be used to good effect. This would not only result in reduced electricity consumptions but also save a few dollars. Also, peripheral devices like printers, scanners and speakers attached to a computing device consume considerable amounts of power. So, in a state of disuse all such devices must be suspended. This would save some important Kilowatt hours. Clearly, energy saved on computer hardware and computing will equate tonnes of carbon emissions saved per year.

V. CONCLUSION

Green computing lays emphasis on providing the society with a greener and cleaner environment to live in by reducing carbon dioxide emissions through various practices. Green computing in fact is not just an environmental issue but also a financial issue, hence the need of the hour. The IT industry needs to take up responsibility for meeting all the requirements to provide a better atmosphere to live in. It is true that industries have started taking some serious measures, however with every passing day, the need to further narrow down on the global greenhouse gas emissions becomes even more paramount. At the very basic level, every common-man needs to be apprised about the concept of green computing and how every small contribution made by them would make a difference. Also, there must be some policies and guidelines that must be regulated by the concerned authorities of every nation so as to reduce the usage of power consumption because when it comes to protecting the environment, everyone must demonstrate social responsibility and initiative. Despite having said that, green computing is still a rudimentary concept and requires a lot more research to be done, especially in the area of development of eco-friendly data centers as it will play an instrumental role in the coming years.

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