Green COMPUTING

The Environmental Benefits of Going Green

Let's Make Our Planet Green

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Executive Summary

"Green" is in vogue. It has an impact on the way people and business think about environment.

Over the last few decades, green computing has proven itself to be the most concerning issue for governments and businesses around the globe as computing becomes increasingly more pervasive. The way in which we are doing business or living as a society, is environmentally unsustainable. Rising energy prices are increasingly impacting the total cost of doing business, which in turn, makes many business practices economically and environmentally unsustainable.

It is becoming progressively important for all businesses to act green, not only to fulfill their legal and environmental obligations, but also to improve their brand value and corporate image. Green computing can help businesses achieve this, which is currently, for some - primarily about the environment; for others - it is just an efficient use of computers and computing.
In this paper we'll summarize valuable information and practices to implement green computing as a step towards building 'Green Planet' and 'Environmental Friendly Business', including these 6Ws:

- What does green computing mean to businesses and individuals?
- Why there is a need for green computing?
- What are the various approaches to implement green computing that will help your organization take full advantage and benefits of computing?
- What does Green IT have to offer to businesses?
- What are the barriers – both real and perceived – to Green adoption and how to address them?
- What role can industry and government play all together to achieve economic and environmental sustainability?

Government and industry has a large part to play in all this. As concluded by OECD, only 20% of government and industry initiatives have measurable target. In short, there can't be a solution unless everyone – Individuals, Businesses and Governments across the globe participates in a major way.

What is "Green Computing?"

The Information and Communication Technology (ICT) has changed the way we live, think and work but at the same time, has an impact on our environment in several ways. This could have a negative or positive effect depending on the design of supporting policies.

As on Wikipedia [1]: *"Green Computing, Green IT or Green Technology is the practice and study of environmentally sustainable computing."*

And here is what Microsoft [2] said: *"Green IT simply means building an IT infrastructure that uses fewer resources — most notably energy."*

In other words, green computing is the environmentally responsible use of computing resources that reduces environmental footprints of technology. To promote green computing at all possible levels, the four complementary approaches mentioned below are employed

- Green Design – Designing objects and services that comply with the environment such as energy efficient computers, printers, green data centers etc.
- Green Manufacturing – The discovery and development of new products that reduces or eliminates the use or generation of hazardous substances in manufacturing.
- Green Use – Using resources in eco-friendly manner that reduces the usage of hazardous materials.
- Green Disposal – Re-making an existing resource or recycling e-waste with no or little impact on the environment.

As computing becomes increasingly prevalent, finite natural resources are rapidly being diminished and cost of energy is rising. This makes "Green Computing" an important and timely issue.

Let's dig deeper

What is driving 'Green' in IT?

In the recent years, companies have come to realize that using green IT is in their best interest, both in terms of reduced costs and public interests.

We have great gadgets and equipment to accomplish our tasks that make our lives more impressive and smooth. Today, the need for green computing is being driven by a number of factors such as, a growing behavior of eco-responsibility from the individual side and need for low capital expenditures (CAPEX) and operational expenditures (OPEX) in an organization.

1. Environmental Statistics – Our climate is rapidly changing and weather is becoming more extreme due to greenhouse gases such as CO2. According to The Organization for Economic Co-operation and Development (OECD) [3], in 1990 there was 6219524 tons of CO2 equivalent, thousands emission in USA which has been increased to 6487847.1 tons of CO2 equivalent, thousands in 2012.

Pollutant		Greenhouse gases					
Variable		Total emissions excluding LULUCF					
Unit		Tons of CO2 equivalent, thousands					
Year		1990	1995	2000	2005	2010	2012
Country							
Australia		414973.7	436863.96	489812.92	523479.26	540210.87	543648.45
Canada		590908.11	639072.03	721362.48	735829.05	699302.26	698626.47
Japan		1234320.1	1335888.3	1340522.6	1350321.4	1256094.7	1343117.7
United Kingdom		778805.3	726758.05	693693.37	678252.8	609147.47	584304.29
United States		6219524	6597665.2	7075609.4	7228293.2	6854728.2	6487847.1

The rapid increase in greenhouse gases is a problem because it is changing the climate faster and impacting the living things. To adequately address this issue, green IT can be a powerful solution since by using electricity as infrequently as possible, will reduce the carbon footprint.

2. Energy Consumption – According to The U.S. Energy Information Administration (EIA) [4], data centers heavily consume energy, between 1.1% and 1.5% of the world's total energy use in 2010. Another example is that the total primary energy consumption in United States in 1990 was 85.5 Quadrillion Btu which has been increased to 94.9 Quadrillion Btu in 2012.

Table: Total Primary Energy Consumption (Quadrillion Btu)						
	1990	1995	2000	2005	2010	2012
Canada	10.98094	12.21439	13.02112	13.84243	12.94674	13.29223
United States	84.48507	91.0291	98.81445	100.2815	98.01641	94.94583
United Kingdom	9.27058	9.4535	9.72914	9.81502	8.92321	8.49372
Australia	3.71364	4.03627	4.83336	5.8233	6.05912	6.14008
Japan	18.76828	20.94195	22.40915	22.57441	21.85216	20.4345
World	346.98299	364.5116	398.2769	454.0699	507.096	NA

More specifically, energy consumption (electricity or whatever form is used) is a major concern for many IT organizations since energy costs are increasing day by day. In order to reduce the demand for energy and new facilities, green computing must be used.

3. **Electronic-Waste** – E-waste includes electronic products such as computers, mobile phones, TV, fax machines etc. which are near the end of their "useful life".
According to StEP (Solving the E-Waste Problem) Initiative [5], E-waste is one of the fastest rising streams globally. The e-waste volume placed since 1990 has grown from 19.5 million tons to 57.4 million tons in 2010 and is going to triple the approximately 75 million tons in 2015.

   Only 15–20% of e-waste is recycled, and the rest of these go directly into landfills. This shows how vastly the environment is contaminated and green growth is going to die!

4. **Increased Costs** –The key issue for most of businesses is the rising cost of energy due to increased oil and natural gas prices since finite natural resources are rapidly being diminished. For example, According to Committee on Climate Change (CCC) [6], business energy costs will rise by around a third by 2030 in United Kingdom.

   Analyst Gartner [7] predicted that IT spending on data center systems has grown to 2.3% in 2014 as compared to 0.2% in 2013. That's why organizations are now realizing that the amount of their energy consumption for the business operation significantly contributes to their total spending and greenhouse gas (GHG) emissions.

Benefits of Green Computing

Why should you move to green computing? There are a plenty of good reasons but what makes more sense is that it allows you drive innovation and compute with reduced cost and lower impact on environment.

Before we move over to how to implement green IT practices, we should look at what it has to offer.

1. **Resource Utilization:** Green computing helps in efficient and effective resource utilization which includes infrastructure – office space, data centers, computers, light, electrical power etc. It helps reduce wastage of resources by matching them with the actual demand. For example, the systems with less workload using the same energy and resources can be further utilized into one with fair workload.

2. **Cost Saving:** As discussed, we are in the era where electricity prices are rising day by day since natural resources are finite. Green computing practices can help businesses reduce operating costs in areas such as energy consumption, administration, maintenance, disposal and recycling. For example, instead of adding or purchasing new IT assets to existing infrastructure, it's better to utilize the existing ones.

3. **Environment Sustainability:** Green IT ensures diversity and productiveness of biological system by reducing the negative impact of processes used in manufacturing a product through green design, green manufacturing, green use and green disposal practices. This reduces the impact of hazardous materials on the environment.

4. **Improved Social and Corporate Image:** Environmental sustainability can be a powerful Corporate Social Responsibility (CSR) action for businesses that help them build customer loyalty, strong brand awareness and differentiation from competitors**.** This better engages employees and they can become more committed to the company by participating in activities that promote green practices.

5. **Meeting Compliance and Regulatory Requirements:** Green IT helps businesses to improve their corporate image and environmental responsibility by meeting compliance, regulatory requirements, developments of laws and regulations in respective regions by offering eco-conscious products or services.

6. **Risk Management:** Risk management is the biggest concern for any business. Brand and reputation that takes decades to build can be ruined within few hours through practices against environment. Green practices can protect businesses against regulatory changes, rising fuel prices, public relations liabilities and the changing requirements of customer at large.

Beyond these cited benefits, green IT has the potential to offer more. The success depends on the collaborative efforts of all including – businesses, individuals and government.

How to implement green computing?

No doubt, technology plays an ever-larger role in our lives resulting in increasing energy demands, costs, and e-waste. However the good news is, by embracing simple, everyday green computing practices; you can easily save energy, reduce e-waste, and cut your bills!

5.1 Product Longevity and Lifecycle Extension

As natural resources are limited and fast depleting, it becomes important for manufacturers to create products having longer useful lives. The longer a product is in use, the fewer manufacturing needs to be created.

According to PCWorld [8], manufacturing, a PC accounts for 70% of the natural resources used in life cycle of a PC. However, it is a bit difficult to provide reliable and practical measures of a product lifetime, but average lifetime of a product can be measured and incentivized.

It is essential for businesses to understand why and how increased product lifetimes have become an important part in resource efficiency, energy saving and waste reduction for environmental sustainability. The businesses should look product longevity and lifecycle extension in terms of –

5.1.1 Upgradability of equipment: It is the ability of the product to have an improved functionality by replacement or addition of components. For example, when you bought your current desktop a few years ago it seemed like the latest thing, especially compared with the PC it replaced. Now that it's starting to feel old, what should you do about it? You can either replace it entirely or upgrade a few parts to make it work better.

5.1.2 Modularity of products: In context to product design, modularity is a technique that builds larger systems by combining smaller subsystems. The common modules will not only increase the chances of efficient reusability and recycling operation, but also offers ease of upgrade and maintenance, ease of diagnosis, repair and so on.

So what businesses can do, is just to prolong the equipment's lifetime. A smart buyer should always look for product longevity in terms of modularity and upgradability. *A well-made product would last longer than a less durable one that needs to be replaced sooner.*

5.2 Green Data Center – Energy Efficient Data Centers

According to The U.S. Energy Information Administration (EIA) [9], data centers heavily consume energy, between 1.1% and 1.5% of the world's total energy use in 2010. Another statistics from Green House Data [10] says that the data center industry sucks down over 30 GW of energy per year and increasing day by day. The carbon footprint of a medium 10 MW data center can range from 3,000,000 to over 130,000,000 or more kg of CO2.

A data center can occupy a single room, one or more floors, or an entire building. There was a time when finding enough physical space for the data center was a problem. Today, however, the scenario is changed; the problem today is that there is space but not enough volume to cool and power.

Here is the solution to this problem: Energy efficient data center, or more commonly known as ***Green data center***, is an enterprise level computing facility that is fully built, operated and managed on green IT principles (green design, green use, green manufacturing and green disposal) that save energy and have a lower carbon footprint on the environment.

Is it worth asking why green data centers?

Yes it is! Here are some reasons why companies want to invest in green data centers:

1. **Save energy:** Green data centers are the remedy for the businesses in order to save costs by reducing the energy consumption.
2. **Save money:** Green data centers reduce the requirement of additional network equipment, power and cooling, resulting in the reduction of both capital and operating costs.
3. **Resource utilization:** Green data centers are best capable of utilizing resources such as office space, electricity, light, air etc. in an eco-friendly way.
4. **Improve corporate and social image:** Green data centers can significantly improve the social and corporate image, since businesses have the opportunity to meet compliance and regulatory requirements to save the environment.

Here are few best practices to adopt Green data center practices [11] [12]:

1. **Determine and monitor your current energy usage:** In order to manage energy use, it is the first step to measure and quantify it. By doing so, IT executives can understand where the energy is actually being used within the data centers and what can be done to cope with the inappropriate and useless energy consumption.

2. **Consolidate your servers:** You can easily minimize costs by optimizing the use of existing servers instead of buying additional servers. Whenever you make a purchase decision, opt for the servers that follow green IT principles. Virtualization can also help consolidate servers and storage.

3. **Optimize server efficiency:** Simply making few changes to the existing servers on the green IT principles can significantly increase server efficiency and performance. CPU throttling is enabled on the server which is used to adjust the CPU speed to conserve battery and consume less energy.

4. **Use of energy efficient network devices:** Deploy low energy consumption network devices in the data center. For example, upgrading to high efficiency power supply units eliminates redundancies and inefficiencies with multiple AC/DC conversion units.

5. **Redesign cooling system:** The cooling system must incorporate outside air and operating temperature that reduces the energy usage up to a great context. Thermal profiling which is a complex set of time-temperature data should be used to identify hot spots and overcooling in data centers.

6. **Redesign air management:** To achieve efficient green data center, a good air flow management is necessary which would prevent recirculation of hot air exhausted from machine and IT equipment and reduces bypass airflow.

7. **Meet compliance and regulatory requirements:** Several initiatives may help the IT executives to identify and select the energy efficient equipment for data centers for example, 80 Plus standard certification for power supplies and energy star ratings. Several bodies regulate the Green initiative over the world such as ISO (International Organization for Standardization), USEPA (United States Environmental Protection Agency), TCO (Tjänstemännens Central Organization), NIST (National Institute of Standards and Technology), EU Guidance, and Energy Star.

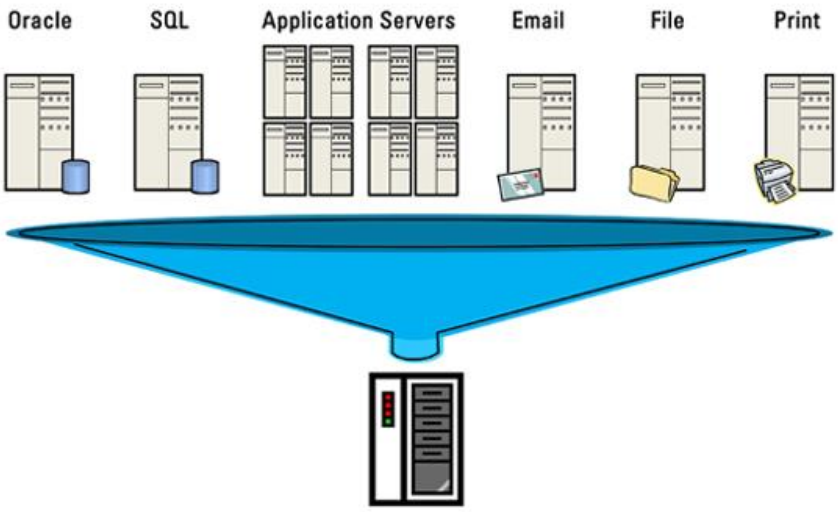
5.3 Optimize Software Deployments

The software used in the IT system has an impact on the amount of resources used. Better and optimized software deployments could significantly improve the resource utilization to make computers work more efficiently. Here are the ways to optimize software deployments -

5.3.1 Algorithmic Efficiency: Algorithmic efficiency is the property of an algorithm used in computer software that relate to the amount of resources used by the algorithm. The selection of the algorithm must be analyzed on the basis of its resource usage depending on:
Time – How much time the algorithm takes to execute and complete
Space – How much memory (RAM) is needed to execute the algorithm.

5.3.2 Scheduling, Resource Allocation and Scaling: These are methods that are used to maximize the use of resources in order to facilitate the execution of large scale complicated tasks. A scheduling algorithm is required to better utilize the computational tasks and the resources so that the system with light workload using same energy can be further utilized into the fair workload with less energy consumption.

5.3.3 Virtualization: Virtualization is the technique through which several operating systems and applications can run on a single physical machine, thus eliminating the need for a different machine for each and every operating system or application [13]. Each virtual machine (VM) is isolated from the others and utilizes as much of the computing resources.



Server Virtualization (Image Credit: Energy Star [14])

For example, server virtualization method can utilize every server up to 80% and reduce the hardware requirements by a ratio of 10:1 or better. Thus you have many applications on server, utilizing it to the best having a minimum number of server counts.

5.4 Power Management

A system operates in different power states with different power consumption rates. During idle periods, for example sleep or standby, it may consume less energy while, on the other hand, power-up operation may consume a significant amount of energy. The Advanced Configuration and Power Interface (ACPI) is an open standard that allows operating systems to directly control the power states of its fundamental hardware.

5.4.1 Energy efficient data center: Energy efficient data center includes air management, cooling system, heat recovery and electrical configuration in such a manner that reduces the energy consumption to a great level. Storage consolidation, virtualization, on-site electricity generation and waste heat recycling can be used for data center power management.

5.4.2 Energy efficient and Green use of personal computers: We all use personal computers in our daily lives whether it is home, office or other work place which is drastically increasing the energy demand, costs and wastes. According to Schneider Electric [15], an average desktop computer requires 85 watts just to idle, even with the monitor off. A computer left on 24 hours a day dumps 1,500 pounds of CO2 in the environment which costs you around $150 annually.

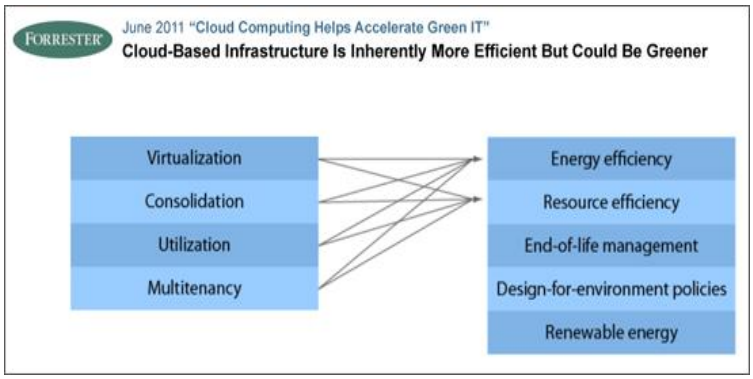
Here are some general tips that you can easily implement to save energy and reduce carbon footprint. [16]

- Turn off the monitor or even computer if not in use.
- Enable PC Power Management and sleep mode feature in your operating system.
- Screen saver doesn't save energy. So instead of using screen saver it is better to turn off monitor.
- Always use 80 plus certified power supply units in your PC.
- Use LED monitor over LCDs and CRT monitors.
- 2.5 inch smaller form factor hard disk drives (HDD) often consume less power per gigabyte than comparatively larger drives.
- The faster the GPU (Graphics Processing Unit), the more power it will consume. Use motherboard video output instead of a faster video card.
- Always use energy star labeled accessories. The greater the number of energy star, higher the efficiency and energy saving.
- Avoid unnecessary printing, view emails and other documents on screen instead of printing them out.

5.5 Cloud Computing :

Cloud Computing is way of delivering, consuming and producing IT resources via internet using one of the three service models - SaaS, PaaS and IaaS. This is recognized by governments and private sectors as a huge game changer for green technology. A report by Microsoft [17] found that large businesses could reduce their energy consumption, carbon emissions and its capital expenditure on IT resources by up to 30 percent by moving on premise applications into the cloud. Similarly, small businesses could reduce energy use and emissions up to 90 percent by using cloud instead of an on premise IT infrastructure.

For example, cloud services such as online shopping help people purchase products via internet without requiring them to drive and waste fuel to reach out to the physical shop. Another example is Teleconferencing, in which physically separated people meet and communicate using electronic communication channels such as telephone, radio or internet that reduces greenhouse gas emission related to travel, costs related to office space , light and increase employee satisfaction.



Cloud computing and its green benefits (Image source: Forrester [18])

Cloud addresses two major IT challenges related to Green technology – energy consumption and resource consumption. Whatever cloud service model is implemented, it has a lot more to offer:

- Resource utilization and consolidation of IT resources through Virtualization.
- Pay per as you go and anywhere, anytime access encouraging the green usage behavior.
- Green design for data center complying with industry and government regulation.
- Ability to scale up or scale down resources as needed.
- The IT resources are shared among many users, thus saving cost.
- Disaster recovery and better risk management.

Dynamic provisioning, multi-tenancy, server utilization, data center efficiency approaches are enabling cloud computing to lower energy usage and carbon emissions from ICT. Cloud computing is a viable, flexible and scalable technology that has a major impact on the global carbon emission.

E-Waste Management

The use of electronic devices has grown significantly over the last decade, changing the way we live, communicate and get information. Electronic waste or e-Waste includes discarded electronic appliances such as mobile phone, computers, printers, televisions etc. According to EPA [19], around 50 million tons of e-waste are produced each year in USA, out of which, 15–20% is only recycled, and the rest go directly into landfills, causing major environmental issues.

There are significant economic and environmental benefits of e-waste recycling:

1. It helps in preserving scarce materials.
2. It helps to minimize the impact of extractive industries.
3. It facilitates recovery of materials.
4. It helps reduce the resources and energy used in manufacturing a whole new electronic product.

Here are different methods that can be used for e-waste management [20] -

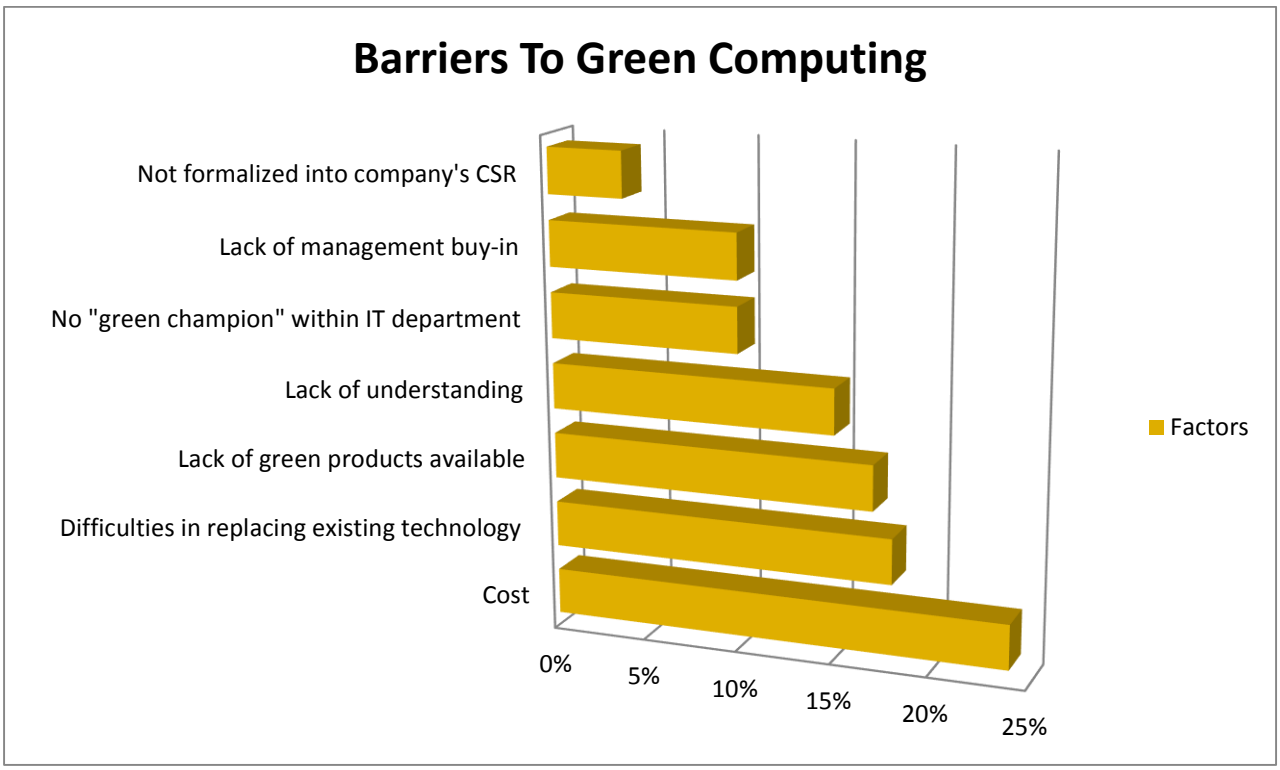
- Reusing and Donating: Individuals, businesses and households can contribute their unused electronic equipment to non-profits and charity organizations that can be reused. Reuse is not only an environment friendly option but also benefits society. As a business you can also take advantage of this donation in tax benefits under 21st Century Classrooms Act.
- Recycling: If you don't want to donate used electronics, you can send them for recycling to the certified electronic recyclers or Municipals Corporation. Recycling a product under green principles saves energy, reduces pollution and costs.

However before donating or recycling your electronics, you should follow these practices:

1. Try to upgrade your hardware or software in the device before dumping it off completely.
2. Delete all the personal or business data from your electronic device so that the sensitive information couldn't be exposed or re-opened.
3. Remove batteries, cells from the device since they contain hazardous material such as led, which need to be recycled separately. It is becoming more and more important for consumers and companies to properly recycle e-waste, promote positive social conservation, help prevent environmental impacts, and take financial benefits associated with recycling these materials.

Barriers to Green Adoption

As computing is becoming pervasive and costly, more and more companies are now investing in green computing, however, debate is still going on and there are some barriers that are obstructing businesses to adopt the green idea for the business processes. According to The Register [21], cost is the biggest barrier hampering businesses who want to adopt green IT. Survey respondents named the following key barriers:



Companies adopting green IT may face these barriers but they should figure out how to remove those barriers and facilitate the transition from interest to action. Going green isn't just for the businesses but also for the entrepreneurs, individuals and customers at large. Each should work collaboratively as well as independently to implement the green IT practices.

Regulation and Industry Initiatives

Governments and businesses have several programs and initiatives to deal with the impact of Information and Communication Technology (ICT) on environment. According to OECD [22], there are more than 92 programs and initiative on ICT across 22 OECD countries, out of which 50 were established by governments and 42 by industry associations.

Government Policies and Programs

An increasing number of governments have established initiatives to tackle the environmental problems. For example,

1. The US Environmental Protection Agency (EPA) has established the ENERGY STAR label program
2. Data Center Energy Efficiency Program (DOE, 2008) was established by the US Department of Energy (DOE)
3. The Ministry of Economy, Trade and Industry (METI, 2008) has established the Japan's Green IT initiative program
4. Denmark's Action Plan for green IT has been established by the Ministry of Science, Technology and Innovation (2008)
5. Chief Technology Officer (CTO) Council has established a Green ICT Strategy in United Kingdom (2008)
6. The European Commission (EC) has formulated "Addressing the challenge of energy efficiency through ICTs" (EC, 2008)
7. Asia-Pacific Economic Cooperation (APEC) has established Energy Standards Information System (APEC- ESIS)

Industry Initiatives

There are numerous industry initiatives by associations to reduce the environmental impact of ICT sector. These associations differ in the type and number of their members, objectives and overall impacts, categorized in following three categories:

- **Sector specific industry associations,** which only include companies within a specific sector. For example the European Telecommunications Network Operators' association (ETNO), the Consumer Electronics Association (CEA), and the Silicon Valley Leadership Group.
- **Non-sector specific industry associations,** which include companies from different sectors. For example the Global e-Sustainability Initiative (GeSI), Green Grid and Climate Savers Computing Initiatives.
- **Associations that promote standardization,** among members. For example the Institute of Electrical and Electronics Engineers (IEEE), The European Telecommunications Standards Institute (ETSI) and the Alliance for Telecommunications Industry Solutions (ATIS).

These programs and initiatives are not the only ones implementing the green IT practices but there is a wide range of other agricultural and social initiatives such as Digital GREEN initiative [23] in India that provides agricultural information to farmers through digital videos instead of using papers.

Our Approach

As a global cloud hosting provider, we at **AceCloudHosting** are committed to actively measure, report and continuously reduce our carbon footprint of activities by efficiently utilizing and optimizing resource usage, under following theme:

1. Green Infrastructure

Our IT infrastructure is designed for the best resource efficiency [24]. For example, maximum use of day-lights instead of using electric lights, use of solar lights, use of air quality management within the building and use of products that have long life and green certified.

2. Efficient Operations

We are committed to minimize the impact of our operations, with key focus on:

- **Energy management** by optimizing our energy usage and investing renewable energy sources to fulfill the energy demands.
- **Water management** by focusing on water conservation through proper water management system and awareness.
- **Waste management** by ensuring that we properly reuse, recycle and responsibly dispose each kind of waste - solid, wet, toxic and e-waste.

3. Employee Engagement

We encourage our employees, partners and customers to actively participate in green initiatives and friendly competitions. Organizing a cross company battery recycling challenge to collect old and dead batteries from all employees for the appropriate recycling, planting trees are few examples to keep them engaged and motivated.

At Ace Cloud Hosting, we are committed to compute more while consuming less and provide services that can make a positive impact on the environment we live.

About Author

Working as a technical writer and digital marketer at Ace Cloud Hosting, Deepanshu Gahlaut is an environmental enthusiast, bridges the techno-environment gap in promoting green computing practices. As an active writer and having 3+ years' experience, he has written many articles related to environment, cloud technology, marketing and startups. In his spare time, he loves to explore social media and read about the latest happenings in the world of technology.

About Ace Cloud Hosting

Ace Cloud Hosting powered by Real Time Cloud Services, LLC is a global leader in providing cloud services for over 10 years. Headquartered in United States, the company is well known for its Application and QuickBooks hosting services and ranks amongst the most trusted providers for CPAs, Accountants and SMBs. Possessing SAS 70 compliant, Type 2 and Type 4 data centers in United States, we aim to deliver our customers with the best cloud services having minimal impact on environment.

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