

Make IT Green- The TCS Way

Green IT is creating a buzz these days, with a wide gamut of vendors -hardware suppliers, software developers, vertical integrators, service providers and customers- talking about the green activities and products in their organisation. This article seeks to articulate what TCS means by Green IT, together with identifying the key business drivers and the growing business opportunities in Green IT.

Green IT's benefits are innumerable. It spells efficiency and cost savings for not only the IT organisations but also various disciplines such as manufacturing, engineering services, transportation and more. It is also critical for regulatory compliance with the growing number of environmental policies across diverse geographies.

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What is Green IT?

Information Technology (IT) has, without doubt, substantially improved business productivity and enhanced the overall quality of our lives. Consequently, there has been a proliferation in the number and size of IT facilities, the equipment and people working in these facilities. This growth is placing a tremendous burden on our environment, both in the consumption of natural resources such as fuel, water and other raw materials as well as in greenhouse gas emissions and the waste that is generated. This phenomenon is raising several red flags in the minds of corporate executives, governmental organisations, environmentalists and the broader public, thus leading to green IT initiatives. At TCS, we classify these initiatives into two broad categories, which together capture our view of Green IT:

- How can we mitigate the environmental impact caused by the growth in IT? Solutions for reducing the power consumption of IT equipment, e-cycling, environmentally friendly buildings and other related elements fall in this category.
- How can we use IT to enhance the environment and to mitigate the environmental impact of other industrial, logistical and business processes? Technological solutions for telepresence/telecommuting, Geographic Information Systems (GIS) for environmental studies, engineering design of industrial processes with computational models for energy efficiency and waste reduction fall in this category.

TCS has many internal initiatives as well as customer engagements in both these categories.

There are several corporate social responsibility and cost efficient green initiatives, which are not necessarily pertaining to IT. Many such efforts are in progress at TCS, and some of these are explained below. Please refer our Corporate Sustainability Report [1] for more details.

TCS Corporate Sustainability Highlights

There are several green practices employed across TCS facilities. These include opportunities for (i) energy savings (for example, energy efficient LED lighting, sensor based light turn on/off, building design for cooling efficiency, automatic cooling system modulation based on need and load, alternate energy for lighting and cooking), (ii) reducing water consumption (for example, recycling, rain water harvesting) and ground water recharging, (iii) waste reduction (for example, paper reduction, composting and digesters for bio waste) and (iv) fuel and emissions reduction through cycling, car-pooling and buses. At TCS, we have made significant strides across all these fronts, leading to 12.5% reduction in electricity consumption, 76 MWH of solar energy generation, 1.5M cubic metre of water reuse, 28% and 67% reduction in paper and printer cartridge consumption, leading to a 2% reduction in the carbon footprint in FY 07-08 compared to the prior year. This has been achieved through corporate level policies, raising awareness of our employees, setting targets and achieving them systematically, and obtaining ISO 14001 [2] certification for 22 of our delivery centers and LEED [3] green building certification for 3 locations.

Green Business Drivers

The key business drivers for Green initiatives include:

- **Cost Reduction:** Increasing energy and fuel costs, together with the cost of other raw materials used in infrastructure construction and operation has led to opportunities for exploring green alternatives that can substantially lead to cost reduction. Reducing power consumed by IT equipment, energy efficient lighting and cooling, alternative energy sources, recycling and telepresence can help improve the bottom line in corporate balance sheets.
- **New Business Opportunities:** With the growing need for employing green products and processes, there are several business opportunities to promote (i) environment-friendly products such as low power hardware, (ii) services for assessment, transformation and management for setting and attaining environmental impact targets and (iii) streamlined business and operational processes for increased efficiency. Products and capabilities that have environment friendly features offer a competitive advantage in the market. For instance, performance per watt of a server is now being used as a marketing pitch as opposed to just raw performance.
- **Corporate Social Responsibility:** Many corporate policies now include targets for reducing their impact on the environment. With IT – equipment, infrastructure and people – constituting a significant footprint of any industry today, identifying and reducing its impact is becoming very important. Green IT is thus as important to an industrial manufacturer as it is to a telecom or an IT services organisation.
- **Regulations, Incentives and Standards:** The environmental policies in different geographies can be broadly classified as regulatory (bans, permits and standards), economic (incentives for adherence and reduction) and informative (environmental reporting, audits, product labeling and so on). Green IT awareness and concerns are leading to legislations along all these fronts. Specifications for adherence to ENERGY STAR [4] ratings for a variety of IT hardware are effective since 2007 in USA. Optimising the carbon footprint of IT is also becoming important for acquiring environmental certifications. Penalties by policing agencies to enforce carbon credit adherence is another motivating factor for Green IT initiatives. Many incentives are being offered by the governments (tax incentives) and utility companies to undertake projects such as cooling system retrofits, equipment consolidation and self-generation through alternate sources, to offset some of the investment costs for undertaking these transformations.
- **Public and Customer Perception:** Widespread awareness is likely to lead to preferential choices in vendor selection based on Green IT practices. A successful Green IT strategy is largely dependent on an end-to-end adherence across supply chains [5], together with sharing the best practices in organizations across the supply chain

The chart in Figure [1] from Gartner shows that corporate executives expect both financial and public relations payback, with green being an important competitive advantage while not serving as a cost burden.

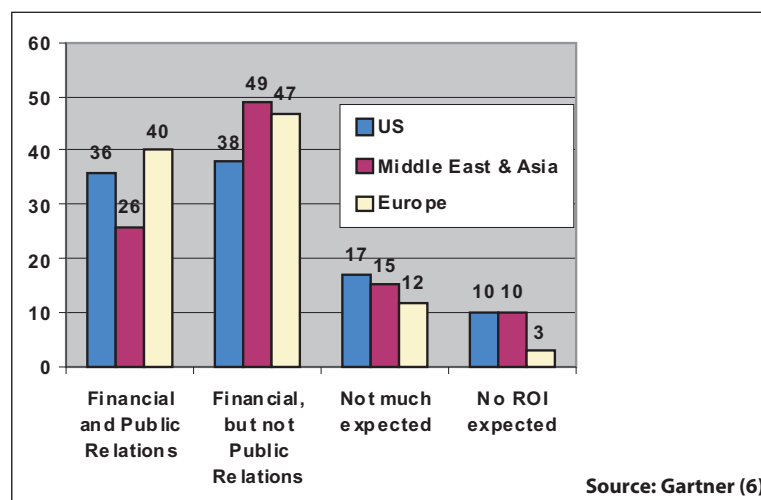


Fig. 1 Percentage of senior executives who expect ROI on Green IT Investments

These business drivers have led to a considerable buzz around Green IT. Apart from numerous conferences across the globe on this topic, a Google search reveals over 16000 web pages from the .com domain with Green IT in the title, and over 2 million hits on this keyword occurring anywhere in the page of a .com site. As per an IDC survey [7], over 80% of corporate executives say that Green IT is gaining more importance in their organisation. Over 63% of the Global Fortune 500 companies are already reporting greenhouse gas emissions using the Corporate Standard of the Greenhouse Gas Protocol Initiative [8], which has also now become the basis of the ISO 14064-I reporting standard.

Mitigating the Environmental Impact of IT Growth

This section details the two main IT induced environmental problems of energy consumption and waste generation.

Power Consumption of IT Equipment

The annual expenditure on powering IT equipment across the world was estimated at \$7.2 Billion in 2005, with the number doubling over five years [9]. As IT takes on more critical roles, data centres are becoming larger and more power consuming. There is a proliferation of desktops and laptops across the enterprise personnel. One spends almost as much on powering a server over its lifetime as procuring the server. With hardware costs dropping, and energy costs rising, the severity of this power problem is only likely to get worse. Although hardware and software vendors are employing power management tricks such as voltage and frequency scaling, clock gating [10], dynamic speed modulation of disks [11], and exploitation of different sleep modes based on activity patterns, the problem persists because of the proliferation of computing devices at all granularities – increasing number of transistors on chip to numerous blades and disks in a rack, and growing number of racks in a machine room. Compounding this problem is the power consumption by the cooling infrastructure required to remove the generated heat which is essential to ensure reliable operation in the data centres. In addition to replacing existing equipment with less power consuming (as measured by performance per watt) devices, a systematic and continuous power management strategy is required.

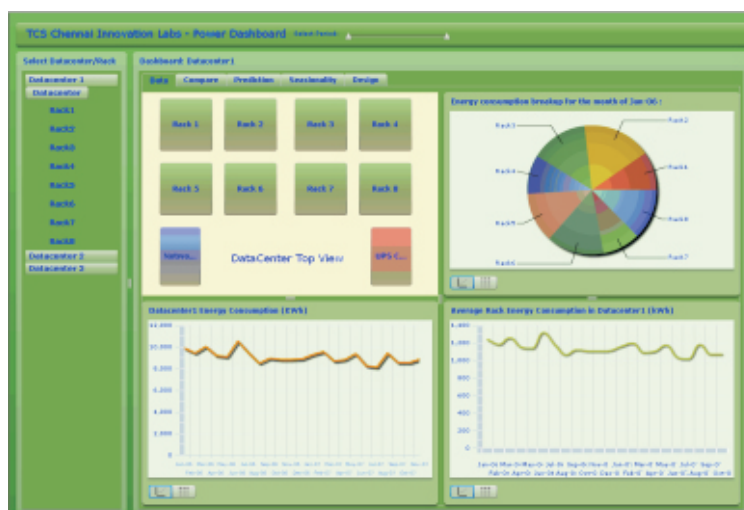


Fig. 2 TCS Dashboard for Monitoring Data centre Power

TCS' solutions are intended to address the following three important aspects of this data centre power problem-assessment, transformation and management.

- **Assessment** - The first step to understanding the magnitude of this problem in any facility is being able to assess the power consumption on a real-time basis in order to identify inefficiencies and opportunities for enhancement. Rather than an aggregate electricity bill that is received at the end of the month, a continuously monitored, evaluated and predicted solution is being offered by TCS. Such monitoring as in Fig.2 can help assess the data centre power efficiency metrics identified by the Uptime Institute [12] at different spatial and temporal granularities. Additionally, our monitoring solutions can identify sources of inefficiencies and opportunities for improvement in the power utilisation of the IT equipment in the data centre. It is equally important to assess the cooling capacity, air flow and power distribution in the machine room to ensure that the latest technologies are deployed, together with the right provisioning and efficient layout for cost savings [13]. Numerous papers and case studies on this subject can be found at [14].
- **Transformation** - Reducing the equipment footprint in a data centre can reduce both the direct power consumption as well as the power consumption by the cooling equipment required to eliminate the heat. Such consolidation is facilitated by the available virtualisation technologies. Virtualisation is a mechanism, which bundles the entire software stack including the underlying operating system in a unit called the virtual machine that is easy to deploy and migrate across different systems. We can pack several such virtual machines on each physical server since the physical servers themselves are never really completely utilized, thereby reducing the equipment footprint in the machine room. TCS has undertaken such transformation exercises with many clients, while maintaining the required service level agreements (SLAs) of each application during the consolidation to avoid any interference between the applications being co-located on a physical server.
- **Management** - Over and beyond consolidation using virtualisation, we can also dynamically transfer the workloads across the servers to further consolidate the load over time. Since peaks and valleys in resource requirements are quite common in many workloads, consolidating the load into fewer servers during the valleys (and provisioning more resources during the peaks) can allow shutting down servers. TCS has used utility computing solutions for such dynamic resource management in the data centre to further reduce power consumption.

Moving from the data centre to desktops, streaming applications and even the operating system from a back-end server offers thin (less power consuming) client deployments. TCS is also piloting awareness solutions for desktop users that informs them about their historical power usage patterns, compares their usage with the population at large and offers tips for power savings.

Waste Reduction and E-cycling

Around 20-30% of IT equipment is rendered obsolete and is phased out every year. A study from Manufacturers' Association of Information Technology records that India generated 3.3 lakh tonnes of e-waste in 2007, with the number expected to touch 4.7 lakh tonnes by 2011 [15]. Plastic blends in this equipment are non-degradable and difficult to recycle. They can also contain cadmium, mercury, lead and brominated flame-retardants, which are not environment friendly.

At the corporate level, TCS has enforced a Reduce, Reuse and Recycle policy for the lifecycle of all products from procurement to eventual disposal. Opting for environmental friendly version of the product, exploring lease/buy-back options and working with authorised agencies/vendors to ensure close to 100% recycling/reuse after the lifetime, even for the equipment donated to charities/NGOs are some of the e-waste handling initiatives within TCS.

Enhancing the Environment with IT

IT has several roles to play in reducing consumption of fuel and other raw materials, and making engineering and business processes eco friendly.

Transportation and Fuel

IT and telecommunications have started playing a critical role in reducing travel across different units of an enterprise. At TCS, we use teleconferencing and video conferencing to replace face-to-face meetings. In addition to saving costs and contributing to eco-friendliness, these options allow greater flexibility for the attendees, enabling meetings that would have otherwise been difficult to schedule. We have also adopted webinars for presentations, enabling a larger audience spread across geographical sites to participate, as well as online meeting and collaboration tools to facilitate teamwork without mandating physical proximity. With many of these measures being mandated as a corporate policy, we have observed substantial reduction in travel costs year-over-year despite a rapid rise in the fuel costs over the same period.

The advent of laptops, mobile phones and high-end mobile devices such as blackberries has, for the most part, played a positive role in reducing travel-induced carbon footprints. On the downside, the multitude of these devices, compared to their desktop or data centre counterparts mandates their environment-friendly disposal and/or reuse after their lifecycle, including batteries that contain toxic chemicals.

In addition to travel reduction, IT is also widely used for route planning and reducing fuel usage in transportation services (airlines, fleet cars). Simulation software can also be a training platform for fuel-efficient driving.

Going Paperless

Online forms, business processes and workflows have yielded a significant reduction in paper consumption for all our operations. Measures to enforce double-sided printing, shared printing services and recycling printer cartridges have led to a 28% reduction in paper consumption and a 68% reduction in printer cartridges in 2007 compared to the prior year.

Engineering and Industrial Services

Software is already playing a vital role in the design and manufacture of numerous industrial products and is instrumental in rendering these products and processes environment friendly. Computer-aided design (CAD) and other simulation tools can be used for designing energy efficient products (as in Fig.3), reducing waste and enhancing the efficiency of the manufacturing process. In many cases, these simulation tools can help avoid the physical process of prototype generation and evaluation, which has high costs, energy requirements and possibly non-ecofriendly waste.

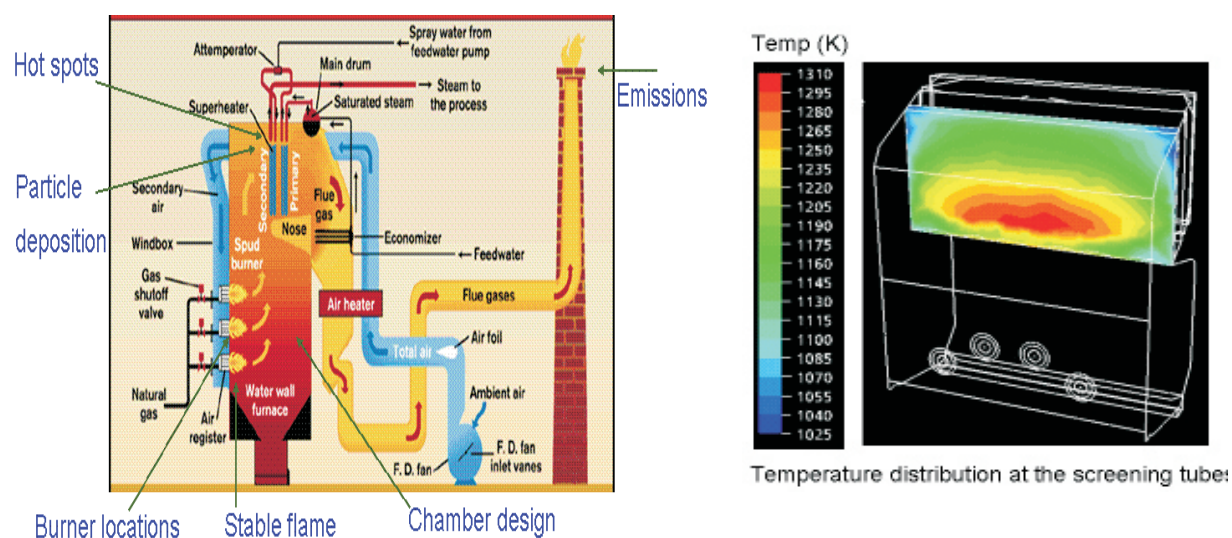


Fig. 3 Design Modifications and Process Improvement done by TCS Engineers for enhanced efficiency of a Combustion Boiler in a Power Plant using Computational Fluid Dynamics Software.

At TCS, our R&D and delivery teams in Engineering and Industrial Services have served the design and manufacturing community with environmental friendly technologies on several fronts using innovative IT capabilities. We have developed customised cultures for a variety of agro-wastes and set up highly efficient bio-methanation plants based on our adapted cultures, non-edible oil cakes, tobacco waste, tea waste, night soil and water hyacinth. In addition to the biogas thus produced, the residue generated in the process is an excellent fertilizer.

Our researchers have also developed patented technologies for replacing precious wood with rice husk as a fuel in curing of tobacco. Rice husk ash from this process has also been demonstrated to be an excellent insulating material for tobacco barns. It is also an excellent additive in cement manufacture and a remarkably efficient filtration (including removal of pathogens) medium for water purification. We have developed a domestic filter to provide potable drinking water in rural areas that is not just economical but also does not require any electricity.

TCS has also made innovations in the production of Eco-cements, exclusively produced from a combination of different industrial and mining wastes. Our energy efficient Eco-cements with physical properties comparable to Portland cements have been successfully made from fly ash and steel plant wastes, gold ore tailings sands, fertilizer chalk waste, municipal incinerator ash, red mud and pot lining waste from aluminum refineries. We have also designed efficient solar dryers for different industrial applications and clean coal combustion technologies.

Design and simulation software has been used in different client engagements for reducing fuel consumption in the airline and automobile machinery. We are also using software to model the cooling efficiency of physical infrastructure, including data centres, which can be used to supply and modulate the cooling capacity for maximum efficiency.

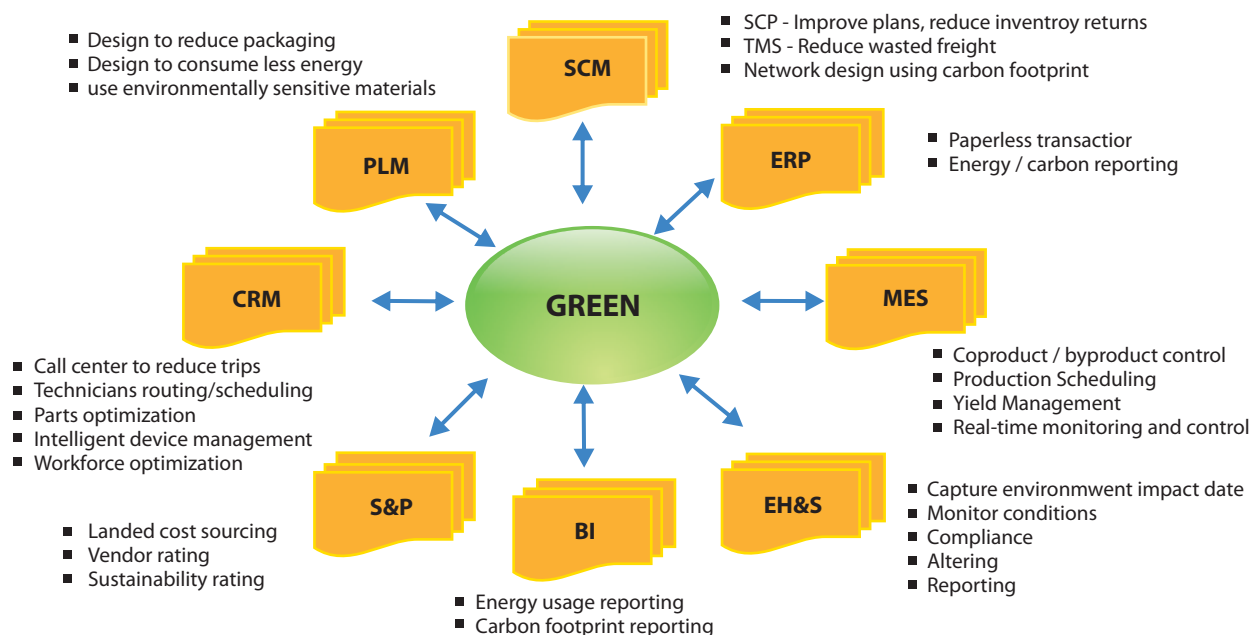
Some of these design and simulation tools can be very resource and time consuming because of the spatial and temporal granularities mandated by the simulation model. TCS is availing high performance computing facilities (such as, the supercomputing facility at the Computational Research Laboratory from the Tata Group) and Grid technologies as vehicles for executing such large scale design and evaluation models.

Environmental Services

In addition to the design of eco-friendly products and services, IT can play a direct role in managing the environment in several ways. For instance, Geographical Information Systems housing large spatial data warehouses are extensively used by environmental organisations, government agencies and numerous industries to track natural resources, manage their usage and logistics and study the impact of the different possible scenarios. For instance, TCS has been engaged by the National Centre for Antarctic and Ocean Research (NCAOR) to undertake a comprehensive marine geophysical data acquisition programme for the Antarctic region that will help understand the marine ecosystem and the global changes in weather and environment better.

Similarly, the emerging area of wireless sensor networks has significantly enhanced environmental monitoring and management. Applications include monitoring for natural disasters such as earthquakes and tsunamis, habitat monitoring for different flora and fauna, monitoring for weather prediction and so on. Rather than passive raw data gathering of past years, sensor networks are becoming smarter, with the ability to integrate and act upon multiple sources of information. For instance, the mKRISHI project at TCS uses a sensor network of weather and soil sensors, camera phones, cellular networks and GPS technologies to provide customised environmental information to grape, cotton, soybean and potato farmers in several rural Indian villages.

Business Processes, Compliance and Accounting



Source: Gartner (6)

Fig. 4 Green Dimensions to Business Software

With the Kyoto protocol mandating the retracement of greenhouse gas emissions to 5% below 1990 levels, the need for tracking, accounting, managing and enforcing these emissions will filter down from the national level to the corporate levels and eventually individual business processes, services and products. Tracking and managing these footprints at the magnitude and scale of current enterprises requires sophisticated software that can integrate with supply chains and workflows in the existing infrastructure as pointed out in a Gartner briefing (as in fig.4.).

Creating Awareness

One of the biggest hindrances to the adoption of Green IT initiatives is the deficiency of awareness among clients, partners, employees and management of the importance of the issue and what each individual can do at a personal level to address them. Educating this population about the emerging rules and regulations, which may be quite specific to a geography, cost savings together with the growing business opportunities in Green IT can be key drivers towards rapid adoption of Green IT initiatives. On an individual basis, periodic education on how small ideas collectively executed across the population produce large savings can motivate adoption. IT can also help increase the awareness by sending key messages to individuals in an effective manner. For instance, we, at TCS use screen saver messages of what individuals can do (turn of monitors/LCDs, adopt darker versions of frequently visited web pages, planting a tree, and so on) to drill down simple ideas to our associates. We are also piloting a desktop power meter that would make individuals aware of their power consumption and how they are faring compared to the rest of the team members in the business unit. Our internal online eco-footprint calculator enables associates complete a questionnaire to gauge their eco-friendliness and identify scope for improvement.

TCS has also built an internal Green IT social networking portal. This is not just an informational site on different issues related to Green IT, but also a useful channel for submitting ideas, finding out what worked in different sites, sharing experiences and obtaining a critical mass of like-minded people across geographic boundaries.

Holistic View of Green IT

Green IT needs to be viewed from a holistic perspective, requiring cross-disciplinary expertise and a comprehensive decision making strategy from multiple angles. For instance, consider the data centre power reduction problem, which is often at the crux of most discussions on Green IT. In addition to the normal business case reasoning for establishing the infrastructure to execute the applications, one also needs to weigh the carbon footprint of this infrastructure against any possible eco-improvements that may be provided by the applications running in the facility. For example, savings on fuel in an airline company with sophisticated scheduling mechanisms or waste reduction in a manufacturing facility with computer-aided design software. Further, one would also need to evaluate the pros and cons of building this infrastructure in-house versus outsourcing it through a cloud computing model, either within the enterprise or to an external service provider from both return on investment (ROI) and eco-footprint perspectives.

Once the decision is made to build the infrastructure, one should go about systematically assessing and optimising the power requirements within the data centre for the desired goals. This, in turn, may mandate the following diverse set of tasks:

- (i) Scouting for a location to house the facility – which can be a function of eco-friendly accessibility of the facility by the employees, the carbon footprint per kWh of electricity consumption, which varies across geographic regions, the local laws and rules and regulations.
- (ii) Identifying products that deliver maximum performance per watt to host the applications.
- (iii) Ensuring proper insulation, air flow and rack placement for efficient cooling.
- (iv) Exploiting opportunities for consolidation and sharing of physical resources to reduce the equipment footprint.
- (v) Continuously monitoring the infrastructure for inefficiencies and opportunities for enhancement.
- (vi) Working with vendors and NGOs to ensure proper recycling of the equipment that is de-commissioned.

With the imminent need to track and optimise eco-footprints at the corporate level, such a holistic multi-disciplinary approach is needed for all operational and business processes to ensure that these processes work in tandem rather than have the optimisation of one process unfavorably impacting another.

Summary

In this white paper, we have explained our view on Green IT, together with the business opportunities and services that we are undertaking externally for clients as well as internally within TCS. A successful Green IT strategy requires:

- Examining the issue holistically from different perspectives and on a continuous basis as explained in this paper, rather than a single isolated transformation exercise.
- Creating awareness at all levels of the organisation and across all business units, with the information ranging from the laws and regulations of different geographies to the cost savings and new revenue opportunities.
- A corporate Green IT policy that defines the mission and goals of the enterprise with respect to cost, business opportunities, regulations (different perspectives), and roadmaps/milestones for achieving these goals.
- Each operating unit to refine these goals and come up with new business opportunities based on its capabilities.
- Working with vendors, partners, clients and governmental bodies to ensure that we bridge corporate boundaries since environmental impact cannot always be isolated by these boundaries.
- A governance mechanism to track the enforcement of policies and to audit the resulting benefits/environmental impact.

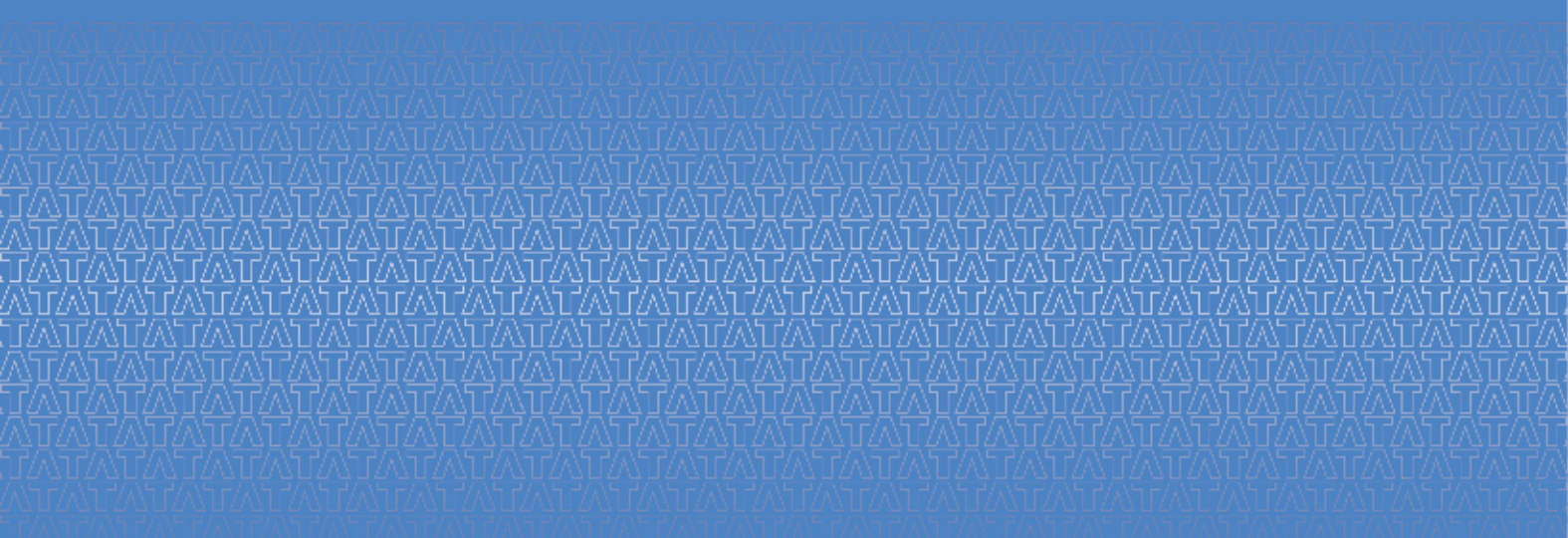
As Senge says in his book *The Necessary Revolution*, successful sustainability stories have the following elements:

- (i) A set of people passionate about the cause to drive any innovation.
- (ii) A mindset that focuses on the long term rather than the immediate present to appreciate the benefits.
- (iii) The ability to connect and collaborate with several people across different boundaries.
- (iv) A shift away from the negativism to invest in sustainability efforts.

References

1. TCS Corporate Sustainability Report, 2007.
http://www.tcs.com/about/corp_responsibility/Documents/TCS_Corporate%20Sustainability_Report_2007_Final.pdf
2. ISO 14000 Essentials. International Organization for Standardization.
http://www.iso.org/iso/iso_14000_essentials
3. The Leadership in Energy and Environmental Design (LEED) Green Building Rating System. U.S. Green Building Council. <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=222>
4. ENERGY STAR for Computers. U.S. Environmental Protection Agency.
http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CO
5. Product and Supply Chain Standard. The Greenhouse Gas Protocol Initiative.
<http://www.ghgprotocol.org/standards/product-and-supply-chain-standard/>
6. B. Sood, The CIO's Role in Enterprise-wide Environmental Responsibility, Gartner Briefing, Mumbai, July 2008.

7. Green IT a Natural Fit for Enterprise Executives, IDC Press Release, October 2007.
<http://www.idc.com/getdoc.jsp?containerId=prUS20932407>
8. The Greenhouse Gas Protocol Initiative. <http://www.ghgprotocol.org/>
9. J. G. Koomey, Estimating Total Power Consumption by Servers in the U.S. and the World, February 2007.
<http://enterprise.amd.com/Downloads/svrpwrusecompletefinal.pdf>
10. A. Chandrakasan, R. W. Brodersen. Low Power Digital CMOS Design. Kluwer-Academic Publishers, 1995.
11. S. Gurumurthi, A. Sivasubramaniam, M. Kandemir, H. Franke. Reducing Disk Power Consumption in Servers with DRPM. IEEE Computer 36(12):59-66, 2003.
12. How to Apply the Four Metrics to Achieve Data Center Greenness Online Seminar <http://uptimeinstitute.org>
13. T. Schudi et al. High Performance Data Centers: A Research Roadmap. Lawrence Berkeley National Laboratory. http://hightech.lbl.gov/documents/DataCenters_Roadmap_Final.pdf
14. Data Centers: Annotated Bibliography. <http://hightech.lbl.gov/dc-bibliography.html>
15. Manufacturer's Association for Information Technology, 2008.
<http://www.business-standard.com/india/storypage.php?tp=on&autono=42371>



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