A Perspective Analysis of Green IT

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***Abstract*— The unabated thirst for energy is a recurring story in news headlines every day. Some developing nations are even struggling to meet up their power requirements. Energy consumption however has negative fallout on our atmosphere in the form of outflow of dreadful carbon dioxide to the environment. This leads to global warming, melting of ice, and climate change. People in different parts of the world are forced to relocate to safer places due to accumulation of greenhouse gases due to uninhibited usage of carbon-based energy. Nations, as a way of fitting response to this sickening trend, are formulating and firming up promising plans, processes and policies to sharply improve energy efficiency across the spectrum and to reduce greenhouse gas emission. In short, the goal is to have clean, green, and safe environment. Environmental degradation has to stop forthwith. Every individual and institution has to look inside objectively to devise methods and strictly follow them to quickly combat this menace otherwise a greater catastrophe is to befall on us sooner than later.**

ICT assets consume more energy in their everyday operations and obligations contributing greater risks and dangers to the existence of total human society. Today ICT is the prime enabler of every business type and it has become an inseparable companion of every individual. Enterprises in order to meet their growing IT needs have been accumulating numerous sorts of power-hungry servers, storages, network connectivity solutions and facilities in a central place in the form of data centers and server farms. Therefore the urgent need is to unearth energy-saving technologies, methods and practices and leveraging them to the core in order to minimize and moderate energy usage and wastage, which is highly problematic for human subsistence in the long run. In a nutshell, the significant outcome of this pervasiveness and uninhibited penetration of IT into every single and tangible domain purposefully and powerfully is heightened energy consumption and the resulting heat dissipation leads to unrestrained outlet of dangerous carbon dioxide (CO2). As nations are ready to combat the impending catastrophe due to climate change, green movement (environmental sustainability) is getting more perceptible and popular. Though IT is touted as the main sponsor for this predicament, yet IT is being recognized as the enabler of green revolution for the earth planet. In this paper, the details of how IT can be smartly leveraged for energy conservation & world community would be covered. Further the impact of cloud computing for the important goal of environmental sustainability has been briefly highlighted.

Keywords- Green IT, cloud, ICT, clean environment, carbon dioxide, IT assets

I. INTRODUCTION

In view of increasing IT business growth, it is essential to effectively design, build and maintain the data centers (DC) to minimize the operational cost without compromising on quality and green IT concept. DC could use high power capacity per square feet since they provide online collaboration and offering key opportunities for savings in both costs and reducing carbon emissions. Green data centers are important to meet business demands and reduce environmental impact. Power minimization and cooling capacity are the key factors to be focused with reference to Green IT.

Definition of Green Data Centre is as follows: A data centre designed and/or operated for optimized energy efficiency and minimum environmental impact Extracted from SS 540:2010. Data Centre design should incorporate the following:

- Establishment of Green DC Standards:
- Establish policies, systems and processes to improve the energy efficiency of data centres
- Reduce data centres energy consumption and operating costs
- Enhance data centres competitiveness
- Lessen data centres impact on the environment

There is an urge to push data centres to Green IT and also emphasize to increase the certification of staff by establishing relevant guidelines. There are several programs between government and industry to meet the data centre requirements and realized that this would lead to significant savings in operation cost of data centres. There is a need to provide a framework for DC to establish systems and processes to improve energy efficiency and achieve improvement in their facilities. It is suggested to recommend metrics and best practices for DC efficiency. Further it is recommended to align with current international efforts and best practices/standard which can be implemented by all DCs (due to constraints on the building / shared cooling system).

There are several challenges faced by data centre operators in view of fast catchup with the latest technologies (Fig. 1). In view of various data centre related categories, it is essential to look into the green IT initiatives with reference to virtualization and servers/data centers consolidation (Figs 2 & 3).

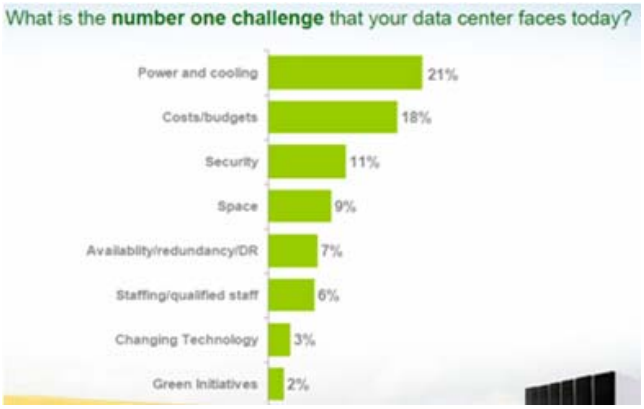

Fig 1: Data Centre Challenges (Source: Green Data Center Survey 2008 IDC No 504)

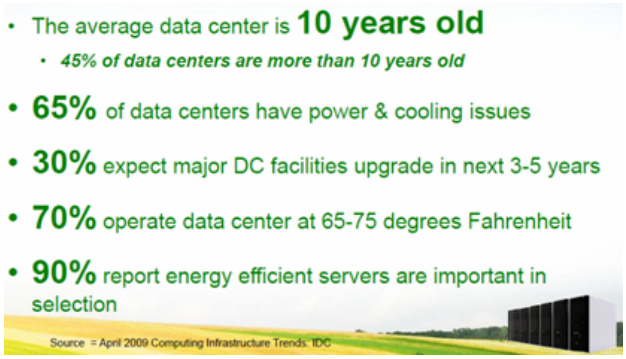

Fig 2: Green Data Center Issues Category

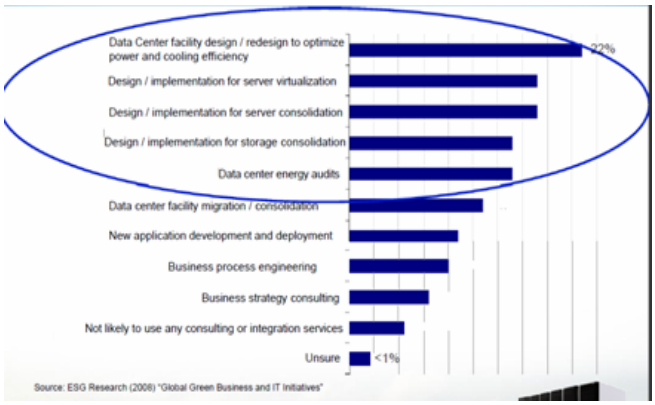

Fig 3: Services requested by IT Manager

The below figures (Figs 4 &5) indicate Data centre related operational cost rise over a period of time, and the best practices to reduce energy consumption. While specifying the requirements for the management of DC, there is a focus on energy efficiency and other aspects applicable to the DC industry. This is not only applicable for both DC services provided as in-house support to organisations and those provided as outsourced services to clients. There is a need to cover key aspects governing the management of electrical systems, mechanical systems, IT equipments, design of DCs etc with supplementary reference to help DC operators identify and implement measures to improve energy efficiency.

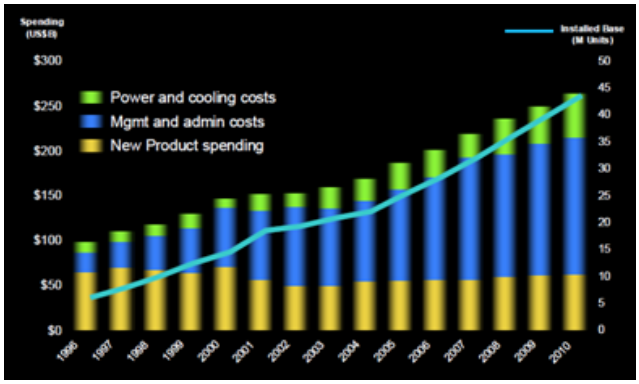

Fig 4: Data Centre cost and complexity of the rise (Gartner 2011)

Action	Savings	How
Virtualization/ Consolidation	10-50%	Push server performance to 65% (CPU/Workload utilization) Reduce physical footprint – High Density & Blade Servers
Air economizers	4-15%	Use outside air whenever possible (free-cooling – geography). Enable economizer mode in existing equipment.
Right sizing	10-30%	Build and provision IT only what you need today — optimize power & cooling to support current IT – expand when needed.
Air Management	5-12%	Hot aisle/cold aisle - reduce/optimize air movement (distance).
Power equipment	4-10%	Best in class UPS. Focus on light load efficiency, not full load.
Cooling	7-15%	Row and rack-based cooling for high density servers. Higher return temperature modeling – auto CRAC unit control.

Fig 5: Best Practices to reduce Energy Consumption (Gartner 2011)

Benefits of Green IT Data Centre are listed as follows:

Save Cost

- Eliminate costly infrastructure with a self-contained, high-density, cost-effective and energy efficient data centre.
- Reduce the costs to plan, build and implement your data centre
- Reduce overall operating expenses

Save Energy

- Patented closed loop cooling dramatically cuts cooling and electrical costs
- Significantly reduce data centre's harmful carbon footprint

Save Time

- Micro-Modular Data Centre's can be built, fully populated and delivered in weeks vs. months or years
- Have a fully functional data centre when, where and for however long you need it

Save Space

- Reduce your data centre footprint by up to 70 percent

Supplementary metrics for more specific diagnostics (based on work done by the US Lawrence Berkley National Labs (LBNL), The following are some of the metrics guidelines to be considered to establish baseline information.

a) Airflow Management Metrics: Temperature: Supply and Return, Return Temperature Index

b) Cooling Metrics: Data Centre Cooling System Efficiency

c) Electrical Power Chain Metrics: UPS Load Factor, Data Centre UPS System Efficiency, IT of Server

Equipment Load Density

Best Practices for Management of Mechanical Systems Cover areas such as: Humidification / dehumidification, Management of CRAC, Airflow Management, Data Management, Best Practices for Management of ICT Equipment, Selection of ICT Equipment (IT industry trends 2011)

- Use of hot aisle / cold aisle configuration
- Apply supplementary cooling
- Position supply and returns to minimise mixing and short circuiting

Cooling Management

- Best Practices for Management of Electrical Systems, Electrical Infrastructure
- design of UPS system for efficiency

Lighting

- •reduce lighting power use through use of sensors and better lighting circuiting and switching design
- •Select ICT equipment for energy optimization

Deployment of New ICT Services

- Optimize the number of ICT equipment for a new ICT service

Covers areas such as: Management of Existing ICT equipment and services. And Best Practices for Design of Data Centre Resilience Level and Provisioning

- Build resilience to business requirements

Built-in Monitoring Capability

- Metering of total energy consumption
- Metering of total ICT energy consumption

Design of Facilities Data Centre Layout covers the following areas:

- Statement on moving to green standards
- Commitment to comply with related requirements including legal requirements
- Must include a framework for setting green data centre objectives and targets
- Disseminated to staff
- Must be reviewed (usually at the Management Review) for continuing suitability

In the planning stage, steps such as 1) Perform energy review, 2) Establish energy baselines 3) Set policy, objectives and targets and action plans for achieving energy improvement to be followed. Next, Optimise design and operations for energy performance by adopting best practices etc. Ensure competence, training & awareness of personnel, document and communicate green DC requirements, and consider energy efficiency in design and purchasing

For Check phase, 1) Monitor DC operations that can affect energy performance, 2) Conduct internal audits of green DC management system, 3) Identify and implement corrective and preventive action to deal with nonconformities, 4) Review green DC management system by top management, 5) Decide and act on changes to management system, energy policy, objectives and targets etc. and 6) Allocate resources for carrying out action items arising from review

Further documenting the below are quite important, and Organization shall establish a procedure to control & maintain its documentation.

- Description of the scope of the energy & environmental management system;
- Description of the main elements of the energy & environmental management system and their interaction, and reference to related documents,
- The green data centre policy;
- Objectives and targets including those related to significant energy usage (and other significant environmental aspects as appropriate);

It has been clearly shown that data centre related green energy saving would lead to significant cost saving up to 30%. Hence there has been lot of Green IT initiatives recently as described in Fig 6.

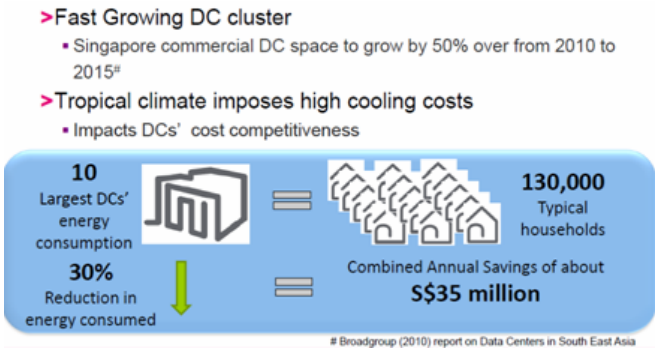

Fig 6: Data Centre Green Initiatives

Fig 7. Green Efficiency of Data Centre (ICT 2011)

The regression model predicts Power Usage Effectiveness (PUE) value based on IT energy. Predicted PUE value is then compared with actual measured PUE. If actual PUE lower than predicted PUE means data center is doing better than average. The rating system maps the difference in actual PUE and predicted PUE on a 1 to 100 scale. Data centers that achieve a score of 75 or higher are awarded ENERGY STAR for data centre label (Ronnie Lee, 2010; Phillip 2011).

Benchmarking data for data centres would be based on the following factors (Metricsll, 2009).

- Measure of amount of useful work done per unit of energy consumed by data centre
- No single holistic metric exists today
- The Green Grid and Japanese Green IT Promotion Council's efforts to develop one through Global Harmonization efforts
- Power Usage Effectiveness (PUE) metric by The Green Grid
- Most widely used and accepted
- Focus on Data Centre Infrastructure
- Does not cover Energy Efficiency of IT equipment and IT processes
- A good metric to guide self-improvements at data centres but not to benchmark with peers.

It is inevitable to make the environment as eco-friendly by standardize the working environment and automation and efficiency of organization compliance with environmental regulations. Areas of improvement that can aim to further energy efficiency by implementing relevant solutions to improve business and environmental benefits through cost and energy. Increasing process efficiency is fundamental to ensure business sensibility in all aspects. The first step is to think holistically about what IT can contribute across the business.

There are several factors that help to achieve green IT by reducing environmental impact through virtualization, less power consumption, data centers consolidation, power reduction etc. Reducing IT function related energy would lead to several business benefits including tangible and intangible. Organistion related IT transformation initiative to be changed to Operational objectives . Green IT initiatives have to focuss on delivery oriented benefits that covers famous principles such as Reduce, Reuse and Recycle that covers the following:

- Reduced energy costs both through lower usage and more efficient operations of equipment.
- Streamlined IT processes to reduce cost inefficiencies and decrease environmental impact.
- Increased collaboration and more efficient interaction with suppliers and customers, reducing the carbon footprint on both sides.
- A more mobile and agile workforce enabled for flexible and remote working, further reducing carbon emissions from unnecessary travel.
- Greater corporate citizenship credentials and increased brand value through a demonstrable commitment to environmentally aware operations.

All the above mentioned benefits generated through the advances would have a collective effect of moving the organization to higher level and thus improver green business model through overall level of process efficiency.

II. OBJECTIVES AND PROCESS

Green IT is designed to highlight quick wins, quantifiable benefits and longer-term opportunities, thereby providing the Top Management with the basis and rationale for further action. Furthermore, its explicit assessment of the potential gains helps to create traction and credibility both internally and externally. The tool is also designed to support a focus on best practice in IT's efforts to reduce the organization's environmental impact.

There are 3 stages involved as follows: Initial Assessment, Detailed Assessment and Outputs. The ideal framework is to underpin a holistic approach that will boost the perception and contribution of IT to the green agenda.

These are:

Initial Assessment: This provides a rapid assessment of an organization's green maturity and identifies, at a high level, the changes that should be made.

Detailed Assessment: Using the output from the initial assessment, specific assessments are carried out in areas identified as weak. Depending on the organization's requirements, various levels of analysis can be undertaken. The deeper the analysis, the lower the level of assumption in any business case proposal.

Output: Based on the results of the detailed assessment, recommendations for specific actions can be produced, along with a tailored road-map for implementation.

Government needs to assist in the development of innovative technologies, promote the dissemination of energy-efficient technology and products. Also standardize the measuring environmental contributions, and collaborate with overseas organizations through international partnership. Some of the examples for achieving Green IT are as follows:

- 30% or more reductions in power consumption of routers
- 30% or more reduction of power consumptions of data centers (servers, storages etc)
- Reduction of number of servers to manage the usability and efficiency.
- Optimize IT investment by consolidating the machines of low hardware usage with powerful servers of required virtual machines.

III. KEY AREA OF FOCUS

There are several key areas to be focused with reference promote and support Organization green agenda. The future challenge is to focuss and target efforts to exert influence of most areas. IT can have the most rapid and demonstrable impact on energy consumption and thereby on the corporation's green agenda.

A. End user working practices

Top management can play a pivotal role in driving forward employee/customer behavior change. IT's most obvious potential contribution is to enable people to work remotely by providing 'thin client' and web-enabled business services. In some cases, this may help to avoid the emission of millions of tons of carbon from transport by enabling employees to work from home or other locations. Furthermore, web enablement creates process efficiencies and reduces paper usage. People can also be encouraged to conserve energy through their behavior, such as turning off computers after use (rather than leaving them on standby), recycling waste, and only printing documents when absolutely necessary. Smart logistics principle of using as little packaging as possible, and organizing shipping and couriers on a consignment, rather than individual order, basis can make a further contribution to saving emissions. However, it is important to stress that transforming users' behavior requires more than just changes in technology. For example, there is little point in changing default printer settings for employees if they are simply going to override them. Initiatives such as switching off laptops when appropriate or printing as little as possible can save substantial amounts of energy and other resources, but the full potential benefits can only be realized by undertaking the necessary infrastructure change and then proactively educating people to take advantage of it.

B. Office environment and equipment

More energy-efficient office equipment such as multi-function and double sided printing devices can create significant savings in consumables such as paper and toner, as well as cutting energy consumption. Efficient cooling and heating systems, including using underground water for cooling, can also make a contribution, as can ensuring that office equipment, computers and lights turn off automatically when not in use and at night. Using IP links for all communications including VoIP to replace traditional phone landlines can reduce duplication in office cabling, whose production and installation impose costs on the business and a heavy burden on the environment.

C. Office infrastructure/data center

This focus reflects the current mainstream agenda around many of the green IT initiatives. Effective strategies such as virtualization, standardization, orchestration and automation can enable the data center infrastructure to deliver the same level of processing with a smaller footprint. These methods are often applied with an 'intelligent systems refresh' approach, enabling IT to shrink the carbon footprint of its hardware infrastructure, even as demand for IT processing continues to rise. Server consolidation and application renewal can extend the life of existing systems and limit investment in new equipment. In this context, the traditional mainframe has emerged as a relatively efficient model, owing to its high level of reuse. Optimization of processing takes place which can also help to tackle energy inefficiency, while smart scheduling of computer usage may reduce energy consumption and costs significantly.

The trend for enterprise data centers is towards off-the-shelf, more powerful CPUs with more cores and memory which are better suited for running multiple applications in a virtualized environment. Using low power CPU and components to lower OPEX by providing high power efficiency in standard platform that reduces power consumption during normal or idle operation & eliminates inefficient server fans. Majority of enterprise data center operators don’t buy thousands of servers at a time; which the IT vendors will design and build to their specifications.

The 2010 European Code of Conduct includes best practices for purchasing IT equipment and software.

(including compute, networking and storage resources). Energy cost saving is based upon the following factors:

Energy efficiency at peak as well as at expected utilization levels;

External control of energy use including clock speed, maximum energy use or remote shutdown of components, sub-systems or the entire system;

Installation with on-board power management features enabled at the BIOS, operating system and driver levels.

Finally, real-time monitoring of IT hardware/software utilization levels using CPU utilization as a proxy is also encouraged.

Energy savings based upon purchasing more efficient equipment than average ENERGY STAR Servers, achieving higher than normal industry consolidation levels and using power management techniques to control server energy use. U.S. Green Building Council (USGBC) adapted LEED rating systems to provide cooling and power system efficiency standards & best practices for reducing IT energy in data centers. This would provide calculation methodology to baseline IT energy and potential energy savings for servers using CPU utilization as proxy for workload.

Server manufacturers and data center efficiency experts believed that most data centers can run hotter than they do today without sacrificing reliability while saving cooling energy. A higher temperature setting can mean more hours of "free-cooling" possible through air-side or water side economizers. This is especially compelling to an area like Silicon Valley, where outside air temperature is 21°C (70°F) or below for 82% of the year. Provided that elevated server inlet temperature doesn't result in additional, unnecessary consumption in the server fans or other components of the cooling system such as the pumps and compressors. Thus more Data Centers are operating at Higher Temperatures if not monitored properly.

Data center temperatures have been kept low to offset the mixing of re-circulated hot air from the IT equipment discharge with the cold air supply to keep the server inlet temperature within the recommended range. Air Flow containment can effectively reduce the mixing of hot and cold air and allow for a safe, practical temperature increase. Containment or raising server inlet air temperature in of itself does not save any cooling energy.

Gartner (2011) revealed that energy-related costs account for approximately 12 percent of overall data center expenditure and are the fastest-rising cost in the data center. Data center operators will increase their focus on controlling their energy consumption and costs. Measurement of energy-related data including continuous PUE readings will be required for all new large data centers. By 2015, Gardner expects that most new large data centers will measure environmental & energy-related data across the building, the critical power and cooling systems and the IT equipment.

Basic components of data centre maturity model are shown in Fig 8(a). This clearly listed out the categories components under facility and IT which affect the Green IT. It is important to have proper control of the listed components which will lead to the category of data centres as listed in Fig 8(b). Also thermal maturity model based PUE categories have been listed in Fig 8(c). Lower PUE values indicate the good green environment maintained data centres since there would be lot of energy consumption.

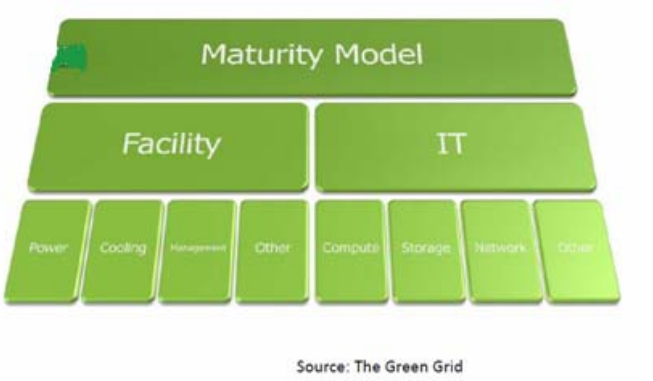

Fig 8: (a) Data Centre Maturity Model

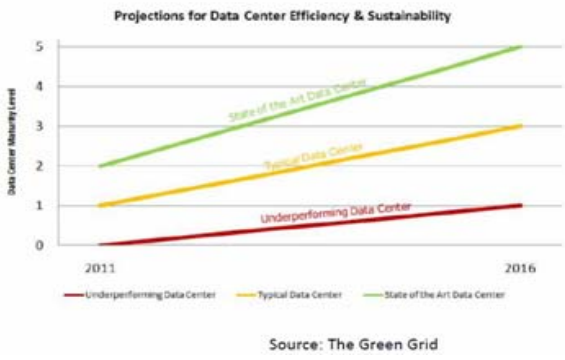

Fig 8: (b) DC Maturity Model – Path to Maturity

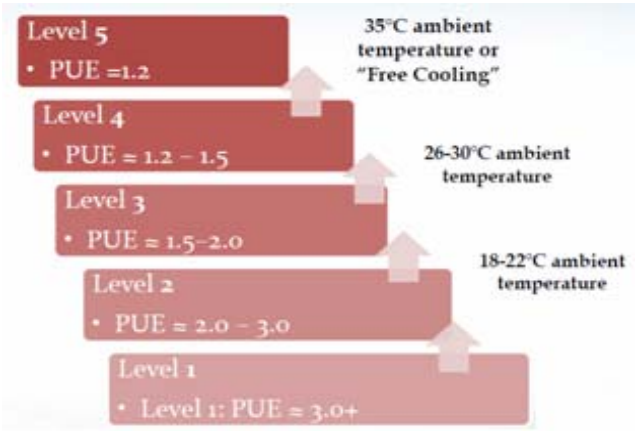

Fig 8: (c) DC Thermal Maturity Model (Source: Intel Corp, Data Center Dynamics, 2010)

D. Green Printing

Xerox, Fax and Printing machines are the most common devices widely used in various industries. It is essential to go for energy saving printers and also to save less paper while printing. Some simple techniques such as duplex printing, consolidating old printers into new, efficient units, disabling color printing except when color is required, and using recycled paper are some of the easiest ways to go green. Also retaining fax copies in the centralized storage system and use of soft copies is always suggested to improve the green working environment.

It has been noted that 15 to 20% of papers wasted by staff who print but not collect the materials from the machine. This kind of waste could be minimized by moving for secured password option so that staff needs to go near printers or Xerox machines and key-in the password. This process will force the staff to collect the print outs or Xeroxed materials without any waste.

Also a centralized system of controlling staff movement over regional offices will allow the staff to automatically switch over to corporate setup and this does not need any tedious configurations. This will provide facility to users who are mobile frequently.

The following are some of the suggestions for improving the green environment.

- Use of recycled paper would reduce the waste and provision for draft work save paper significantly.
- Duplex printing and multiple pages printing on single page will lead to reduction of paper usage by 50%. Also this significantly reduces the waste reduction.
- Print infrastructure consolidation and black & white printing would reduce the power as well as maintenance cost usage & toners usage respectively.
- Digital storage of documents would be the better option rather than keeping hard copies which will reduce paper usage, less power and maintenance cost, space utilization, toner usage, and equipments etc. Further provisioning the same through centralized infrastructure system would allow the global offices staff to effectively access the system.
- Communication channel related savings is quite significant and this will save staff travelling related cost, flight related fuel savings, staff travelling duration (especially for mobile resources) etc. This constraint could be managed through proper audio and video conferences setup in various organizations. Apart from Green IT related aspect, the above proposed measures would lead to increase the productivity of organizations.

E. Procurement

This is potentially the broadest area for IT's involvement, and requires a holistic view all the way along the supply chain and into suppliers' and customers' operations. The focus should be on energy efficiency throughout the procurement life cycle, from acquisition, via usage, to disposal.

F. Corporate citizenship

Environmental risk, responsibility, reputation and compliance are now pivotal areas of focus in an organization's overall efforts to act, and be regarded, as a good corporate citizen. By taking a central and proactive role in executing the green agenda, IT also positions itself to help build responsibility internally across the workforce, and communicate it externally to the wider community of stakeholders. Investors and analysts, for example, now take a keen interest in companies' environmental performance and by pursuing initiatives of the kind outlined above

Employees also value working for a responsible business. The real cost of cheap servers Data center energy consumption worldwide has doubled since 2000, with an abundance of cheap commodity servers driving the installed server base up from 14.1 million to 27.3 million worldwide between 2000 and 2005. With energy costs continuing to rise, Moore's law addresses the space constraints, leaving power and cooling as the limiting factors. This means conducting a diagnostic across all five of the areas highlighted above, enabling IT to benchmark the organization's current performance and maturity in energy efficiency, and to identify focus areas for improvement.

The latest technologies such as virtualization and cloud computing plays a significant role in consolidating servers and thus reduces the emission of carbon dioxide. Alternatively the above process also helps to lower the power supply requirements in view of reduction in the number of servers and related network devices.

A project cloud hub has been setup with an investment of US $1.3 million as part of ICT environment. This cloud has been setup for our leading supply chain and logistic customers in the form of private cloud. A reduction of annual maintenance cost of electrical energy of $ 215000 million revenue. Further total cost improvements of about $ 574000 have been achieved.

Conclusion

It is essential to make all data centers as Green Cloud Data Center. Further set and standardize Green IT program for all data centers across the regional countries. In future, evaluation and rating of data centers will be more popular and new energy conservation indicators for evaluating data centers to be discussed in domestic and international arenas. It is essential to strive for green data center with environment conscious and high performance features. The future buzz words for next generation data centers are ‘Green’, ‘Cloud’ and ‘’Global. To achieve sustainable corporate development, implementation of environment-oriented management is essential for supporting customers and investors. It is essential to continuously integrate advanced approaches and existing technologies.

REFERENCES

[1] Data Centre design (2010), Extracted from SS 540, Singapore.

[2] Data Centre Dynamics (2010). Intel Corporation.

[3] ESG Research. (2008). Global Green Business and IT Initiatives. Gartner (2011). Green DC program (2011), Singapore

[4] Green Data Centre Survey (2008). IDC No. 504.

[5] http://hightech.lbl.gov/benchmarking-guides/docs/datacenter-benchmarking-guide.pdf (2011). Self-

[6] benchmarking Guide for Data Center Infrastructure: Metrics, Benchmarks, Actions (2010), Report no:6-28-10, Sponsored by Nyserda, USA.

[7] IDC (2009). Computing Infrastructure Trends, April, 2009.

[8] IT Industry Trends: Data Center Energy Efficiency Standards Development, Data Center Energy Efficiency Design Trends, Which Design Trends Fit the Best for You, ICT 2011, Singapore.

[9] Marty Poniatowski. (2010). Foundations of Green IT - Consolidation, Virtualization, Efficiency, and ROI in the Data Center,

[10] Metrics ‖ (2009). How to Use the DCiE and PUE, Gartner research report. Published in 23 Feb 2009.

[11] Philip Sy (2011). SS 564:2010 - What is it? Green Data Centre Standards Working Group, Singapore

[12] Ray Pfeifer (2011). Keynote Address; Data Center Design Trends, One size doesn't fit all, 31 Mar 2011, ICT, Singapore.

[13] Report on Data Centre in South East Asia (2010). Broad Group.

[14] Ronnie Lee, WG. (2010). Future Directions from the Green DC Standards, Green DC Standards Work Group, ITSC.

[15] The Green Grid (2009). Technology & Strategy. M Paterson and R Jones (eds.,)