CS8078- GREEN COMPUTING

Lecture Notes

UNIT – 1

Introduction to the Green Computing

- –The study and practice of designing, manufacturing, using disposing of computers, servers, and associated subsystems (such as monitors, printers, storage devices, and networking and communications systems) efficiently and effectively with minimal or no impact on the environment.‖
- –Green IT is the study and practice of using computing resources efficiently.‖
- Green IT (green information technology) is the practice of environmentally sustainable computing.
- Green IT aims to minimize the negative impact of IT operations on the environment by designing, manufacturing, operating and disposing of computers and computer-related products in an environmentally-friendly manner.
- The motives behind green IT practices include reducing the use of hazardous materials, maximizing energy efficiency during the product's lifetime and promoting the biodegradability of unused and out-dated products.
- The concept of green IT emerged in 1992 when the U.S. Environmental Protection Agency launched Energy Star, a voluntary labelling program that helps organizations save money and reduce greenhouse gas emissions by identifying products that offer superior energy efficiency.
- Other components of green IT includes the redesign of data centers and the growing popularity of virtualization, green networking and cloud computing.
- IT includes the dimensions of environmental sustainability, the economics of energy efficiency, and the total cost of ownership, which includes the cost of disposal and recycling.

The Environment Today

- Human activity is the cause of change in the environment who work in them are all socially affected by this use of IT by business.
- Furthermore, as the social fabric gets disturbed, it in turn affects the overall environment in which the society exists.
- Finally, there is also a direct influence of IT on the society and environment—independent of its influence on business.
- GC is direct influence of IT is seen in the massive propagation of household gadgets, use of computers in schools and hospitals, the popularity of social networking, and the high level of communications technology (such as a GPS) in vehicles
- Despite this huge popularity of IT, it appears as if the corresponding environmental considerations of the impact of IT's usage have lagged behind substantially within business strategies.

- From the below figure the sustainable triangle of an organization is shown to be made up of a balance between society–economy

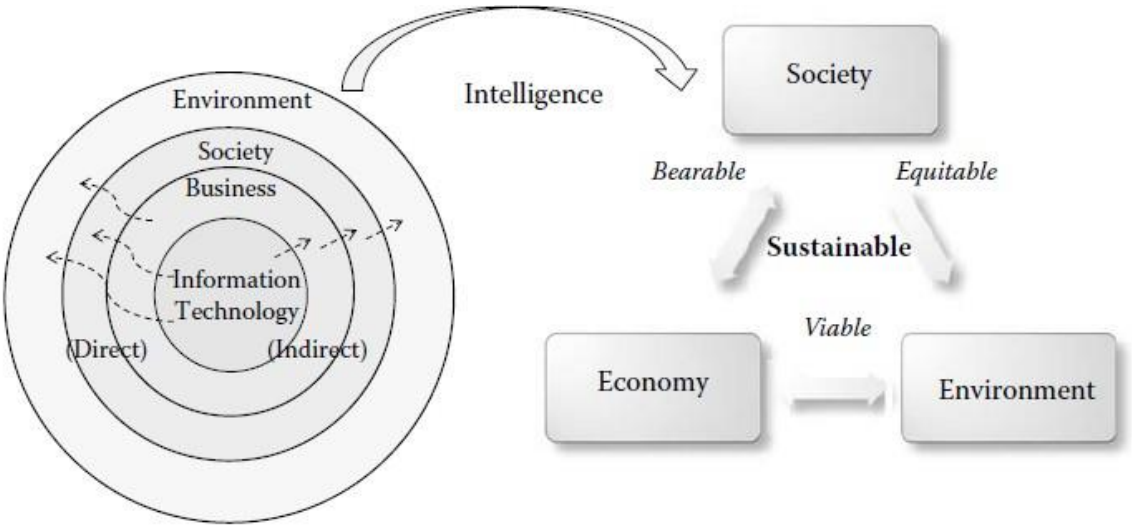


Figure 1.1 Information technology influences business, society, and environment—lead up to the sustainable triangle.

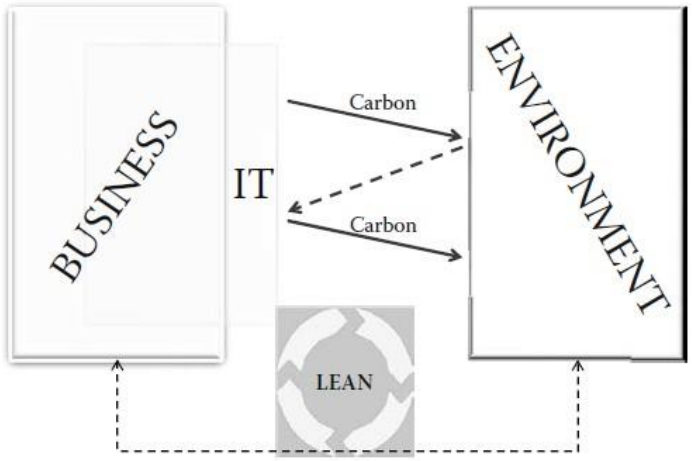
- A comprehensive Green IT strategy fully utilizes technology resources, reengineers processes, and uses the positive attitude of people in bringing about environmental consciousness in the daily activities of the business
- The following are some of the specific ways in which a comprehensive Green IT strategy is beneficial to an organization
    - Incorporates environmental issues within the business strategies in way that is complimentary to each other.
    - Demonstrates the importance of environmental issues as one of the ‐core‖ business issues rather than merely ‐good to have‖ add on
    - Explores the possibilities of enhanced green performance to discover and develop new business opportunities
    - Expands the technologies of Business Intelligence for the purpose of reducing the organization’s carbon footprint—leading into what is called Environmental Intelligence
    - Applies the concepts of carbon efficiency to business processes leading up to Green business process management (Green-BPM) and Green business process reengineering (GPR).
    - Proposes a Green enterprise architecture (GEA) that builds on the technologies of Web Services/Service Oriented Architecture and Cloud computing

- Expands on the vital role of business leadership in bringing about positive green change across the organization.

Information Technology and Environment

- IT is an inseparable, integral part of modern business. In fact, IT is so closely intertwined with business processes that it is difficult to imagine any modern core business process as an IT.
- In addition to being an integral support to business processes, IT particularly with communications technologies, is a creative cause for many new and wide-ranging business interactions.
- ‑Business is IT‖ is even more relevant in today's heavily analysed, networked, and interconnected world of business
- It is impossible to imagine a typical banking, insurance, and hospital or airline process without IT.
- Energy between business and IT implies that growth in business also implies corresponding growth in IT.
- Jain (2011) mentions studies that show the effects of IT usage on the environment specifically indicate the various levels at which IT affects the environment.
- An initial level of impact is associated with production, use, and disposal of IT hardware that affects the environment directly.
- A subsequent level of impact is caused by the effect of IT on the changes in structure and behaviour.
- Verticals such as financials, travel, and hospitals are all aff ected fundamentally by IT and its emissions. While these industries are themselves not IT, still there is hardly any transaction in them that can be conducted without IT being an integral part of it
- Process of getting a quote for an insurance cover, the process of buying an airline ticket, and the process of checking the availability of a doctor all have information and communications technology at their base.
- Each process requires an underlying database (or data warehouse), a means of communication (the Internet together with all its add-ons), user interfaces, data and transaction security, and the overall user experience considerations
- Changes to the technical systems and database aspects of these processes impact the business aspect of those processes.
- In fact, it is increasingly becoming difficult to segregate the IT aspect from the pure business aspect of these processes
- Therefore, many a thinkers believe that the IT industry has a significant role to play in reducing GHG emissions.
- To start with, this indicates that a reduction in overall carbon footprint of the organization can be effectuated by specifically tackling IT-based emissions.
- Reduction in IT-based emissions—such as the data centre and the end-user monitors

- Below figure attempts to depict this on-going interplay between the business and the environment
- A carbon impact is shown by an arrow from left to right



Interplay of business and environment through information technology.

The impact of business activities through IT on the environment has to be understood in three ways:

The length of time,

The depth of activity

The breadth of coverage of the carbon effect

The greater the intensity of business activities, the higher is the carbon generation

Table 1.1 Major IT Area Influencing Environment

IT Areas	*Major Environmental Influence*
End-user devices (desktops, laptops, mobiles)	Large numbers of these devices, together with their rapid obsolescence that depends on factors other than their usefulness. Aim to reduce the number of devices and the emission per devices.
Data center servers	Growth of business associated with greater transactions invariably requires greater number of servers. Together with their backups, security, and mirroring requirements, these servers substantially impact the carbon generation. Techniques of optimization and virtualization need to be incorporated in data server management.
Communications equipment (switches, networks)	These equipments, usually part of the data centers, increase in numbers and usage with growth in transactions. New networking technologies, self-healing networks, and use of mobile networks over wired ones can be part of the Green IT strategy here.
Infrastructure (buildings, towers)	Greater the number of servers and office machines, more is the office space required. This increase in physical facilities and infrastructures have their own carbon impact that contributes to the carbon footprint. Building architecture and design, policies and practices for its operation, and maximum use of space as well as location are of importance here.
Metrics and measurements	Inclusion of new KPIs for carbon-related performance in the measures.
Risk management	Includes risks associated with not controlling emissions. Also includes the risks that may come due to green enterprise transformation.

Business and Environment

- The business and the environment interact with each other primarily through IT.
- IT has served businesses well by enabling them to expand their capacities, providing them with global customer reach, and enhancing their customers' experience.
- IT has also enabled businesses to optimize their internal processes such as inventory management and HR management and cut their operational costs through process automation.
- IT is integrally embedded in business processes making them cost efficient and/or enabling businesses to grow and expand.
- Care in the use of IT to ensure minimal carbon footprint is now becoming a priority for both business and IT.
- The key to creating Green IT strategies for business is to treat the entire organization holistically.
- During the execution of the green enterprise transformation program, the organization will be divided into many smaller, departmental level manageable chunks
- The Green IT strategy itself cannot be for a single unit of the business. Instead, unified strategy will apply to the entire organization as an entity
- A unified approach provides valuable checks and balances in the Green IT efforts of the organization.
- An individual, or a single department, can always attempt to become green by applying its own procedures and practices so long as the effects of these changes is not to increase in carbon and costs elsewhere

Carbon Foot Print

- It's the total of all the CO2 (carbon dioxide) that your activities directly and indirectly contribute to the environment.
- Focusing on carbon emissions is important because carbon dioxide is a greenhouse gas.
- The greenhouse effect is the warming that happens when solar radiation is trapped by the atmosphere.

Here's how it works:

- In the natural course of events, sunlight shines down on the earth, and most of that light is absorbed and warms the surface of the planet; some of that warmth is then radiated back out into space.
- Not all of it reaches space, because greenhouse gases, which are made up of carbon dioxide (CO2), methane, nitrous oxide, and fluorocarbons, trap a percentage of the warmth in the lower part of the atmosphere.
- The more greenhouse gases there are, the hotter the earth and air gets.
- And as the earth's temperature rises, the polar ice caps melt and the sea rise.

- Some of the components of greenhouse gases occur because of natural processes; in fact, simple watervapor is the single biggest contributor.
- But the second biggest contributor is CO2, which can range from 9 to 26 percent of all greenhouse gases.

The carbon cycle: Don't hold your breath!

- Yes, when you exhale, you add carbon dioxide to the atmosphere. But that doesn't mean you have to breathe less — or hold your breath! Some carbon dioxide is part of the natural carbon cycle.
- Green landscapes, including trees, grass, plants, and shrubs, all absorb the carbon dioxide we exhale and convert it to oxygen during photosynthesis, which is the process plants use to turn sunlight, water, and carbon dioxide into oxygen and energy.
- Photosynthesis also helps reduce other chemicals — such as nitrogen oxides, ozone, and more — that contribute to greenhouse gases.
- Even indoors, plants can refresh your air supply by converting the air you've already breathed to oxygen

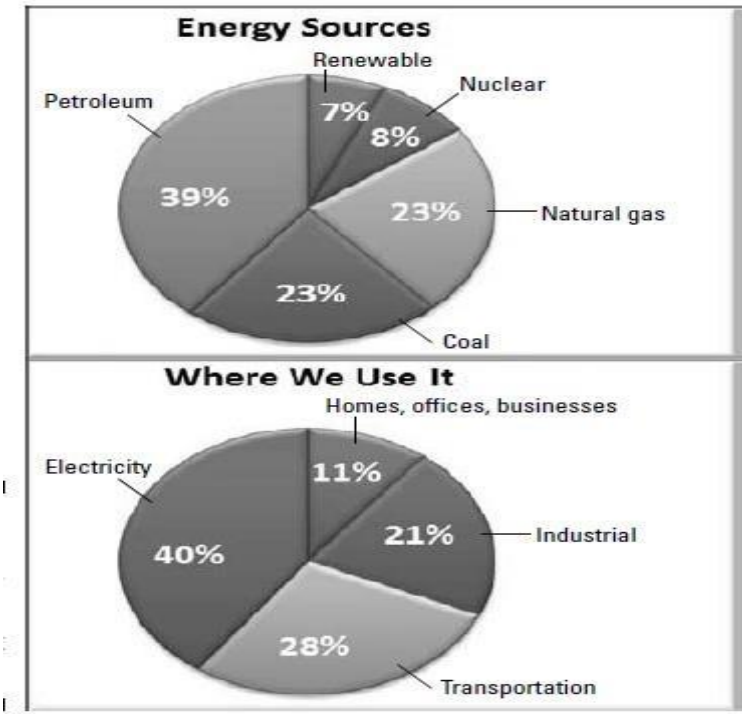
Connecting fossil fuels to carbon emissions

Fossil fuels that we burn for energy are the largest contributors of the type of CO2 that we need to reduce. Materials we use for transportation, heating, cooking, and manufacturing burn some kind of fossil fuel. Fossil fuel consumption has skyrocketed over the last 50 years, and you're sure to recognize these fossil fuels

Oil

Coal

Natural gas



scoop on power

- The electricity that supports your lifestyle right this very minute is a manufactured product and not a natural renewable resource.
- An electrical generator somewhere in your area uses a technology based on magnetics and copper wire to create the spark of life that keeps your technology going: the light shining on this page, the charge in your cell phone, the current keeping your laptop charged, and the electricity running the ceiling fan.
- When you flip the switch or plug in the cord, you open the gate for the electricity to flow to the device, appliance, or computer hardware.

Creating electricity

- Electricity is a secondary power source — meaning that other primary energy sources are used to generate it.
- We can generate electricity from many different sources, but all those sources, except solar technologies use a process in which a turbine spins and converts movement energy into electric energy.
- Steam, gas, and diesel turbine generators all use this process, as do nuclear power plants and alternate energy systems.
- When power plants create electricity by burning fossil fuels such as coal, oil, and natural gas, they boil water to produce high-pressure steam, which turns the turbines in the generator that creates the electricity
- Nuclear reactors (which use nuclear fission to split atoms, releasing a great amount of energy) and hydroelectric power plants (which use moving water to generate electricity) use similar turbine-based procedures without burning fossil fuels
- When you look at how green these methods of generating electricity are, the differences among these energy sources become apparent

Renewable versus non-renewable energy:

- Today, you see the terms renewable and non-renewable energy everywhere. The difference between the two (not surprisingly) is that one type of energy continually replenishes naturally (like wind and water) and the other doesn't
- Non-renewable energy resources, like coal, nuclear, oil, and natural gas, are available in limited supplies. This is usually due to the long time it takes for them to be replenished. Renewable resources are replenished naturally and over relatively short periods of time. The five major renewable energy resources are solar, wind, water (hydro), biomass, and geothermal.
- Since the dawn of humanity people have used renewable sources of energy to survive -- wood for cooking and heating, wind and water for milling grain, and solar for lighting fires.

- A little more than 150 years ago people created the technology to extract energy from the ancient fossilized remains of plants and animals.
- These super-rich but limited sources of energy (coal, oil, and natural gas) quickly replaced wood, wind, solar, and water as the main sources of fuel. Fossil fuels make up a large portion of today's energy market, although promising new renewable technologies are emerging.
- Careers in both the renewable and non-renewable energy industries are growing; however, there are differences between the two sectors.
- They each have benefits and challenges, and relate to unique technologies that play a role in our current energy system.
- For a range of reasons, from the limited amount of fossil fuels available to their effects on the environment, there is increased interest in using renewable forms of energy and developing technologies to increase their efficiency

By-products of different energy sources:

- Most of the technologies that we use to generate electricity pump CO2 into the atmosphere, including any technology that burns fossil fuels.

What isn't a renewable energy source?

- Fossil fuels are not a renewable source of energy because they are not infinite. Plus, they release carbon dioxide into our atmosphere which contributes to climate change and global warming.
- Burning wood instead of coal is slightly better but it's complex. On the one hand, wood is a renewable resource – provided it comes from sustainably managed forests. Wood pellets and compressed briquettes are made from by-products of the wood processing industry and so arguably it's recycling waste.
- Compressed biomass fuels produce more energy than logs too. On the other hand, burning wood (whether it be raw timber or processed waste) releases particles into our atmosphere

The future of renewable energy

- As world population rises, so does the demand for energy in order to power our homes, businesses and communities. Innovation and expansion of renewable sources of energy is key to maintaining a sustainable level of energy and protect our planet from climate change.
- Renewable energy sources make up 26% of the world's electricity today, but according to the International Energy Agency (IEA) its share is expected to reach 30% by 2024.
- In the future, it's expected that the number of renewable energy sources will continue to increase as we see an increase in demand for power. This will drive down the price of renewables – great for the planet, and great for our wallets.

Renewable energy and your home

- The advantages of using renewable energy in a domestic setting are persuasive:

- Cut your electricity bills: Once you've paid for the costs of installing a renewable energy system, you can become less reliant on the National Grid and your energy bills can be reduced.
- Get paid for the electricity you generate: The UK Government's Feed-in Tariff pays you for the electricity you generate, even if you use it.
- Sell electricity back to the grid: If you are generating enough energy to export an excess back into the National Grid, you can receive an additional payment from the Feed-in Tariff scheme.
- Reduce your carbon footprint: Green, renewable sources of energy don't release carbon dioxide or other harmful pollutants into the atmosphere.

Table 3-1 Types of Renewable Energy

Type	*Description*
Biomass	Organic matter, such as plant and animal waste, is burned or changed into gases to produce electricity.
Fuel cell	Chemical reactions combine hydrogen and oxygen to create electricity.
Geothermal	Pipes bring to the earth's surface dry steam or hot water, which powers a turbine that drives a generator to produce electricity.
Hydroelectric	Water flowing through dams turns turbines and generates electricity.
Solar	Photovoltaic cells gather sunlight and generate electricity.
Wind	Wind power turns two- or three-blade propellers mounted on rotors, which turn wind turbines that generate electricity.

Penning Up Energy Hogs in Your House

AC Unit

- What temperature do you set your air conditioning to when you're not home? Do you know how to set and use your thermostat properly so that your home is comfortable, and the A/C unit isn't working overtime?
- If you work 9:00 AM to 5:00 PM Monday through Friday, you probably average somewhere between 40-60 hours spent outside of your home every week. This is precious time that should be used to conserve energy by setting your air conditioner to a more neutral temperature. The less that your home has to work to heat/cool your space, the more energy you're saving.
- It doesn't have to be a drastic temperature change, by the way. You can spare a few degrees in energy and still ensure your pets are comfortable while you're out and that your home feels good when you walk in after a long day.

Water Usage

- Another energy hog to be aware of is your water usage. This pertains mostly to hot water, but our overall water usage could be cut back considerably to save more on energy and help the environment.
- When it comes to hot water, there's more to it than just the showers and baths you take. We also use it when washing dishes, and doing laundry. The day-to-day use of hot water is endless.
- Every drop adds up. Whenever you're using hot water, energy is used to heat the water. It's not always necessary to use hot water for daily tasks like laundry. Making the simple adjustment, while also conserving your water use as a whole, could be worth it if you want to cut back on energy expenses.

Lighting

- Close your eyes and imagine all the lights you have in each room on the inside and outside of your home. Are there more lights than you might have guessed? Well, every single light you use throughout the day increases your energy bill.
- The best thing you can do is try to make better use of natural light and to make it a habit to turn off the lights that aren't in use. This is super simple and incredibly effective.

Battery Chargers

- You may be surprised to see this energy hog on the list, but it is definitely an abuser of what we call vampire power.
- Most people leave chargers plugged in when they're not using them and don't ever think twice about it. Phone chargers, computer chargers, and other devices like Bluetooth speakers or smart-home devices take up your home's energy even when nothing is plugged in! Start unplugging them when you're not charging and encourage everyone else in the home to do the same. Get the full list of appliances and devices you should pull the plug on to save energy and money.

Microwave Oven

- If your microwave is hooked up to the wall or built into the cabinets, don't bother trying to unplug it after each use.
- However, if it rests on a counter, this is another item you should unplug when not in use if you want to save energy.

Game Consoles

- Another energy hog sitting in your home is a game console. If you have more than one game console, you're wasting a lot more energy than most homeowners.
- Unplug these when they're not in use. This allows them to rest and keeps their battery from overheating, which is great for the lifespan of the consoles. More importantly, it will do wonders for your monthly energy bill.

Televisions

- The game consoles aren't the only entertainment pieces taking up a lot of energy in your home. Televisions are doing the same thing. This goes for old TVs and recently-made ones, too. It's also applicable to Smart TVs with internet and streaming capacities, which tend to take up more energy.
- Identify which TV's you don't use often that you wouldn't mind unplugging - like the one in the guest room or the den that you rarely use. Maybe even see if there are a few TVs you wouldn't mind getting rid of altogether!

Set-Top Boxes

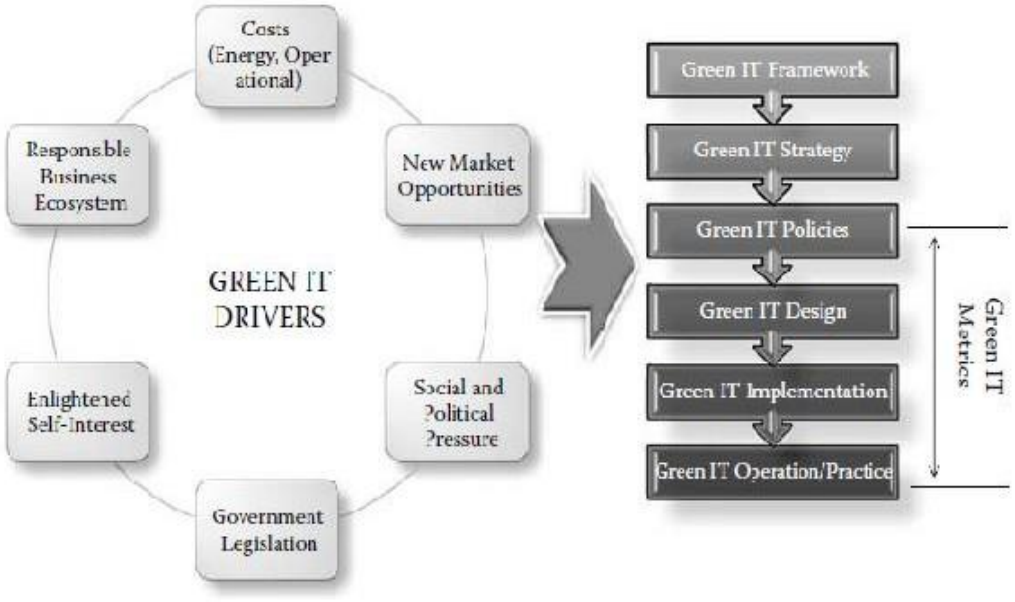
- Set-top boxes are part of a cable or satellite TV service. This is basically what helps TV's get the signal needed from major companies and networks that gives you access to the shows and movies you watch on a daily basis.
- If you use an Apple TV, a smart TV, or any of the many other streaming services available today, you probably don't have a need for a set-top box and can get rid of cable altogether. This will help you save you a little extra money each month as well.

Computers

- Computers of all shapes and sizes can be energy hogs if they're not used correctly. Turn off your desktop's monitor whenever it's not in use. Also, make it a habit to unplug your laptop from its charger (and unplug the charger itself) when you're not using it,

Green IT Drivers

- Basically responsible for environmental growth
- Below figure shows a mapping between the drivers and the corresponding Green IT framework



Drivers for environmental responsibility of business.

- Green IT strategic approach considers both internal and external organizational characteristics, including its structure, dynamics, macroeconomic incentives, compliance constraints, and the need to align corporate social responsibility with mainstream corporate business
- It contains the six drivers
- Six groups of business drivers for environmental responsibility, as shown on the left in Figure are the costs (including energy costs, operational costs); regulatory and legal; sociocultural and political; new market opportunities; enlightened self-interest; and responsible business ecosystem.

Costs (Energy, Operational)

- A good sustainable approach by an organization includes opportunities to optimize its processes, consolidate its technologies, and thereby reduce its costs
- Costs provide an excellent driver for the organization to come up with a comprehensive Green IT strategy
- Examples of cost reduction include reduction in the use of raw materials and equipment, recycling of equipment, and optimization of storage and inventory as a result of the green initiative

Regulatory and Legal

- Environmental legislations put together by governing bodies have a greater enforcing power than the aforementioned social opinions.
- Formation of a comprehensive environmentally responsible strategy is then undertaken to ensure that the organization is compliant with the legal requirements

Sociocultural and Political

- It is the driver that comes mainly into play when the society in which an organization resides accepts the environment as of significance in its value system
- The effect of the social opinion is seen in the formation of corporate social responsibility (CSR, 2010) as a part of an organization's portfolio of activities
- CSR, also known as corporate responsibility, corporate citizenship, responsible business, and sustainable business, integrates self-regulation into a business model
- The formulation of a CSR policy that functions as a built-in, self-regulating mechanism monitors the organization's behaviour, its adherence to law, ethical standards, and international norms.

Enlightened Self-Interest

- This driver can include a range of interests including the desire of an organization to undertake genuine common good, the need of the business leadership to achieve personal satisfaction, or simply the understanding of the decision makers that costs can be reduced and customers can be more satisfied with a self-interest approach that also helps the environment
- Enlightened self-interest, as a driver, is in between the good behaviour for financial gains and avoidance of bad, carbon-intensive behaviour due to fear of penalties.

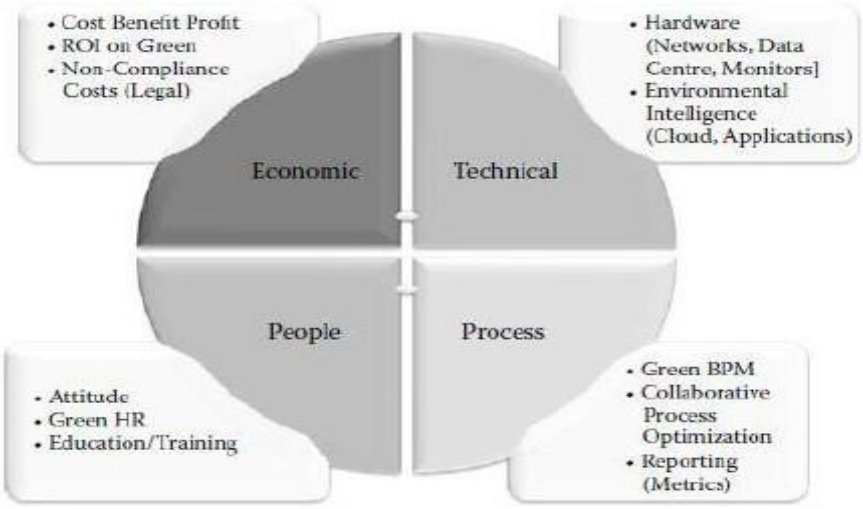
- Self-interest can itself depend on varying factors such as the size, sector, and methods of production, climate, location, and even management decisions of the firm in question

Responsible Business Ecosystem

- A large global green organization in has three major areas through which it can influence: Green Processes, Green Data Center, and Green Consortiums.
- When such a large, global organization changes to environmentally sustainability,an entire ecosystem made up of the business partners, suppliers, and customers and internal users organizations, together with the industry and the corresponding business consortiums in which the organization exists are all affected

Green IT Business Dimensions (Factors)

- Once the drivers that provide the impetus to the business for its green initiatives are identified and documented, they lead to the discussion on the areas of business that are likely to be affected by the changes.



Economy

- Economic considerations are one of the key factors in an organization's decision to implement environmental policies and systems. Ā ese considerations that deal with the costs associated with green transformations and the return on those costs, are the first ones to appear in the minds of the leaders and those in charge of the green transformation.

Economic growth in the current economy is usually associated with increase in carbon emissions.

Technologies

Technologies primarily include the hardware, network infrastructure, software, and applications within the organization. Switching off monitors, virtualization of servers, and eschewing printing on physical paper are the initial, visible aspect of change that occurs along this dimension.

Emerging technologies, such as Service orientation, SaaS, and Cloud computing take this dimension to the next level—leading up to what is called ‑Environmental Intelligence.‖

Processes

The process dimension of an organization deals with ‑how‖ things are done within an organization. It need to reengineer the business operations, process, and services according to the environmental parameters has also been highlighted by Murugesan (2008).

The process dimension of an organization remains as perhaps the most visible one and it is often used to judge the level of ecological responsibility for Green ICT of the organization

People

While the people aspect of an organization's behaviour has been studied to in great depths, in this discussion the focus is on the attitudes of individuals and the sociocultural setup in which they operate in the context of the environment.

While such involvement from the senior leadership requires substantial commitment in terms of time, money, and other resources (as discussed earlier in the economic dimension), still the attitude and the subjective viewpoints of people play an equally major role in the success of a Green IT project

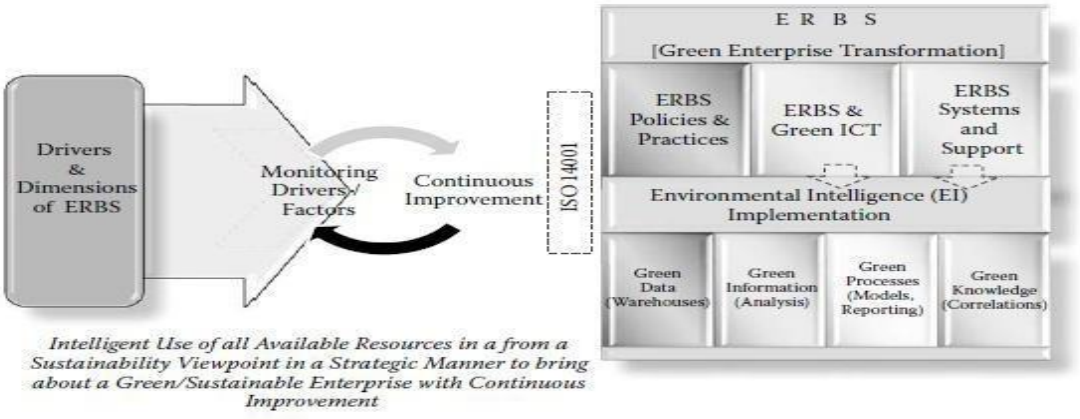


Figure 2.11 Drivers and Factors lead to an ERBS.

Policies and Practices in ERBS

- Purchasing Green equipment's/services and turning existing services into green services
- Disposal of used materials and equipment's.
- Equipment recycle and use.
- Environmentally responsible business policies.
- Use of renewable energy sources.
- Awareness and positive attitude.

Environmental Areas Covered

- Policies and their practices can be viewed from three different angles—the breadth of coverage, the depth at which they operate, and the length of time they are influential within the organization.

Breadth of Environmental Policies (Areas Covered)

- As shown in Figure 3.4, one axis shows the breadth of environmental policies that cover the various areas of an organization, including its various departments, subsidiaries, and partners. For example, the green policies in an organization may affect its inventories and its production activities
- This may be a relatively ―narrow‖ effect of the green policies on the organization as reduction in inventories itself may not immediately and necessarily affect the supply chain of the organization.

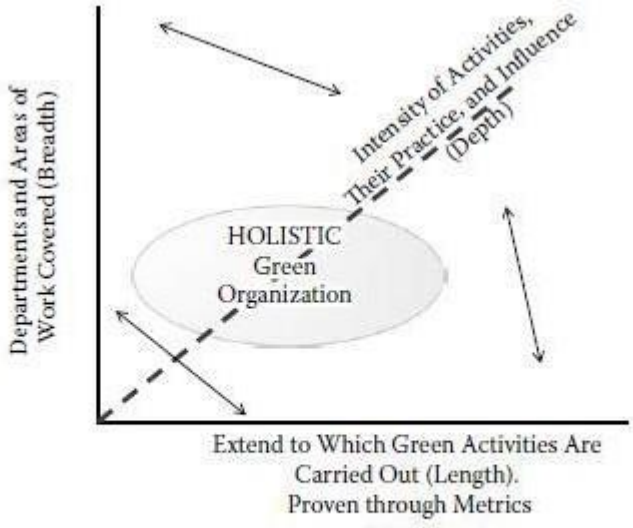


Figure 3.4 Green IT policies impact in three ways (length, breadth, depth).

Depth of Environmental Policies (Intensity of Coverage)

- As shown in Figure 3.4, another axis represents the depth of environmental responsibilities of an organization. The depth is an indicator of the intensity with which the policies are implemented and practiced by the organization.
- For example, if reduction in inventory is correlated with reduction in wastages and therefore reduction in carbon production, then the participation, coordination, and use of systems and tools to achieve that inventory reduction will be concentrated to provide the necessary depth of coverage.

Length of Environmental Policies (Duration of Coverage)

- Figure 3.4 also shows that length of time in terms of Green IT polices formation and practice is another vital consideration.
- Sustainable policies are the policies that, interpreted simply, enable a business to sustain itself for a long period of time.

- Therefore, a correlation between environmental sustainability and economics can be established through time. The relationship between success and time has the potential for driving green business advantage depending on the understanding and emancipation of the policy
- A Green IT can transform the organization, but maintaining that transformed green state over a period of time is only given due importance when the –length‖ is considered.
- Ideally, such length should be the length of the organization itself, and are therefore an integral part of its sustainability drive.
- Implementation of policies, however, require them to be further broken down and applied with varying timings to ensure they are gently and successfully introduced with the organization

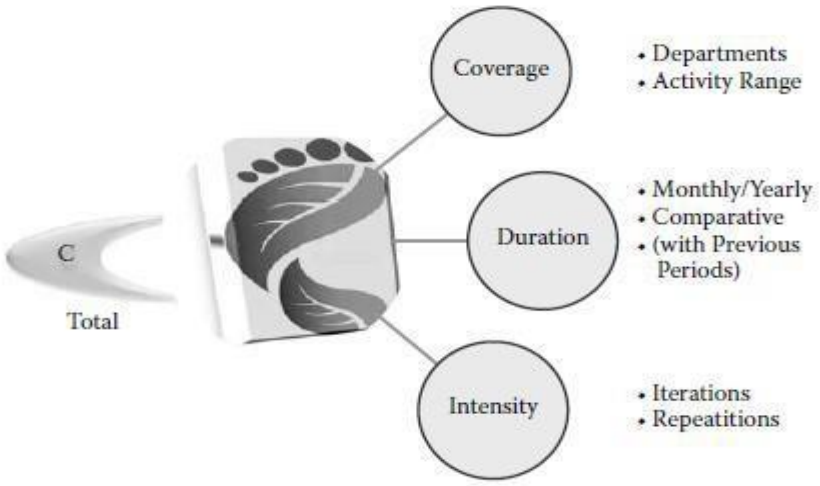


Figure 3.5 Carbon footprint of an organization is based on coverage, duration, and intensity.

- Figure 3.5 shows that eventually, the carbon footprint of an organization is made up of the coverage, duration, and intensity across all its functions. Carbon footprints are directly proportionate to the work area of an organization and the type of business sector.
- For example, a chemical industry which is manufacturing dyes and fertilizers will emit more emissions than the education sector.
- Examples of converting short-term policies into practice are as follows:
    - Computing power management.
    - Use a blank screen saver
    - Limited printing.
    - Reuse and recycling of equipment.
    - Environmentally conscious procurement
    - Single machine.

Chapter 12

Case Study in Applying Green IT Strategies and Applications to a Hospital

Key Points

- Presents a Green enterprise transformation (GET) case study for a service organization
- Uses GoodMead hospital as a hypothetical organization to present the case study
- Describes the practical aspects of a preliminary Green IT audit
- Describes the Green business objectives of a hospital
- Conducts a high-level SWOT analysis of the hospital from a GET perspective
- Suggests the use of mobile technologies in optimizing hospital processes that will result in carbon savings
- Lists the lessons learning in applying Green IT strategies to a service sector organization like a hospital

GoodMead Hospital

GoodMead is a hypothetical large hospital in a metro city, providing public sector medical services. Ā ese services cover various areas of health including the standard out patient department providing regular consultation to patients, as also various specialities such as pediatric, gynecology and obstetrics, orthopedics, radiology, sports medicine, and so on.

As a result of the recent preliminary Green IT audit of the hospital, it has been revealed that the hospital had a significant carbon footprint. Significant reviews of patient management processes, management o f e lectronic pat ient re cords (EPR), l aboratory e quipment m anagement, m edical drugs and material management, and management of equipments and buildings were undertaken. Initial opinion of the aud itors a nd that of the tentatively ap pointed chief g reen offi cer (CGO)

was that significant optimization was possible in all these areas of the hospital that will reduce its carbon footprint. The cost-effectiveness and efficiency of the hospital's service processes is as important as its carbon efficiency. Thus, the benefits envisaged in terms of its cost reduction and process optimization are significant. Further to the attention on processes in terms of their carbon reduction, the initial investigation also highlighted that GoodMead has a significant investment in a data center. The building and infrastructure of this data center is now more than 10 years old, and the server machines themselves are averaging 4 years in use.

The audit also revealed that the hospital, by undertaking a Green enterprise transformation (GET), would be able to influence many of its partnering organizations. These are the labs, pharmacies, and suppliers.

The return on investment (ROI) of the hospital's attempt to transform to a Green hospital is meant to go beyond the carbon focus and into the overall business optimization arena. Thus, the hospital leadership is keen to make effective use of new fund allocations that have been indexed to carbon reduction. This effective use includes an approach that will benefit the hospital overall and is not limited only to IT-related carbon reduction.

Preliminary Green Investigation

As a result of the decision taken by the new, visionary leadership of GoodMead hospital, the aforementioned preliminary Green IT audit was conducted. This audit took place over 4 weeks. The main sponsor of this audit was the tentatively appointed CGO. The CGO, together with the IT auditors, departmental heads, and the CIO sought input into the current state of the hospital. The framework for this audit was based on the four dimensions of GET. Thus, input was obtained in terms of the economic performance, sociocultural or attitude, business processes, and technical infrastructure of the hospital. The CGO is seeking input from Green IT experts as well as experts from the medical administration domain on how to approach the GET.

Following is a list of the noteworthy findings from the preliminary Green IT audit of GoodMead hospital:

- The hospital being a large, public sector hospital, has to undertake action in terms of measuring, reporting, and reducing its carbon emissions.
- The hospital has significant opportunity to influence its partnering organizations.
- The OPD (out-patient department) of the hospital is a large and complex department that operates out of its own separate building and infrastructure. This department is serviced by 220 stationary desktop machines, 100 mobile laptops and PDAs carried personally by the staff and numerous supporting IT paraphernalia—such as printers. This department alone, according to estimates and with assumptions in terms of computer usage, accounts for 60 to 65 kT (kilo Tonnes) of carbon emissions of the hospital.
- The hospital has additional desktops, printers, laptops, and PDAs that are in the other departments such as surgical and laboratories. These devices amount to 20 kT of emissions at this stage.
- Printers are heavily used for writing of scripts, printing of patient records and reports and related documentation (such as a referral). On an average, the hospital prints 5,000 pages of normal paper and consumes corresponding ink and printer time.
- The hospital has an attached pathological laboratory that conducts diagnostic blood and related tests. The lab equipment is aging. Similarly, the data stored in the hospital's servers

that provides that information to staff on the results from the tests is also significant consumer of power and generates carbon emissions.

- Pre- a nd p ostsurgical a ctivities re quire subs tantial number o f e lectronic e quipments a nd information technology support.
- Ā e hospital has to n eed to p roduct subs tantial a mount of l egal do cumentation (such a s signing of authority to perform certain operations), and so on.
- Ā e hospital collaborates with external pharmaceutical organizations as well as manufacturers and distributors of drugs and hospital equipments. Ā is collaboration is a combination of manual interactions and also some initial web services based interaction.
- Staff rostering is not optimized, leaving the administrative staff to occasionally use physical notepads, whiteboards, and diaries to book availability of doctors.
- Scheduling system for patient appointments, surgical procedures and human relation (HR) (e.g., doctor vacation) is also not optimized and requires a major upgrade. Scheduling patient consultations, scheduling work rosters for nurses and administrative staff is many a t imes happening manually.
- A c omprehensive multimedia d ata w arehouse project i s u nderway. Ā is project is a imed at consolidating the large amount of data, in multiple formats, in a si ngle data warehouse. Furthermore, selected past consultations in audio and video are also to be made available to authorized users like doctors, patients, and external specialists.
- With the availability of a multimedia database, there is opportunity for optional extensions to the project is to incorporate possibility of remote consulting by doctors through audio and video media using high-speed connectivity.
- Security of access and privacy of patient's data (EPR) is of top priority and is not to be compromised under any circumstances.
- A range of relative cross-functionalities (like sports information) to be included to at tract and keep nonpatients to the site as well. Ā is may help in keeping the community aware of the site.
- Internal administrative systems (like booking of surgeries to operating rooms, or leave roster of nurses) be moved to the Internet-based system to enable global (or off-site) management.
- Ā ere are provisional inventories that are in excess. Ā ese are both medical and IT inventories. For example, there are 15 PCs sitting in the IT departments as potential backups for breakdowns. Similarly, the data center has excessive unused storage capacity.

Green Business Objectives

Ā e green business objectives of GoodMead hospital a re ba sed on the re sults of the preliminary investigations into its Green IT maturity level. Ā ese objectives provide the basis for the transformation plan. Figure 12.1 shows the overall approach to GET for GoodMead hospital. On the left is the description of the "as is" state of the hospital from the environmental perspective. On the right is the "to be" or desired state of the hospital. Ā is "to be" state of the hospital is based on the formation of green objectives of the organization. In between, in Figure 12.1, is the outline of the GET framework, as applicable to GoodMead. Ā e four major phases of transformation—diagnose, plan, enact, and review—interspersed with metrics, are shown in this high-level transformation framework.

Following are the important objectives of GoodMead in undertaking the GET:

- Reduction in carbon emissions across all departments and processes of the organization
- Compliance with carbon legislations and related carbon initiatives of the government (even if they are not fully ratified as law)

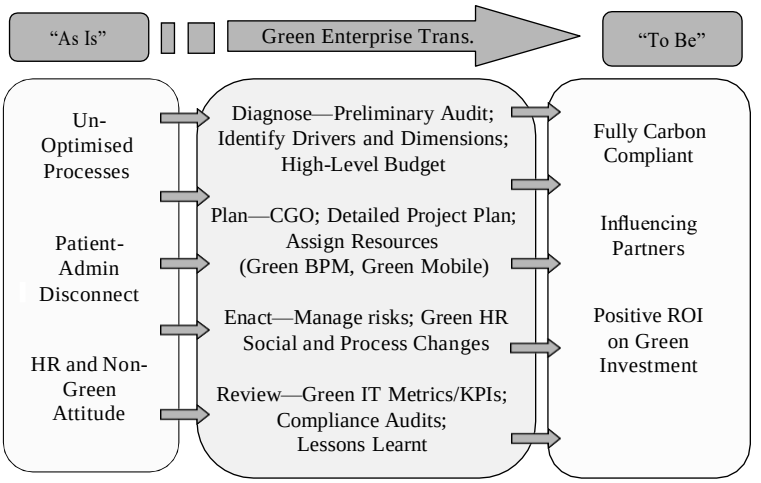


Figure 12.1 GET for GoodMead hospital.

- Be a leader in carbon management and, thereby, influence many business partners in reducing their emissions
- Undertake electronic collaborations with partners, government regulatory bodies for monitoring and reporting
- Undertake comprehensive Green BPM program that will enable result in modeling, optimization, and merger/elimination of processes
- Aim for a comprehensive and holistic GET that is futuristic
- Create positive green attitude across the entire staff through Green HR

SWOT of GoodMead Hospital

Figure 12.2 shows the SWOT analysis of GoodMead hospital. Such a SWOT analysis is helpful in understanding the approach that can be taken for the GET. For example, GoodMead is a l arge hospital with multiple campuses and departments within them. A SWOT analysis makes it easier to understand how to capitalize on the inherent strengths of the hospital. Ā e areas that will be directly affected by the transformation and bear risks will also become evident in such an analysis. In practice, this will be a substantial exercise encompassing all these departments. In this example case study, the SWOT analysis can help understand the scope and coverage of work during this transformation.

Following understanding develops as a result of the SWOT analysis of GoodMead hospital in its "As is" state:

Strengths

- *Well-known public sector hospital*. Ā is popularity of the hospital is an important impetus for the hospital to undertake GET. Ā e impact of such transformation will be far reaching, beyond the hospital. Ā ere is significant support to the hospital in terms of patients and corporate.
- *Financially well sup ported b y gove rnment*. G oodMead h as b een a fl agship hospital in the region, w ith su fficient f unding f rom t he g overnment over t he l ast de cade, en abling i t to undertake its services, together with its research and training.

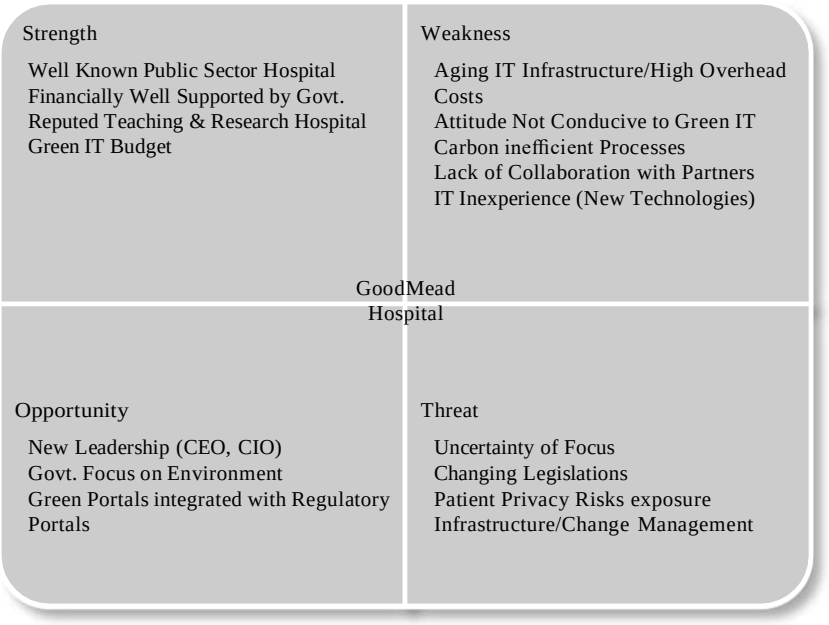


Figure 12.2 SWOT for GoodMead hospital.

- *Green IT budget*. A recently elected government has provided additional, specific grant to the hospital to enable it to improve its environmental credentials.
- *Reputed teaching and research hospital*. Ā ere is an atmosphere of research and experimentation. Ā erefore, the hospital will be ideally placed to experiment with carbon reduction and wastage reduction across its various departments and processes. Besides, the staff it highly skilled in what it does—including medical, administrative, and IT support.

Weaknesses

- *Aging IT infrastructure*. Ā e preliminary Green IT audit finds that the data center is more than 10 ye ars o ld a nd t he av erage s erver i s 4 ye ars i n u se. Ā is i mplies a r apidly a ging infrastructure that is not able to capitalize on the benefits of newer server designs and techniques for cooling. Furthermore, such infrastructure also implies high overhead costs for its operation.
- *Attitude not conducive to Green IT*. A preliminary survey carried out during the audit, and one-on-one interviews with a fe w volunteer staff indicated clearly that the attitude within GoodMead was not positive toward Green IT. Understandably there was skepticism for the initiative—particularly from the medical staff who considered IT-related carbon savings as not substantial.
- *Carbon i nefficient processes*. Numerous p rocesses were i dentified at t he o rganization l evel that was carbon inefficient. Ā ese processes included patient management, inventory management, and staff rosters. Ā e IT systems supporting these systems were a lso not carbon efficient. Ā is implied the processes were taking unnecessarily long, bureaucratic steps that the activities were redundant and the systems supporting the processes were data intensive

without providing required value. Ā ere were no technology innovations within the systems such as use of Cloud computing or web services.

- *Lack of collaboration with partners.* Especially the supplies to the hospital were arriving uncoordinated and the hospital's IT systems were not integrated with those of the supplier.
- *IT inexperience (new technologies).* While the hospital was advanced in research and training in the medical field, it was lagging behind in terms of experience with new and upcoming information technologies. Ā erefore, there was little initiative from the current IT management to undertake major changes relating to carbon reduction.

Opportunities

- *New l eadership (CEO, CIO).* One of t he most si gnificant opp ortunity G oodmead h as to develop and implement environmentally responsible business strategies is the formation of the new leadership team. Ā e appointment of the CGO to oversee the entire green transformation and, together with the CIO, report to the corporate board, is an important development in itself.
- *Government focus on environment.* Ā e re gulatory bodies a re now getting a p ush through government i nitiatives on c arbon re duction. A s a re sult, new l egislative re quirements a re about to b e i mplemented, m aking i t m andatory fo r l arge organizations i n pa rticular, to calculate a nd rep ort t heir c arbon em issions. Ā e pa rticular fo cus b y t he g overnment on organizations that are semi- or quasi-government is providing the necessary opportunities and impetus to carbon reduction initiatives—such as in this hospital.
- *Green portals integrated with regulatory portals.* Ā e push from the government for carbon reduction i s n ot o nly a n o pportunity fo r t he h ospital to t ransform i ts b usiness m odels, portfolios, and data centers, but also upgrades its IT systems and portals with carbon data and information. To that effect, the government is now providing web services through its regulatory portals that can be used by "consumers" of web services. Telework and telemedicine—the te lemedicine m arket i s g rowing at a h igh r ate w ith de veloped nations h aving already implemented several projects and the technology is becoming increasingly affordable. Ā erefore, there are greater opportunities for reducing emissions through telework and, in particular, telemedicine. More and more economical by the day.

Threats

- *Uncertainty of focus.* While the senior management of the hospital is committed to a green hospital, there is occasional shift in the focus due to the changing nature of the technology domain. For example, the social aspect of Green IT is not positive at t his stage, but to bring about a change in that sociocultural domain will require significant training and education of the staff. Changes will also be required in the user devices such as PCs and laptops. Ā ere is high possibility of conflicting objectives and therefore further uncertainty of focus. Ā e senior management has to be taking the initiative and remain in charge to maintain focus.
- *Changing legislations.* While the government is supporting the initiative and is pushing for GoodMead to be environmentally responsible, the legislations themselves are not firm yet. Ā erefore, there are changes to t he way the scopes 1 a nd 2 a re calculated, changes to t he emission benchmarks, and so on. Ā is is creating further uncertainty and risks in formulating and implementing Green IT strategies.

- *Patient privacy risks exposure*. Privacy and confidentiality requirements of the patient's information needs to be protected as the transformation of technical systems and data warehouses takes place.
- *Infrastructure/change management*. Due to the aging and underdeveloped nature of the technical environment, it may be hard to implement some of the technological solutions in which reliability of the service is crucial.

Strategic Concerns of Management

Āe aforementioned SWOT analysis provides significant input in identifying the drivers for environmentally responsible business strategy (ERBS) and vice versa. Āe senior management can start with a general understanding of the drivers for ERBS which, later, get formalized as the SWOT analysis is undertaken.

Figure 12.3 shows the key drivers for environmental responsibility for GoodMead hospital. Out of the six drivers that drive ERBS (as discussed in Chapter 2), Figure 12.3 shows social-political pressure, and enlightened self-interest as the two key drivers for ERBS. Āese two drivers are described as follows:

- Sociopolitical pressure: Āe hospital has a substantial standing in the community. Besides, it is also a flagship hospital within the region. Āere is significant social and political pressure on the hospital to demonstrate its environmental credentials. Āis pressure comes from the general community that views the hospital as a symbol of good service-based organization and cross-section of patients (e.g., youngsters, sports-people).

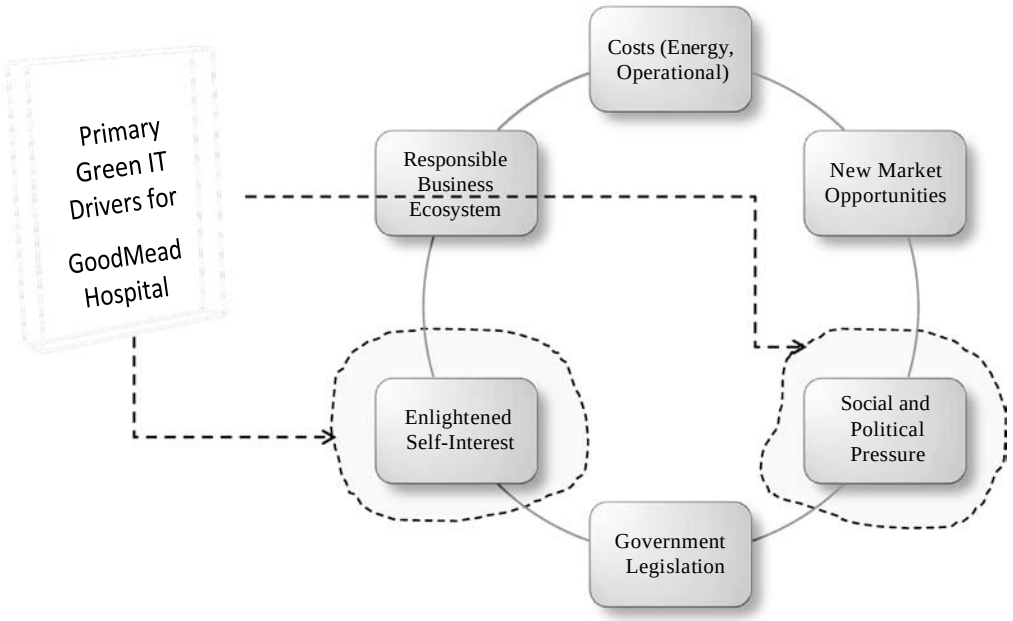


Figure 12.3 Drivers for environmental responsibility of business.

- Enlightened self-interest: Ā e senior management of the hospital, the leaders/decision makers are keen to take up the challenge of changing their processes and internal social attitude to a p ositive, green attitude. W hile they are certainly buoyed by the ava ilability of funds dedicated for this purpose, they are themselves realizing the need to u ndertake this green enterprisewide transformation to enable them to remain as a leader in the upcoming carbon economy.

Steps in Developing a Hospital's ERBS

Figure 12.4 shows the major steps in the development of an Environmentally Responsible Business Strategy. Ā is figure is based on Figure 2.13, which was discussed in detail in Chapter 2. Here, though, Figure 12.4 not only serves as a reminder for the steps in developing an ERBS for the hospital, but also shows the key drivers, dimensions, risks, and metrics for this GoodMead ERBS.

- Ā e business objectives of the hospital in becoming a green hospital were identified earlier on. Ā ese objectives and visions provide the initial direction for the hospital in its strategy formulation. Ā e d rivers for t he objectives a re en lightened s elf-interest a nd so ciopolitical pressure on the hospital.
- Green IT s trategies: Ā ese a re the medium ter ms (3–5 ye ar) s trategies that a re driven by the CGO and that are based on the drivers and objectives of the organization. Strategies for Green IT also contain elements of risks or threats, as were identified during the SWOT.
- Green IT policies and preconditions: Ā ese are the policies that are formed at t he departmental l evel a nd a re i mplemented i n practice by t he depa rtmental heads a nd/or process

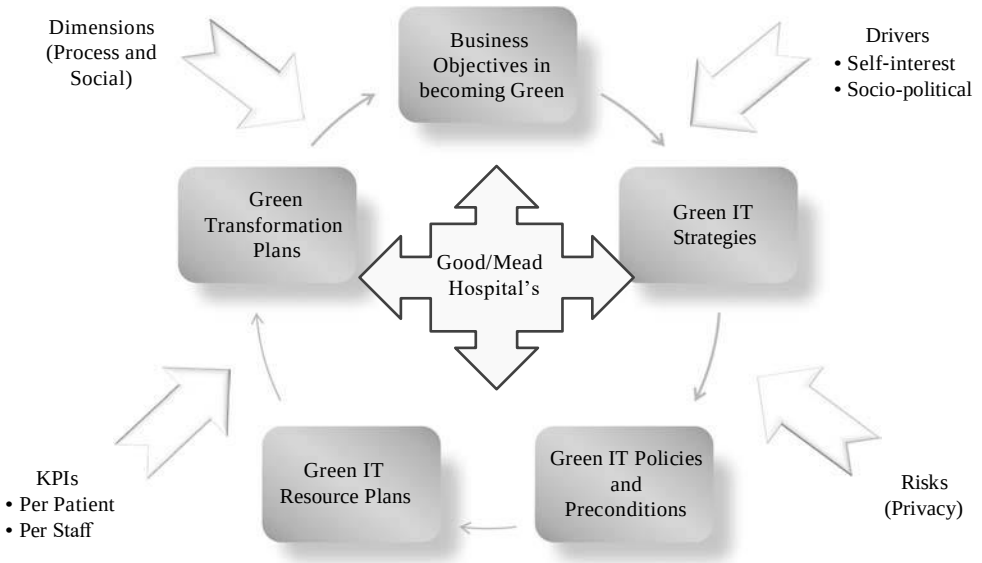


Figure 12.4 Steps in developing an ERBS.

owners. Āese policies related to procurement of new equipments (Energy Star ratings), changes to processes and delivery of training to staff.

- Green IT resource plans: Āese include details of resources required in undertaking transformation. For example, in case of GoodMead, the green transformation team itself would be lead by CGO, supported by the Green HR (as shown in Chapter 8) and will be interacting with the operational staff (doctors, nurses, administrators). Resource plans also include budgets and resources for procuring and implementing CEMS. Āe success of the transformation can be measured here based on Green KPIs (see chapter 2).
- Green transformation plans: Āese are the business transformation and change management plans that will focus on the dimensions and the work areas as described in Chapter 9.

Green Transformational Elements

Putting together the discussions thus far, Figure 12.5 shows the major green transformational elements of GoodMead hospital. Āe overall green transformation framework is shown on top with the various important elements underneath. Āese elements are as follows:

- Āed rivers and areas of influence. Āed rivers for GoodMead are shown earlier in Figure 12.3.
- Āe major dimension along with the GET will take place. Āis is the process dimension also supported by the social dimension for transformation.
- Āe demographics of the organization can play a role in deciding on the type of transformation, its budgets, and its resources. In case of GoodMead hospital, these demographics are large-sized service organization in a metropolitan city of a developed region.

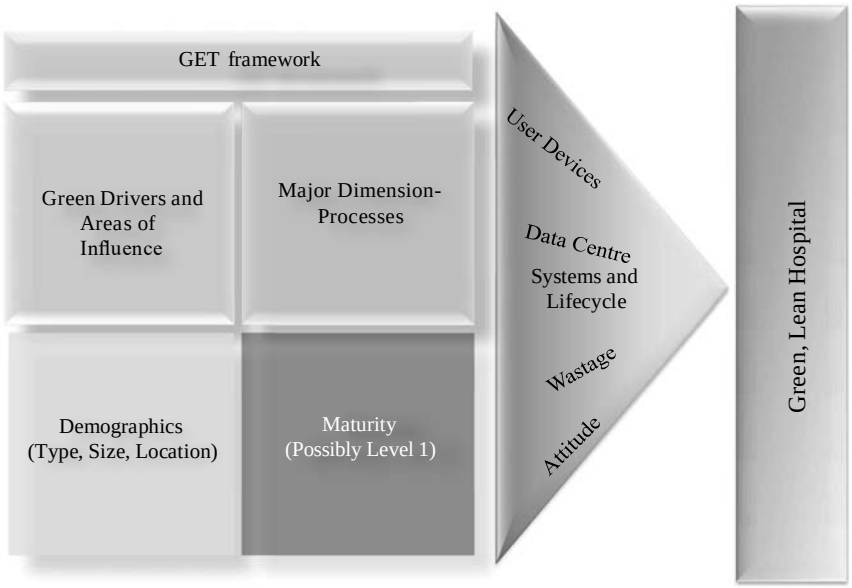


Figure 12.5 GoodMead hospital's major green transformational elements.

- Maturity of GoodMead in terms of its Green IT performance is very basic (Ā is cannot be fully ascertained at the start of the project as the process for measuring itself are not matured enough. However, a rough indication of the maturity level can be provided.).

Once these aforementioned aspects of GoodMead are ascertained, the transformation of the hospital can be undertaken as follows (also shown in Figure 12.5):

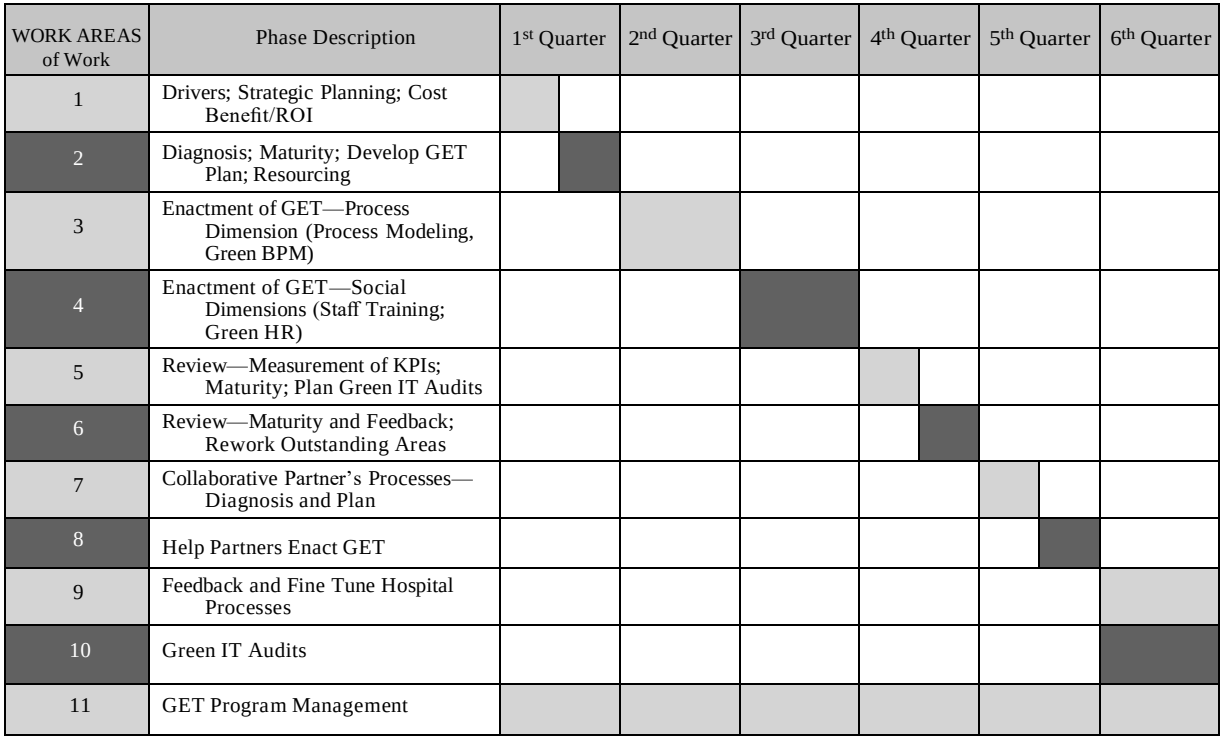
- User de vices—Measuring, upgrading, a nd re cycling monitors, P Cs, l aptops, a nd mobile phones; desktop virtualization; centralized green services
- Data center—Virtualization, optimization; self healing networks; network topology, database design, hardware and software components, security issues, and backup strategies. Redesign of data center to include flexibility and agility to enable easy upgrades of future infrastructure
- Systems and lifecycle—IT systems supporting hospital processes like booking, consultation, diagnosis, t reatment, p rescription, a nd e ducation; E quipment p rocurement, i nstallation and usage; integration of supply chain with local as well as overseas pharmacies and drug suppliers. Interaction with government and other regulatory bodies should also be enabled electronically
- Wastage—Electronic waste resulting from unused or broken devices; also, due consideration is given to areas of bio waste
- Attitude—Undertaking training and consulting programs for staff (doctors, nurses, admin) and promoting it amongst patients and business partners. Internet-based system to facilitate global management of the administration, rosters as well as the most HR (human relations—People) functions. Change management for telework and telehealth

The Green Transformation Project

Ā e overall GET project is to last between 12 and 18 months, with the full carbon value realized over 3 to 5 year's strategic time period. $ 1 million is the budget sanctioned by the corporate board and the CGO is authorized to undertake this transformation.

Figure 12.6 shows greater details of the 18-month GET plan. It is divided into six quarters of 3 months each.

- First quarter: Ā e first quarter of the hospital transformation is primarily focused on investigation and diagnosis. Ā is work includes identification of the key drivers for green transformation (in case of the hospital it is sociopolitical and enlightened self-interest). During the first quarter, the CGO will lead the strategic planning for the hospital, creating a 3–5 year actionable strategic plan. Ā is plan will also include the return on investment metrics for the hospital.
- Second quarter: Ā is i s the quarter where en actment of the plan cre ated i n the previous quarter takes place. In case of GoodMead, the enactment of GET in this quarter deals with the process dimension of transformation. Ā erefore, Green BPM (as discussed in Chapter 5) comes i n to p lay during t his quarter. I n t he c ontext of t he health-care i ndustry, process changes require extensive modeling, verification and validation, and tools support. Carbon content of t he ke y processes needs to b e e stablished beforehand. Ā is will happen in an approximate way in the diagnosis phases. Here, in the Green BPM activities, processes are reengineered and their carbon contents calculated again to ensure it has indeed reduced.



WORK AREAS of Work	Phase Description	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	5th Quarter	6th Quarter
1	Drivers; Strategic Planning; Cost Benefit/ROI						
2	Diagnosis; Maturity; Develop GET Plan; Resourcing						
3	Enactment of GET—Process Dimension (Process Modeling, Green BPM)						
4	Enactment of GET—Social Dimensions (Staff Training; Green HR)						
5	Review—Measurement of KPIs; Maturity; Plan Green IT Audits						
6	Review—Maturity and Feedback; Rework Outstanding Areas						
7	Collaborative Partner's Processes—Diagnosis and Plan						
8	Help Partners Enact GET						
9	Feedback and Fine Tune Hospital Processes						
10	Green IT Audits						
11	GET Program Management						

Figure 12.6 An 18-month GET project plan for GoodMead.

- Ā ird quarter: In case of GoodMead, this quarter of GET is dedicated to transformation of the social dimension. Ā erefore, this quarter focuses on the attitude and behavior of individual staff. Social dimension also becomes important in a service organization as the output of the organization is the service to the customer (patient in this case). Ā us, while the employees are equipped here with training that enables them to tap into the environmental data, information and knowledge within the organization, the patients, and the society in general i s updated with the changes occurring within the hospital. Metrics and measurements associated with the social dimensions come in to play.
- Fourth qu arter: Ā is quarter i s for the " Review" phase of the t ransformation. Ā ere fore, there is heavy focus on measurements ba sed on the earlier defined metrics. Ā e se include the Green KPIs—such as CO2E per computer/laptop/mobile, CO2E per Staff member or per patient, KPIs associated with recycling of computers. Ā e KPIs can also be fine tuned for ongoing and continuous improvement in the future. Review phase can include Green IT audit to a scertain the maturity of the organization. Reduction in complexity of processes, improvement of quality of service and compliance with legislative requirements are included in the criteria for success.
- Fifth quarter: If the Review phase indicates success in terms of GET, then the organization like GoodMead needs to immediately focus on providing the transformation support to its partners. Ā ese are the pharmaceuticals, laboratories, equipment suppliers and, of course, various patient-related bodies such as medical insurance providers.
- Sixth quarter: Ā is is the quarter where feedback from the transformation will have a substantial effect on the next steps by the hospital. Formal external Green IT audits are conducted in this quarter and compliance with the regulatory requirements can be formalized. Ā is quarter also starts an ongoing journey for environmental program management for the hospital that will work closely with the Green HR function in ensuring Green IT specific roles are maintained, and individuals working in those roles are motivated and trained.

Figure 12.7 shows the returns on the GET project for GoodMead hospital. While these returns are not the core drivers for the ERBS, they are still important to prove two key points: (a) the GET is closely tied with the profits and (b) GET will lead to increase in the overall performance.

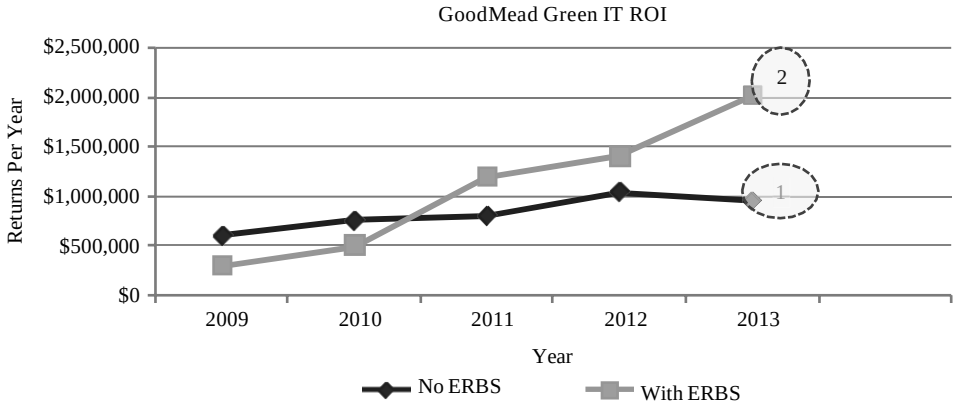


Figure 12.7 GET cost-benefit (ROI) analysis.

Graph 1 in Figure 12.7 shows the growth of the organization and its returns over 4 years with the business as usual. With the investment in the ERBS, the initial expense is higher and therefore the net returns for the first year are lower—this is visible in Graph 2 in Figure 12.7. However, over the period of next 3 years, the overall efficiencies and effectiveness resulting from ERBS also produce returns on the original investment to "go green."

Social Dimension in Hospital GET

Changes to the social dimension of the hospital is particularly brought about during the third quarter of the transformation. Āese changes include the following:

- Creation and delivery of training programs for staff at all levels: Āese training programs range from a 2-hour seminar on what Green IT means through to the detailed 3–5 days worth of training (spread over 3–5 weeks to ensure minimal disruptions to the normal working of the hospital).
- Review of attitude toward Green IT through quick surveys and feedback: Āese surveys can be run online within the hospital's systems ensuring immediate collation and analysis of the results. Surveys are required before and after the transformation—in this case in the first and after the fourth quarter.
- Use of IT systems support to reduce the routine pressures on doctors beyond the needs of their own specialist or generalist skills. Āis would be the result of Green BPM, but is also requires training for the doctors to enable them to use the new green processes.
- Implementation of metrics to provide real-time feedback to users on their daily carbon footprint: A CEMS implementation is inevitable in GoodMead; and such a CEMS will provide the necessary means of capturing and using carbon data on a regular basis.
- Creation of telework program for support functions: Some admin. and support functions in the hospital can benefit by telework. For example, scheduling of rosters, billing of patients and some HR functions can be partially carried out by support staff through Telework. Āis will create opportunities to reduce people and equipment movement, and also reduce carbon emissions.
- Telehealth: It does more than provide assistance of patients in need of medical support but who are not in physical proximity of a medical officer. A physician or a health-care specialist using telehealth also, directly and indirectly, contributes to reduction in the carbon of that process; improve health support in remote regions; education, research, and administration in the field of medicine can be improved through telemedicine without increasing the carbon footprint.
- Development of a Green HR function that includes training, reward, and growth structure, particularly for admin and support staff, in terms of Green IT.

Technology Changes in Hospital

Technology changes in the hospital as the green enterprise transition program gets underway relates to the user devices, data center, equipments, and wastages. Following are the technical changes during GET:

- Replacement of servers to the low-carbon emitting servers in the data center.
- Gradual replacement of devices to low-carbon devices.

- Changes to the current backup, including off-site backups of data on the data servers.
- Upgrade of IT systems to automate processes.
- Upgrade to the EPR by implementing a strategy to move it on the Cloud. EPR can enhance medical record documentation and optimize the consulting process of the doctor with the patient. De spite t he r isks a ssociated w ith t his s trategy—particularly f rom p rivacy v iewpoint—the ap proach o f u sing t he C loud fo r E PR i s l ikely to p rovide si gnificant carbon reductions.
- Paper-less medical reports to reduce not only the paper wastage, but also time and effort in maintaining the manual records is saved.
- Collaboration with partners—such as sending of prescriptions electronically, or sourcing of medical drugs using web services.
- Green BPM for processes, including ordering and re trieving laboratory te sts, prescription writing, consultation or referral notes, and billing.
- CEMS will be involved in recording carbon data that corresponds to various clinical activities. For example, consultation with a patient can be recorded in terms of time, types of examinations, reviews, progress notes, prescriptions, and follow-up consultations. Pathological tests and the delivery of results to the physician's computer will also be calculated for its carbon contents.
- CEMS will be measuring and monitoring the hospital processes surrounding staff rostering. While the actual rostering process is currently a combination of the HR system and some whiteboard manual process, CEMS will be configured to m easure t he "slack" i n the rostering process. Ā e principles of "Lean" business can be applied here to reduce the slack and tighten the process. Corresponding reduction in carbon can also be calculated based on reduced rostering overheads, reduced or elimination of double booking of staff, and so on.
- User devices changes includes end-user devices such as PCs in the consulting rooms, examination rooms, nursing workstations, and administrative hardware.
- Communications and network equipments. Network infrastructure includes virtual private network (VPN) fo r h igh-speed c ollaboration w ith other hospitals, s ervice providers, a nd paterning organizations. Local area network (LAN) supports local communication within the GoodMead precinct.
- Non-IT e quipments a nd t heir l ifecycle h as to b e sub ject to t he G reen P -O-D. Ā es e equipments, such as are used in operating theatres or X-rays or in the pathological tests may not come directly under IT domain, but are still significant contributors to carbon emissions.
- Electronic wastage—policies and procedures. Ā ese have to discussed, updated and brought in practice through training of staff.

Applying Mobile Technologies in GET

Ā e use of mobile technology in the health-care services can provide substantial process benefits that also translate to carbon advantages. Ā ese various mobile advantages to Green IT were discussed earlier in this book. A large number of hospital staff, such as the physicians, nurses, and administrative staff are using mobile laptops, blackberries, and iPhones to connect for both work and social networking. Following are the specific advantages that mobile technologies offer to the major users in GoodMead hospital from a carbon reduction viewpoint:

Doctors

Mobile technology can reduce carbon throughout the physician's work and social processes. For example, h andheld to ols de dicated to a p hysician's ro utine (e.g., TouchWorks f rom A llscripts Healthcare Solutions) can provide instantaneous data and information to the doctor. Ā is can not only improve health-care services to patients and eliminate geographical distances but also reduce carbon content of the service.

GoodMead is providing dedicated health-care mobile tools and supporting technologies to all doctors that will enable them to serve the patients most efficiently, engage in conversations and conferences through their devices, and have fast access to patients' data. Ā e actions taken by the physician are also documented through the device, enabling easy tracking of actions when a staff member hands over the care of a patient to another member.

Nurses

Ā e use of mobile technology is a lso helps the nursing staff to c oordinate with the doctors and the pat ients on a re gular ba sis. GoodMead fi nds that the use of handheld de vices by nurses i s improving the consulting/advisory roles that nurses play (especially in a postoperative situation). Furthermore, m obile de vices a lso i mprove t he v ital re cord ke eping o f pat ients w ith h igh e fficiency and no physical paper. Checking the availability of doctors, quick consultations with doctors, h anding o ver d uring t he sh ifts a nd p ersonal H R d ata a ccess—all o f t hese p rocesses a re improved for nurses through the use of mobility in the hospital which, in turn, has reduced carbon footprint.

Patients

GoodMead as a large, public sector health-care provider needed to provide excellence in service without the carbon overheads. Use of mobile technology has given greater flexibility for the patients without being physically go to t he hospital for check up. Starting right with the use of the mobile phone, patients are now able to connect using various PDAs and mobile laptops. Ā is has reduced patient movement, patient queuing and has provided location-independent advise to patients where they needed it most. Additional mobile gadgets that monitor patient data remotely, provides it to the hospital and also raises relevant alerts has optimized the processes and reduced their carbon contents.

Suppliers (e.g., Pharmacies)

Mobile technology improves receiving and ordering processes between hospital and its drug supplier. In addition, it a lso provides better management and storage system. GoodMead has proceeded w ith Mobile S olutions, a h andheld de vice f rom C ardinal Health, w hich h as sc anning facilities based on a pocket PC. Ā is device enables GoodMead's staff to work directly with hospital inventory, resulting in optimized inventory for the medical drugs and also medical equipments in use.

Lessons Learned in Implementing Green IT Strategies

Following are the lessons learned as a result of the GET initiative for the hospital. Ā e se lessons indicate the significant role of Green ICT in the hospital domain.

- Strategic reduction in carbon will require significant changes in the social, process, and also technical dimensions of the business. Ā ese changes are across the board and not restricted to a single department or process.
- Service organizations are particularly influenced by customer expectations. In the case of GoodMead, the patients and the society in general was more keen to see the hospital become a green hospital, as compared with the internal staff and administrators.
- Telework and telehealth are likely to play a significant role in not only improving the business processes of the hospital, but also its carbon emissions record.
- Operational carbon reduction is more effective when processes are to be changed as compared with the changes to the procurement and disposal cycle.
- Training and education play a significant role in carbon reduction in a hospital—and similar service organizations—as they bring about a change in attitude and approach to Green IT restructuring to Green HR is also a significant boost to the carbon reduction effort from a social angle.
- Changes to IT systems that support business and technical processes should be made with the backdrop of environmental intelligence. Simple carbon data mining will not provide strategic value of directions for a transforming organization.
- Ongoing monitoring of r isks a ssociated with GET should be planned for enacted. Ā es e risks are not restricted to only the main dimension for transformation but can emerge from any of the four dimensions.

Chapter 13

Case Study in Applying Green IT Strategies to the Packaging Industry

Key Points

- Presents how Green IT can be applied to a p roduct-type company in the manufacturing sector
- Outlines a hypothetical organization, AuPack, involved in manufacturing packaging products for various types of clients
- Discusses the importance of ISO 14001 application in the manufacturing sector
- Stresses the importance of recycling and take-back programs by product developers in reducing the overall carbon footprint (and how green integrated supply chain systems can help achieve that)

AuPack Scenario

AuPack is a hypothetical organization in the business of manufacturing packages and containers that, in turn, are used by other manufacturers of goods and products. Medium in size in the context of the developing nation from where it operates, AuPack has established itself over the last decade as a reliable, honest organization. AuPack has around 10,000 workers (which classifies it as a medium-sized company in the region where it operates) and a forward looking corporate board led by a recently appointed young CEO. AuPack is keen to move forward in the area of Green IT. Ā e carbon emissions from its production lines are on the rise, and also the electronic and other wastages. Ā e wastages, in particular, are not just restricted to the organization but are occurring

at an alarmingly high rate with the end-users of the contents of the packages. Ā e local regulatory authorities are also showing interest in AuPack's carbon footprint.

Ā e products of AuPack include va riety of packages that a re made up of materials such a s cardboard, foam, plastic, choir, and rubber. Ā ese packages or containers are sold to other manufacturers who use them to w rap, store, and distribute their own products, including food (raw, finished, liquids), medical drugs, equipments, and electronic goods (such as TV, computers, toys). Ā e containers produced by AuPack, therefore, need to range from boxes, tubes, and bubble-wraps through to tin cans and jars—to name but a few. Customization of these packaging products for specific customers is a regular occurrence.

Manufacturing of the packages requires materials to be sourced, planning of the production process, inventory of produced packages, and a customer management system. Ā ese are business processes that are a combination of manual, paper-based, and electronic (local, spreadsheet based, and system supported) processes.

A recent internal audit revealed that the organization has around 350 desktop machines, close to 100 laptops, and two large data servers in a small, backend data center. Most PCs have been in use for 5 or more years, have cathode ray tube (CRT) monitors, and are used by accountants, production shift managers, and administrators. Connectivity for most machines is provided through internal LANs and WANs and externally using a combination of virtual private network (VPN) (especially with dedicated corporate clients) and the Internet. Ā e hardware of the organization is used to run variety of applications including AuPack's assets and inventory management, customer service, financial management, procurement, and HR/Payroll. Data corresponding to these applications is stored in the underlying data warehouse of AuPack on the two servers. A significant part of the production and inventory data is collected from the shop floor automatically and updated in the data warehouse.

Following are the current observations of the CEO together with the internal auditor in terms of AuPack's situation from environmental sustainability viewpoint:

- Raw materials for packaging are available in abundance. In fact there is excessive availability of raw materials particularly from the regions where AuPack is located.
- Workers are dedicated to the company. However, most workers have had very basic education, and in some cases no education at all. While expert in particular production process, these workers had no current interest in Green IT or carbon reduction.
- Wide customer base from both developed and developing region with the business from the developing regions on the rise.
- Network of transporters who partner with AuPack to bring in raw materials as well as deliver blank, ready-to-go container packages, typically to the corporate customers.
- Continuously changing needs of customers—as their products are changing too. Ā ere fore, there is hardly ever a mass production of packages and most production runs are customized and the production and planning departments are continuously on their toes. Ā is requires substantial c omputing s ystems su pport—especially i n t he pa ckage de sign offi ce and the shop floor.
- Other departments of AuPack, that are under the direct influence of these changing requirements are sales (as the orders keep changing regularly), financial (as it is a challenge to ascertain the exact cost and, therefore, the way in which the product should be priced), customer service (in terms of current management of expectation and future handling of issues arising from nonstandard packaging) and, eventually, legal department (as the packaging products are sold worldwide).

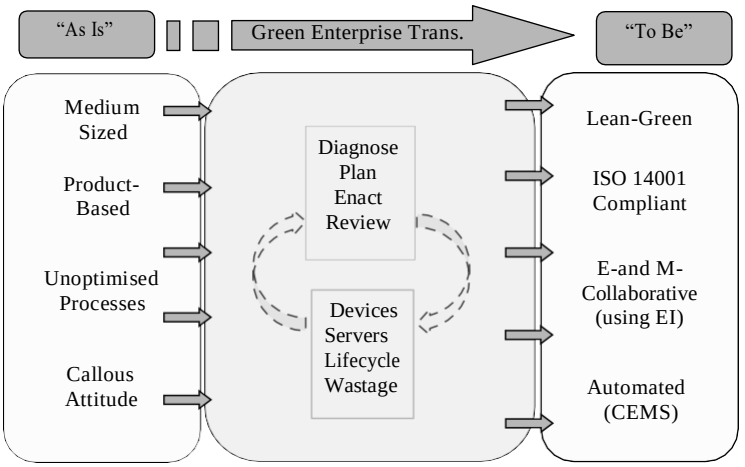


Figure 13.1 GET for AuPack packaging.

Figure 13.1 summarizes the overall approach to G reen enterprise t ransformation (GET) of AuPack. Ā e "as is" state is ascertained through an initial investigation based on an early, approximate Green IT aud it. Such an aud it, a s discussed in Chapter 10, would not be very precise a s the organization itself is not matured enough to re veal exact data in terms of its emissions. Ā is investigation, based on the personal initiative of the chief executive officer (CEO), indicated to the board for an urgent need for a Green IT strategy and subsequent action. Ā e carbon legislations in the region are becoming stringent, and even more importantly, in the overseas geographical regions where AuPack's business i s growing (such a s the EU countries). Ā e "to be" or de sired state, according to the initial vision statement of the CEO, is for AuPack to be a lean-green organization. Ā is ter m indicates that the organization i s interested in *both* cost a nd c arbon i ssues and not one over the other (this philosophy of a Green IT strategy was discussed in Chapter 2, Figure 2.1). Apart from reducing its carbon footprint and becoming a lean organization, AuPack is also interested in making use of and complying with the ISO 14001 standard. Ā is, the CEO believes, will also help AuPack promote itself in the EU region where it is likely to do greater amount of business. Ā e center part of Figure 13.1 shows, in a summary, how AuPack will undertake the GET. Ā e d iagnose, plan, enact, a nd re view phases of the GET process, d iscussed in Chapter 9 will be applied to the four areas of an organization that need to change—the end-user devices, the data servers in the data center, the supply chain lifecycle and the way in which electronic wastage is handled.

AuPack's Green IT Strategies

As a result of the initial audit, the CEO has appointed a new CGO—the chief green officer. Ā is lady, with an IT background, currently leads the computer-aided design (CAD) department of AuPack. Ā is department has been heavily involved in the use of computers to create new packaging de sign ba sed on customer requirements. A s a depa rtmental head w ith more than 5 years of leadership experience, she had sufficient independence from the current CIO

but, at the same time, is aware of the functioning of the organization and has IT background. Ā e CGO has gone through the initial Green IT audit report, discussed it with the auditors and a lso with the CEO a nd has immediately formed a wo rking group. Ā is working group will become the GET team that will undertake the change. Ā e approach taken by the CGO is summarized in Figure 13.2. As shown in that figure, the strategic approach by the CGO is as follows:

- Immediate focus on use and capitalization of technologies with the creation of a Green IT portal. Use of the portal itself for reporting on carbon compliance by the organization.
- Launching of a GET program that is going to enable compliance with ISO 14001 standard; however, this program has to work along side the existing ISO 9001 compliance and certification program of AuPack.
- Understand t he g rowing en vironmental aw areness o f a ll i ts c ustomers—with t he i nput derived from the customers (especially corporate customers) through the Green IT portal itself.
- Extend the current process optimization initiative to make it a formal Lean process implementation that will also be measured and reporting for corresponding green-ness.
- Develop a g reen m arket t hat w ill b e sp ecifically ba sed on t he l ean-green processes (e.g., optimized package designs, use of biodegradable materials in packaging and take back of discarded/consumed packaging material through a reverse supply chain).
- Form a consortium of like minded businesses in the region and provide leadership through initial experience of GET.
- Influence and be influenced by customers and suppliers in terms of carbon compliance.

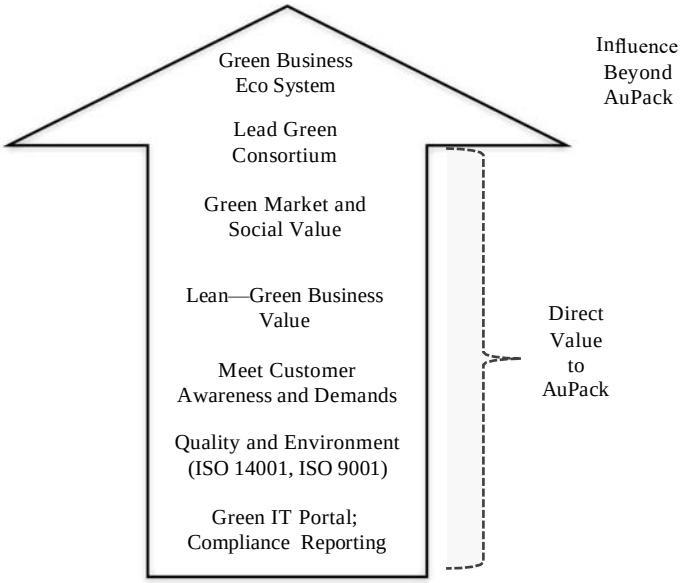


Figure 13.2 AuPack strategic approach.

SWOT of AuPack in Green Context

Figure 13.3 indicates the current strengths, weaknesses, opportunities, and threats relating to AuPack. This is SWOT analysis, however, is with a particular focus on Green IT. The strategic approach, undertaken by the CGO, indicates that this analysis will eventually be part of the overall strategic approach of the business itself. Currently, however, this SWOT analysis shows AuPack's Green IT challenges and capabilities.

Green IT Strengths

- The incoming CEO realizes that for AuPack to survive and prosper in the carbon economy there is a need to create and implement a comprehensive Green IT strategy. This is visionary leadership in itself is a strength of the organization and is recognized by the CGO who is able to work closely with the CEO.
- AuPack is progressing well financially with its business and its profit margins are on the rise. This is growth is a positive opportunity for its Green IT initiatives, as there is a budget for the GET.
- Material-savvy region, with more than a decade of experience in packaging/container production. The processes associated with procurement of raw materials are manual, but the processes are working well. Careful automation will create opportunities for optimization and, thereby, reduce both carbon and costs.
- Strong distribution network for the packages and containers produced by AuPack. This is distribution network includes strong partnership with local and overseas transporters. Some

Strength	Weakness
1. Visionary leadership through the new CEO and corresponding CGO 2. Growing business with sufficient funds—enabling easier green IT initiative 3. Material-savvy region, with more than a decade of experience in packing/container production 4. Strong distribution network—particularly overseas customers	1. Aging infrastructure—especially technical assets such as computers (desk tops and servers) 2. Workforce only experienced in package production—not necessarily IT literate 3. Non-serious attitude of most workers toward carbon footprint 4. Noticeable wastages in packaging products and IT
Opportunities	**Threats**
1. Leadership in packaging materials and designs 2. Potential to leap-frog in terms of computing technologies by directly using the latest, low carbon emitting machines and servers 3. Acceptance of ideas by partners—customers and suppliers—thereby creating leadership in the Green IT/carbon compliance space	1. Attitude of majority of staff 2. Differences in compliance requirements of the developing region versus the developed regions where customers are located 3. Inexperience in undertaking GET in the region

Figure 13.3 SWOT analysis of AuPack.

overseas corporate customers are directly connected to t he integrated supply chain system of the organization.

Green IT Weaknesses

- Ā e technical infrastructure of the organization is aging. Almost all desktop computers are 5 or more years old, and the laptop computers are also more than 3 years in use. In the context of Green IT, this implies computing hardware that has not had the benefits of new, low carbon emitting designs.
- Ā e software systems for AuPack has proliferated as there was little control over the purchase and installation of computers. Provided smaller departments had their budgets, they were allowed to procure and install computers. Ā us each department had not only a collection of desktop computers but also the overheads of networking them.
- Ā e workforce of the organization is highly experienced in production of various types of packages and containers. However, many of the production processes are manual—making use of whiteboards, paper, and the supporting IT systems. Ā e shift managers are the only people from the shop floor who make use of the IT systems for production planning. Ā is leaves almost the entire shop floor workers without any IT literacy.
- Most workers of AuPack are not serious about environmental issues. Ā is is not their personal weakness, as the socioeconomic background from where they come had little opportunity to consider the environment. However, this nonserious attitude of most workers toward carbon footprint is a concern and a weakness of the organization that will have to be rectified.
- Noticeable wastage in packaging products and IT—this wastage is derived from the non-optimized production processes that a re unable to c apitalize on the production planning and execution systems of the organization. Ā ere is also no plan or corresponding system to take back the used packaging materials and recycle them within AuPack. Use of IT—such as desktop machines, printers, and mobile gadgets—is also left to the individual users and there is no planned approach to reducing their emissions right now.

Green IT Opportunities

- Leadership of AuPack in the design and development of packaging products provides it with excellent opportunity to understand, improve, and optimize its designs, including the use of biodegradable materials and recycling of used packaging products.
- Potential to l eap frog in terms of computing technologies by directly using the latest, low carbon emitting machines and servers.
- Acceptance of ideas by partners—customers and suppliers—thereby creating leadership in the Green IT/carbon compliance space.

Green IT Threats

- Attitude of majority of staff is not serious about Green IT. Ā is was ascertained during the spot-surveys of some staff sampled from the various departments of the organization.

- Differences in compliance requirements of the developing region versus the developed regions where customers are located. Thus, even if AuPack compliance with the local government requirements in terms of carbon emissions, the carbon content in producing the packaging product will be much higher than acceptable in the EU region where the company is experiencing growth.
- Inexperience in undertaking GET in the region—there is hardly a known organization in the developing region where AuPack is located, that has undertaken successful GET. Therefore, there are risks associated with this transformation.

Diagnosis in AuPack

The initial investigation of AuPack in terms of its green credentials, and the SWOT analysis provides impetus to carry out the full GET. The SWOT analysis, as discussed in the previous section, can be a part of the diagnosis phase as well—especially if the organization is proceeding with GET irrespective of the outcome of SWOT analysis. Formal diagnosis of AuPack will lead to a detailed understanding and formalization of the drivers and the ensuing dimensions of GET.

Earlier, in Chapter 2 (see Figure 2.6), the survey participants were quizzed on their views as to what drives a GET. Forty-four percent had "agreed" and close to 27% "strongly agreed" that the need to comply with government rules and regulation is a significant driver in an organization undertaking environmental control measures. When asked about the reduction in operational costs as a driver for Green IT initiative, 31% of the participants agreed and close to 11% strongly agreed to that reduction in operational costs as a major driver for carbon reduction. In case of AuPack, the significant drivers of GET, as shown in Figure 13.4, are costs, need to comply with

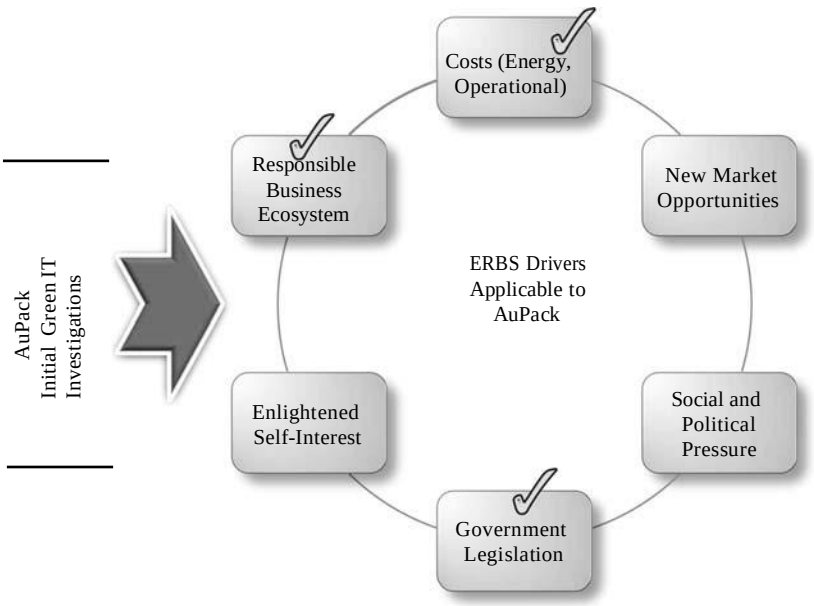


Figure 13.4 AuPack's drivers for environmental responsibility.

government legislations and an opportunity to lead through a green business ecosystem. Ā ese drivers of GET for AuPack are further discussed as follows:

- Ā e CEO of AuPack realizes that the reduction in costs and optimization of processes will be an ideal driver for the Green IT initiative of the organization. Carbon reduction for its own sake may not provide sufficient motivation for the organization. Ā us, a good sustainable approach for AuPack will include optimization of processes, consolidation of its information technology hardware and software and thereby reduce its costs and carbon together. Ā us, cost reduction is an excellent driver for Green IT in AuPack. Examples of cost reduction include reduction in the use of raw materials and equipment, recycling of equipment and optimization of storage and inventory as a result of the green initiative.
- Regional environmental legislation requires AuPack to monitor and report its overall carbon emissions. Ā ese are the operational emissions from the package production process (Scope 1 and 2), supporting IT systems and infrastructure (Scope 2) and the distribution transport network (Scope 3). Ā e regulatory requirements are being specified on a recently launched government portal and AuPack plans to monitor, measure and report directly on that government portal.
- AuPack has many partner organizations—both locally in the geographical region of the developing country where it operates and overseas, where its customer base is growing rapidly. Ā e visionary leadership of AuPack is keen to capitalize on these myriad associations with its collaborating organizations and influence them in terms of their carbon footprint. Although AuPack is a medium-sized organization in the context of the region where it operates, it has opportunity to influence the business ecosystem in which it exists, especially in the context of Green IT and processes. Ā is potential leadership position of a possible Green Consortium is a major driver for AuPack's GET. With potential Green IT portal-based approach within AuPack, there is significant opportunity for AuPack to influence its business ecosystem through electronic collaborations on the web—driven by web services and service-oriented architecture (SOA) (as was discussed in Chapter 6). Such electronic collaborations can reduce overall carbon within a group of companies and also facilitate electronic sharing of information and knowledge on the Green IT initiatives.

Planning for GET

Figure 13.5 shows three of the many major focus areas of work when the GET is undertaken. Ā ese are the customers and business partners, the IT systems and the Regulatory areas of AuPack that are the first ones to be affected by GET. Ā ese areas of work indicate the way in which the organization is divided when the planning and enactment of GET takes place. Ā ese areas of GET work are understood as follows:

- Customers and partners. Changes to these relationships will be based on changes to the way improving the customer information systems to get ongoing sales from customers.
- IT systems and applications. Upgrade of CAD/CAM computers to high powered computers that are networked in a way to reduce the interactions required through the various systems and applications.
- A new Carbon Emission Management Software (CEMS) together with an optimized manufacturing system that would support new and existing business.

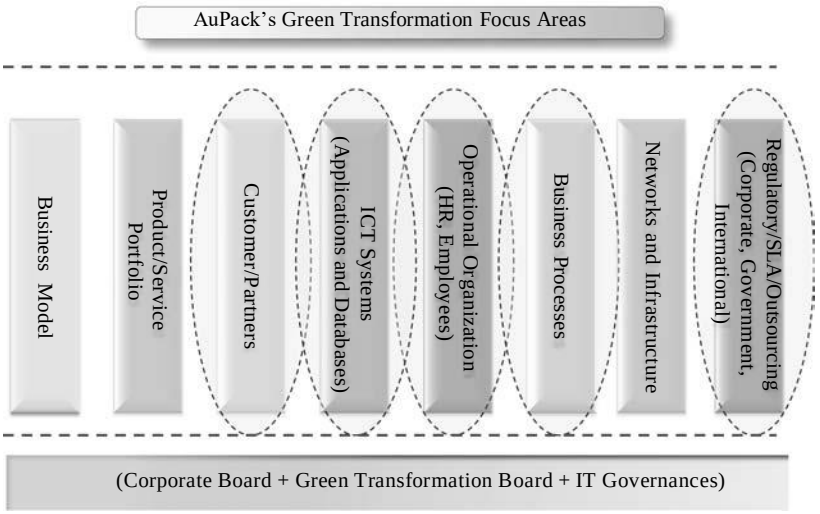


Figure 13.5 AuPack's focus areas for GET.

- Changes to Service Level Agreements (SLAs) with partners as the organization transitions as also changes to governance structures with greater focus on environment (green governance).
- External and internal business processes supporting the manufacturing as well as sales/distribution of the packaging products will be optimized. For example, optimization of the packaging lifecycle from quote to production to distribution, involving accounting and production departments, distributors, and customers.
- Operational organization and green HR resulting from changes to the people structure as a result of green initiative.

Understanding AuPack's current situation in terms of its environmental performance leads to the development of the GET plan. Creation of such a plan was discussed in detail in Chapter 9. Planning for transformation has to also consider the four dimensions along which such transformation can occur. Usually, one dimension out of the four can lead the transformation process—however, all four dimensions are involved in the overall transformation. Ā ese are discussed next.

Economic Dimension in AuPack

Ā e economic dimension for GET in case of AuPack revolves around reduction in cost and increase in profit margins. Ā is action involves creating value for customers through reduced carbon footprint in the packaging product being provided to them. Ā e availability of funds to undertake the transformation is a strength of the organization. However, it also includes responsibility on part of the CGO to ensure there is return on this investment in the next 2–3 years. Direct and positive involvement and interest from the CEO is extremely helpful as the organization moves along this economic dimension. As a result of the green transformation, the CGO anticipates growth and expansion of the packaging product business—especially in the EU region.

Technical Dimension in AuPack

Current client information is stored in a simple CRM package. Underlying the organization's web site is a database with connectivity to internal systems. Current carbon related data, that was used in the initial investigation is in an Excel spreadsheet. Ā ere is no access to this and such information that resides on the company's servers to most employees—typically staff working on the shop floor.

AuPack investigated and has decided to procure a CEMS from Microsoft business solutions called *Environmental Sus tainability Da shboard*. Ā is CEMS product will be integrated with AuPack's existing ERP applications to enable tracking of energy consumption and carbon emissions. Ā is CEMS will help AuPack map its decrease in carbon emissions with corresponding cost savings.

Ā e shortlisted CEMS can be purchased "off the shelf." Ā is CEMS will create opportunity for the staff at all levels to understand, in real time, the carbon emissions of AuPack. Ā e dashboard provides information to all users on their desktop and laptop machines within the organization's firewalls.

In this technical dimension of GET are areas of work including Green SOA and web services. A Green SOA will en sure that the new CEMS is properly integrated with the existing applications. Figure 13.6 shows the positioning of CEMS in the overall IT architecture for the Green IT portal of AuPack. Ā e collaborative business partners will be able to tap into the organization's systems and re ceive as we ll as provide fe edback. Ā erefore, SOA will be applied during CEMS implementation.

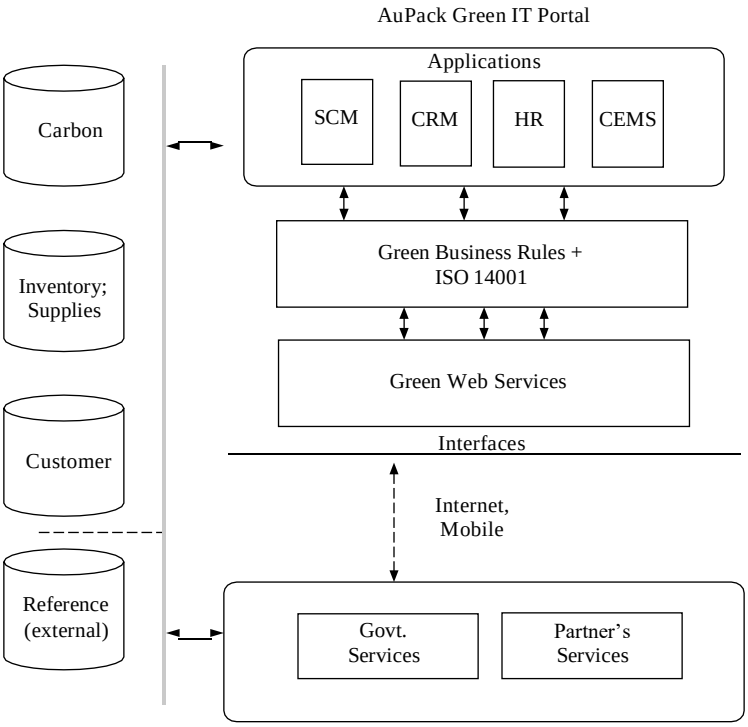


Figure 13.6 Proposed AuPack Green portal.

For example, interaction with the AuPack's web server will provide opportunities to offer and consume green services relating to government limits per type of product, partner's information on carbon emitted during distribution, and so on.

Process Dimension in AuPack

Ā e process dimension of AuPack's GET deals with creation of process models that reflect both existing and new green processes. Ā e modeling of the processes can be undertaken using the use cases and activity graphs, shown in Chapter 7. Ā ese process models, based on use cases and activity diagrams, can be created for various roles within and outside of AuPack.

Ā e process dimension of GET has to consider collaborative customers, who will be interacting with AuPack electronically. Ā e services provided to these corporate customers can be enhanced and optimized to not only add value through accuracy and timeliness but also reduce the overall carbon associated with the collaborative processes.

Social Dimension in AuPack

Ā e social dimension of the GET is involved with the changing of the attitude of its staff and, also, the changing Green HR function. AuPack has to move toward creation of a social networking site. Awareness of the carbon issues and the way they will impact the future of not only the organization, but the country and the global business can bring about a change in attitude.

Green HR brings about changes to the organizational structure. Ā is change starts with the appointment of t he C GO a nd t he subs equent fo rmation o f t he g reen t ransition project te am. In addition to the CGO, there is an external consultant with expertise in Green Enterprise Transformation (GET), two department level managers fully dedicated to en vironmental management a nd si x su pervisory l evel s taff to su pport t hem. Ā es e staff m embers a re i nvolved i n diagnosis, planning, enactment, and review phases. Green IT auditor is an additional support role which is also involved in creation, validation, and use Green IT metrics and measurement.

Staff will also need training in the use of CEMS to u se its data. Smart meters will be fitted to most equipment involved in the production line to calculate directly the emissions from those production lines.

Ā e social dimension of GET also takes responsibility for management of the changes to the designations a nd re sponsibilities of l ine managers, legal implications a rising f rom the changes, possibilities of telework, and related privacy issues.

Enactment of GET for AuPack

Figure 13.7 highlights the major actions during the enactment phase of GET for AuPack. Following are the specific highlights of the enactment:

- CEMS—Implement and integrate with the existing systems.
- Comply and maintain ISO 14001—Ā is is achieved by following the steps outline in the environmental management standard, and verifying the effectiveness of the changes through measurements. Ā is is the application of discussion on this standard from Chapter 8.

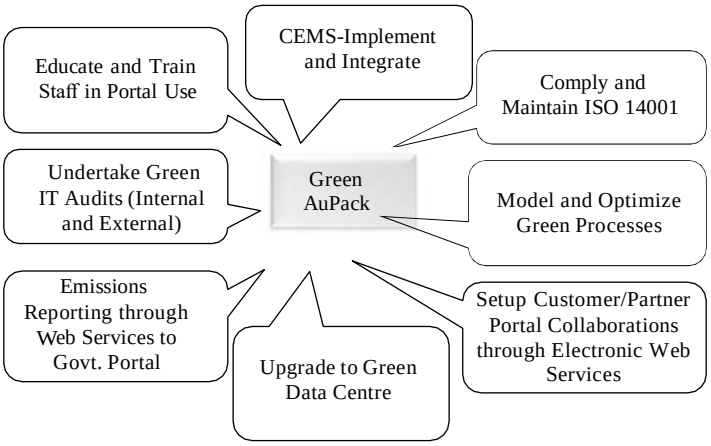


Figure 13.7 AuPack GET enactment.

- Model a nd o ptimize g reen p rocesses—Using t he p rinciples o utlined i n G reen B PM i n Chapter 5. Ā us, processes associated with procurement, operation and disposal of all equipments (IT and non-IT), materials, and the ready-to-go packaging are included in this optimization of green processes (Green P-O-D).
- Setup customer/partner portal collaborations through electronic web services—Ā is would use t he web s ervices ba sed on Green SOA d iscussed i n Chapter 6 . Ā e i ntegration w ith partner's systems will imply immediate reduction in the supply chain carbon. Furthermore, AuPack i s a lso able to u pdate its SL As with its own customers and assure them, through the electronic collaborative portal, of the improvement in carbon emissions in producing its packages. Renegotiation so SLAs would also be implemented as policies within the electronic collaborative portal.
- Upgrade to green data center—Ā e power usage of the data center over the power used only by the data servers was at 2.4. Ā e aim, during enactment was to bring this down to below 2.0 in the first 6 months. Ā is would imply use of power directly in the operations of the servers rather than its use in maintaining the associated building and infrastructure (e.g., air conditioning).
- Emissions rep orting through web s ervices to g overnment portal—Ā is part of the enactment is aimed at fully automating the reporting function of AuPack. Ā e purpose of such integrated and automated reporting is to eliminate the in between step of collating the emission results and presenting them to the governing body. Instead, the CEMS collects the data and submits it as a web service on a daily, weekly, monthly, quarterly, and yearly basis.
- Undertake Green IT audits (internal and external)—Ā ese informal and formal audits will ensure that the collection, collating and reporting of carbon data is as per regulatory guidelines. Discussions from Chapter 10 are applied in this part of the enactment. Educate and train staff in portal use—this would require AuPack's staff to be scheduled for training in the use of the CEMS and the way in which it interfaces with other design and production systems. Ā is training can include a short 1 hour briefing to the shop floor staff, through to de tailed training to t he IT systems and support staff over 2 –3 days. Awareness of carbon emissions and the positive impact of their reduction is achieved through ongoing feedback to the staff, especially on shop floor, in terms of a re al-time carbon update through a

computer monitor, as well as the traditional whiteboard that has also been used on the shop floor. Eventually, the value of GET can be ascertained through a survey and interviews, following the same methodology that was used at t he start of the project in ascertaining the green readiness of AuPack.

Review of GET for AuPack

Ā e re view phase de als with verifying and va lidating the stated outcomes of GE T for AuPack. Green IT audits, discussed in Chapter 10, have already started during enactment. In review, they are formalized and their findings are reported. Furthermore, the outcomes need to be measured and studied not only for the new business, but also for the new environment in which the business is now operating. AuPack's Green IT outcomes are slightly different to the stated goals. Ā is was expected as the business itself was changing and growing during the period of GET. Evaluation of the outcomes include reviewing in accuracy of CEMS, the way in which it collects and reports data and undertaking sample tests to run through the CEMS. Furthermore, green process models are subjected to walkthroughs and inspections to ascertain their accuracy and value in GET. Potential changes to organizational structures and business models are internally audited to ensure they do not adversely affect the business.

Ā ese measurements are incorporated in the feedback by the Green Transformation Champion (GTC) to the boards responsible for the green transformation as also to the business stakeholders. Ā e review process not only ascertains the achievements of the GET but also opens up doors to f urther a nd potential i mprovements w ith c ollaborating business pa rtners. H ence, t he review process should make provisions for these enhancements with business partners by revisitng the SLAs. Issues encountered during GET can be shared with the collaborating partners.

Lessons Learned in GET for AuPack

- AuPack as a product organization with supporting IT systems had to focus on the end-user and its processes.
- GET i s a c omprehensive business t ransformation process that includes people, processes, technologies, and return on investment (ROI) calculations.
- Attitude change for people working on production lines is not achieved only through training; a manual process such as one using whiteboards on the shop floor was as valuable as the implementation of CEMS.
- Data center upgrade required coordination with the production processes that are heavily dependent on the production applications.
- It is difficult to measure the overall carbon reduction by optimizing the design of a package, since the carbon footprint of a package is made up of its usage and eventual disposal.
- Compliance with ISO 14001 is not difficult to implement in a production shop, but maintaining that compliance proved to be more challenging.

Chapter 14

Case Study in Applying Green IT Strategies and Applications to the Telecom Sector

Key Points

- Describes the Green IT challenges of an infrastructure-type company—ZeeTel—operating in the telecommunications domain
- TCCO—total carbon cost of ownership—is an important measure especially in an infrastructure type organization where the carbon consciousness in architecture and design has a long-term effect on emissions
- Green enterprise transformation of infrastructure organizations focuses on buildings, data centers, equipment lifecycle and, in case of telecom, its transmission networks
- Starts t he Green enterprise t ransformation approach to Z eeTel ba sed on a rep ort by t he Focus Group on ICTs and climate change of the international te lecommunication union (ITU)
- Infrastructure companies have an opportunity to influence large number of corporate customers—as compared with end-users—resulting in greater impact of its carbon reduction initiatives

ZeeTel Telecom Scenario

ZeeTel is a hypothetical, large telecom company operating in the African region. ZeeTel is responsible for the core telecom infrastructure in the region, in addition to offering some land-based and mobile services. Main fo cus of ZeeTel's business has been the cre ation of the te lecom platform that provides the backbone for communications infrastructure in that geographical region. Ā us ,

ZeeTel's customers are mostly corporate customers that use ZeeTel's telecom platform to vend their contents (e.g., sports or entertainment providers) or are direct, large-scale users of ZeeTel's services (e.g., banks or airlines). Ā ere are very few direct end users of ZeeTel—except, of course, its employees who use the IT systems to provide business services. Occasionally, some employee households are also involved as small time end-users.

Although owned by the government, ZeeTel's board is able to control its own directions and also has its own responsibility. Ā e corporate board of ZeeTel comprises its business leadership (CxO level), representatives from the trade unions belonging to the large workforce and government representatives.

Ā e core business of ZeeTel (i.e., creation of high-end communications infrastructure) involves technology innovation and adaptations that result in large-scale construction and implementation of physical and wireless communications networks. Ā ere is hardly any competition to ZeeTel as the creation of these communication network infrastructure is highly regulated. Besides that, ZeeTel is owned by the government under financial as well as legal agreements. However, with the operational independence of the organization, and the receipt of a government directive on climate change, ZeeTel is now seriously considering extending, embellishing, and putting into practice its environmental plans. Such planning was undertaken in a less formal way an year ago, mainly in response to the growing demands for environmental consciousness from its corporate customers. Increasing awareness of the environment in the region implies that these corporate customers, including contents and service providers, have started demanding carbon reduction particularly in the networks that are used by them to provide their own contents and services. Ā is is particularly so where these corporate have their own global businesses wherein their own customers are demanding environmental friendliness in the end products. Ā us, from an informal plan, the environmental context has now become an integral part of a formal business strategy across ZeeTel. Ā is, in turn, is resulting into carbon consciousness as a mandatory element in every decision-making process within ZeeTel.

An important aspect of this formal approach to the green telco initiative, however, is to ensure it is not carried out by reducing business volume and service. Ā e green enterprise transition directive from ZeeTel's CEO includes, specifically, the need to synergize between the carbon and cost efficiencies. Ā is synergy between environmental and business benefits is expected to be achieved by optimizing the business processes of ZeeTel with the help of information technologies and systems. Ā is, for example, can include replacement of current legacy systems and hardware by latest low-power emitting technologies; IT systems that will enable improved measurement and control of carbon; and upgrading of the existing communications networks with Next Generation Network or Gigabit Passive Optical Network (GPON) that will be environmentally efficient.

An important motivating factor in ZeeTel's board decision to control and reduce its carbon footprint is that it is a government owned organization that needs to showcase the government's carbon reduction commitment. In addition, being a singular, large, infrastrcutrue organization, ZeeTel has the opportunity to impact many comparatively smaller organizations that have to use its platform and infrastructure services. Ā e impact of changes to communication networks and facilities in the region is also likely to affect social aspects such as telecommuting and virtual group formations. Such an impact opens up possibilities of reduced work travel across the metropolitan cities where ZeeTel's platform is heavily used and, eventually, large-scale attitude, and behavioral change.

Figure 14.1 summarizes the overall approach to GET undertaken by ZeeTel. Ā e Green enterprise transformation will bring together compliance with environmental regulations through technology updates as well as process upgrades. Ā e end result is not only carbon reduction but also

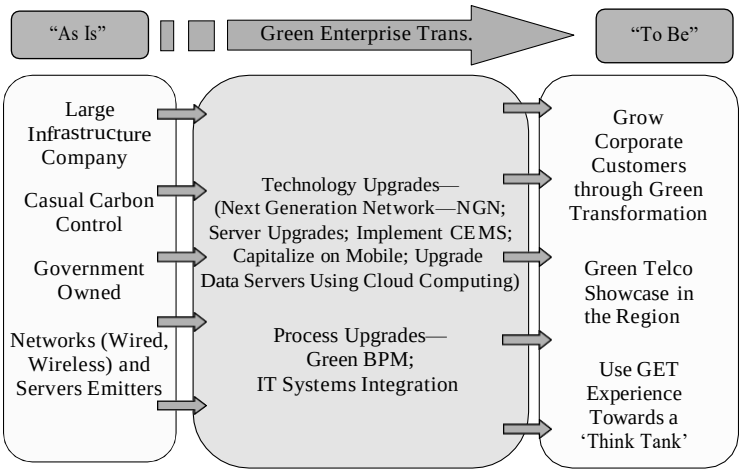


Figure 14.1 GET for "ZeeTel" telecommunications company.

business benefits resulting in an overall green business model. Following are specific highlights of business and technology advantages of the GET approach of ZeeTel.

- Growth in business, pa rticularly w ith corporate customers, due to c arbon re duction a nd corresponding boost in the image of ZeeTel.
- Imminent upgrades of hardware, software, and networks, but now closely aligned with environmental performance.
- Ability to comply with policies, legislative, and regulatory frameworks that are put together by the government as well as telecom's summit bodies and industrial consortiums.
- Ability to handle carbon taxes, particularly as a government organization. Ā e se carbon taxes are envisaged to b e applicable directly to l arge, infrastructure organizations suc h a s ZeeTel.
- Preplanning on how to deal with corporate customers in terms of financial models that will enable sharing of carbon taxes between them and ZeeTel.
- Ability to ensure there are no carbon penalties and fines. Ā ese are applicable to ZeeTel irrespective of its almost government status. Penalities and fines are not only costly exercise, but also create a loss of face for the organization and its leadership position. ZeeTel is required to formally and control its carbon emissions.
- Capitalizing on incentives. Properly a nd accurately measured c arbon em issions a nd their subsequent reduction may also create opportunities for government incentives in terms of financial rewards as well as support for growth—enabling the organization to setup further carbon efficient communications infrastructure in and beyond the region.
- Make good use of mobile technologies and services which, while requiring additional power to operate, also create opportunities to significantly reduce carbon.
- Ability to en hance network efficiency and effectiveness of the communications equipments t hat w ill re sult i n o verall re duction i n T CCO—rather t han o nly o perational carbon.
- Application of quantifiable and measurable values (green metrics) that indicate strategic carbon advantage over entire lifecycle and not just the operational aspect of the equipment.

- Create and promote policies to help the corporate customers with their own Green IT strategies, such as recycling of handsets.
- Ability to dy namically create and manage policies through sophisticated CEMS—carbon emissions management software.

Strategic Approach to Green ICT

Ā e G reen I T S trategic ap proach o f Z eeTel h as to c onsider t he sp ecific i ssues re lated to a n infrastructure-type organization belonging to the telecom industry. As compared with a product or service type company, an infrastructure business like ZeeTel will have substantially large numbers of data servers, communication switches, and related networking equipments, large physical buildings sp read a cross t he re gion a nd m ultiple c ommunications to wers. A t I T s ystems l evel, ZeeTel has service-oriented interfaces with the IT systems of the energy vendors (e.g., the electricity vendors).

Ā is setup is different to a s ervice setup like the hospital or manufacturer of packaging, discussed in the previous two chapters. For example, in the previous two case studies, the end users are easy to i dentify, form part of a k nown user base, make a m ajor contribution to t he carbon emissions, but those emissions can be ascertained relatively easily. In case of ZeeTel, the end-user is not directly visible (except, as mentioned in the beginning, some staff who would be using the business and resource planning systems) and, a lso, not a s significant a c omponent in the overall c arbon em issions o f t he o rganization. I nstead, t he m ajor c arbon em issions c ome f rom t he power consumed by the overall infrastructure including communications network and data servers rather than individual user devices. Consider, for example, the hospital case study wherein the laptops used by a nurse or a do ctor in a hospital is a d irect, visible end-user device. Ā is device, multiplied across the entire organization, is a major contributor to the carbon footprint of the hospital. Ā erefore, using device level power management systems as well as training the users can bring about reduction in carbon emissions. Power-smart add-ons to manage the operating systems of these devices will also enable improved measurement and control of carbon through these large number of end-user devices.

In case of ZeeTel, the carbon produced by the organization is primarily through its infrastructure platform and related services. Ā ese are large-scale communications services across the region consumed by corporate customers and content providers. Ā erefore, strategies for carbon measurement, reporting and control need to focus directly on these large-scale infrasructures such as communications towers, telecom switches, wired and wireless relaying equipments, associated routers, data servers and the many IT supporting hardware. Ā ese infrastructure IT assets are also used by corresponding software systems and applications. For example, the ZeeTel business is supported by customer relationship management (CRM), billing support systems (BSS) operational support systems (OSS), human resource (HR), and an upcoming carbon emissions management software (CEMS). Ā ese systems enable the business to operate but, at the same time, generate carbon that contributes to the overall carbon footprint of the organization. Siloed data in these applications, which requires continuous interaction amongst these data bases, is a source of major, wasteful carbon. Ā us, major action in the green space has become mandatory for ZeeTel.

Figure 14.2 shows t he ke y p oints of Z eeTel's Green I T s trategies a nd t he t ime f rame over which they will take effect. Ā e report on climate change by the focus group of ITU is a va luable input in these strategies. Ā is report by the Focus Group on ICTs and Climate Change (FG ICT&CC), produced in 2009, outlines the gap and provides basis for the road map for Green IT

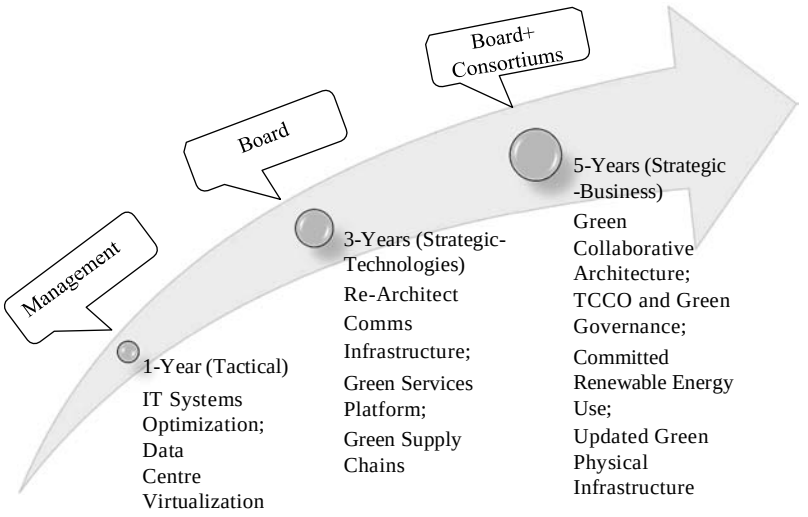


Figure 14.2 ZeeTel's Green IT strategies.

transformation in the telecom sector. Ā ese strategies, as highlighted in Figure 14.2, are divided into three time-based parts corresponding to the 1-, 3-, and 5-year strategies. Ā e generic Green IT strategic approach was discussed in Chapter 2. Here, for ZeeTel, this approach is specifically considered in the context of an infrastructure company. With an infrastructure organization like ZeeTel, the strategies for Green IT are brought forward in time as compared with the generic suggested timelines. Ā us, the strategies that are created, in a generic Green IT approach for 3 years, are a ctually hurried fo rward a nd brought to b ear re sults w ithin a n ye ar fo r t he i nfrastructure organization. Ā is is so because the end user, operational carbon that can be effectively reduced through tactical s trategies i s not a s major a f actor in the c arbon fo otprint of a n infrastructure company a s the communication networks and data s ervers a re. Similarly, the long-term 5 -year strategies are brought closer in time to around 3 years.

Figure 14.2 shows that ZeeTel should move to optimize both its IT systems (such as the billing, operational support, customer relations, and HR) and its data center within an year. While this will be a challenging project, a large infrastructure company will have the resources to undertake those changes. Furthermore, as mentioned above, in case of such an infrastructure company, the end-user devices will not be as large and wide spread as in a product or service organization. Ā erefore, from a te chnology viewpoint, the focus should be on the data center and IT systems right at the outset. Ā e slightly longer-term strategy of Green IT for the organization, in a 3-year period, will be rearchitecture and design of the communications infrastructure. While this communications infrastructure is of immense value in the GET for ZeeTel, the actual transformation of the network is likely to take 3–5 years. Ā is network redesign will closely involve both business and technology expertise—as it will require an investment that goes beyond that only for a Green IT project. Ā is rearchitecture of the fundamental communications platform will also change the business model, the supplier relationship and the way in which the service providers use ZeeTel's platforms. Ā e GET of an infrastrcuture company such as ZeeTel will include substantial influence on all its customers and partners.

Changes w ill i nclude i mplementation o f TCCO m etrics t hat w ill ap ply to d ata s ervers a s well a s the upcoming new g eneration network (NGN) across its operating l ife; f ull u se of the

Green collaborative architecture of its systems—typically through a web services based portal with underlying data warehouse—, full implementation of Green governance that will include application of corporate governance (ITIL, in case of ZeeTel) with carbon consciousness and changes to the physical buildings housing data servers and communications equipments to reduce their carbon footprint. In case of ZeeTel, these will be a suite of buildings and physical infrastructure spread across the geographical region. Ā ese long-term Green IT strategies also incorporate dedicated use of renewable energy sources (in case of ZeeTel, this is envisaged to be solar energy, as the region where ZeeTel operates has ample sunshine and a separate government directive has already secured land for building solar panel farms together with transmission grids).

SWOT of ZeeTel—Environmental Context

Green IT strategies for ZeeTel are further refined based on the SWOT analysis of the company. Ā is SWOT, however, is not entirely from the business viewpoint. Figure 14.3 shows a high-level SWOT analysis of ZeeTel's IT that is undertaken from a carbon perspective. Ā is is briefly discussed next:

Strengths

- Government owned and supported organization that is aware of the upcoming legislations in the carbon context. Ā is also results in good working relationship with the government bureaucracy, further facilitating relatively quick decisions on Green enterprise transformation board formation and launching of the transformation project.

Figure 14.3 SWOT for ZeeTel telecom.

- Excellent c hannel re lations i ncluding c orporate pa rtners a nd government rep resentatives. Ā is relationship creates opportunities to help and support the collaborative partners in taking up transformation.
- Influential, monop olistic or ganization w ith pr actically no c ompetition i n t he c ommunications i nfrastructure business. Ā erefore, t he organization c an fo cus d irectly on c arbon reduction without worrying about loss of business to other competitors who may do so at the cost of carbon.
- Growth forecast for ZeeTel implies an opportunity for steady revenue that frees the organization to focus on its Green IT effort. Ā is growth in telecom users, however, also brings in the challenge of handling the corresponding growth in carbon. Green IT strategies that balance the business growth with reduced carbon will be required, together with Green IT metrics that prove it.

Weaknesses

- Inflexible infrastructure as is expected in a large telecom in a developing region.
- Large, inchoate IT systems that are based on past, legacy databases and applications. Ā es e IT systems are in siloes that do not "talk" with each other, requiring considerable effort at maintaining them.
- Bureaucratic decision-making process, that is invariably a part of a government owned body; but such decision making creates challenges in terms of timings and follow up actions as the organization transitions.
- Physically dispersed infrastructure, with buildings, communications towers, and supporting data servers, all physically spread across the geographical region, making coordination extremely challenging.

Opportunities

- Combining business with green transformation will lead to show casing of the Green IT strategy created by the CGO that does not discount one goal over the other. Ā i s opportunity arises as the Green IT strategy includes increase in business due to upgrade to a NGN backbone together with metrics that show the reduction in carbon due to efficiency of the network.
- Business shift to mobile platform resulting in reducing needs for physical wired connectivity and corresponding reduction in the required infrastructure.
- Growing content and service providers who will need the increasing sophistication of the NGN platform. Ā ese contents and service providers are keen to expand their business both within the region and overseas—leading to o pportunities for them, as well as for ZeeTel. However, ZeeTel has the added opportunity to influence these content and service providers to reduce their carbon contents as well.

Threats

- Resistance to c hange (union d isagreement) re sulting f rom a l arge, s trong, u nionized workforce.
- Long time for visible results of the GET. ZeeTel will need at least 3–5 years, and perhaps more, to be able to demonstrate the ROI on its Green initiative. While this is not unusual

for large businesses, this is still a big challenge for ZeeTel, which is being watched closely by the government, customers, and unions.

- Total inexperience in GET in the region as this would be the first large project of its kind that will bring together the knowledge and expertise of Green It with that of telecommunications. External, overseas consulting help will be required to ameliorate this risk.

Motivators and Dimensions

Developing and influencing a re sponsible business ecosystem, together with reduction in cost of operations is emerging as a major motivator for ZeeTel to undertake GET. While other motivators, such as government legislation and social pressure, will also play a part in this project, the pure business motivation of cost reduction and business growth are playing an important role in this GET decision. ZeeTel, by upgrading its technological platforms, will not only grow its corporate customer base but also influence all its partners in its business ecosystem to be carbon compliant. Ā us, this is a self-motivated pressure to undertake GET.

Ā e technical nature of the challenge, particularly the communications networks, also indicates that the Green enterprise transformation will be best achieved by immediate focus on technologies. Ā ese technologies include the IT systems and hardware, as well as the communications networks. Ā us, the infrastructure assets (discussed earlier in Chapter 3) are the ones that undergo green transformation in case of ZeeTel.

Ā e company's corporate board has sanctioned the formation of the GET board. Ā e current CTO (chief technology officer) has been appointed as the CGO for the transformation. Ā is is an important nomination as the CTO is fully conversant with the communication networks and the d ata s ervers su pporting t he network. K nowledge o f t he i nner wo rkings o f t he te chnology platforms of the company i s cr ucial a s ZeeTel's t ransformation to a G reen enterprise i s c losely associated with the technology upgrades. Ā e CGO, together with select members of the Green enteprise transformation board, has extracted the existing, information Green IT strategy and has created a full programme to undertake transformation.

Discussion of t he motivators a nd t he d imensions of GE T a lso l eads to a d iscussion of t he Green e nterprise t ransformation r oadmap. S uch a h igh-level t ransformation p lan is s hown in Figure 14.4. Ā e diagnose, plan, enact, and review are the four phases also established in business transformation a nd were d iscussed i n Chapter 9. Ā ese t ransformation phases a re interspersed with metrics that help in stating the goals (KPIs) as also measuring whether the stated goals have been achieved or not. Figure 14.4 also highlights the major areas of work in each of these phases. For example, during diagnosis, there is heavy emphasis on understanding the emissions of the network backbone; planning is based on the focus areas of ZeeTel together with negotiations with the trade unions from a sociocultural angle; enactment will include risk management throughout the upgrading of the NGN and IT systems; and review will ensure that the goals of customer growth as well as carbon reduction are achieved.

Diagnosing the "As Is" State

Formal diagnosis of ZeeTel's current carbon footprint and its carbon readiness is being conducted by the Green Enterprise Transformation Board. Ā is major activity was authorized by the corporate board after in-depth discussions with the trade unions representing the large workforce of the organization.

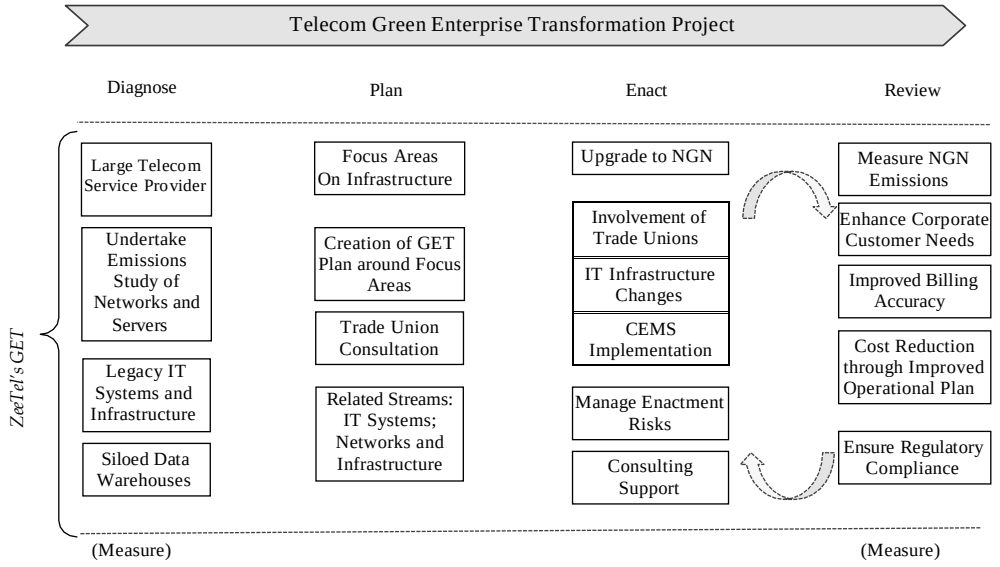


Figure 14.4 GET project for ZeeTel.

Ā is diagnosis phase examined the data center, the communications networks, the equipment lifecycle processes a nd t he supporting HR f unction. One of t he i mportant d iscovery was t hat ZeeTel's as-is business processes were not modeled or optimized. Due to lack of formality associated with modeling and documentation of business processes there was substantial wastage and resultant carbon emissions.

Ā e current investigations are into the assets such as networks infrastructure, information systems, and data bases also indicated a close nexus between the unoptimized business processes and these technology hardware and software. Ā e as-is status of ZeeTel is, therefore, without any green maturity. Formal diagnosis phases also revealed that the transformation of the telecommunication networks and information systems to achieve green maturity has to be closely aligned to business model to ensure that it is not achieved at the cost of business growth.

Green IT strategy for ZeeTel includes transformation of communications networks, IT hardware, I T s ystems, a nd business processes. E stimates a re t hat t he NGN c an re duce 4 0% en ergy consumption compare to legacy networks (Faulkner 2008) and GPON can be even more energy efficient over ADSL2+ networks (as discussed by Ramesh, HRG 2011). Eventually, the organizational culture has to a lso undergo change, which will be brought about through training and education. ZeeTel will undertake transformation in strategy, infrastructure and product (SIP) processes as these are the most technology-intense processes. Eventually, changes in these processes will also change other processes and affect internal staff as well as people from the corporate customer groups.

Starting with the strategic aspect of the l ifecycle, the GET will then undertake changes and alignment to infrastructure lifecycle management and eventually product lifecycle management processes. Ā ese three major aspects of GET in the context of ZeeTel are summarized in Figure 14.5.

Green IT metrics and measurements apply to all of these enhance telecommunication operations map (eTOM) based processes. For example, in case of the Fulfillment process the unit cost associated with execution of one iteration of the process can provide a s tarting KPI. Similarly, carbon em is-sion corresponding to individual network elements, such as switches and routers, provides a KPI for

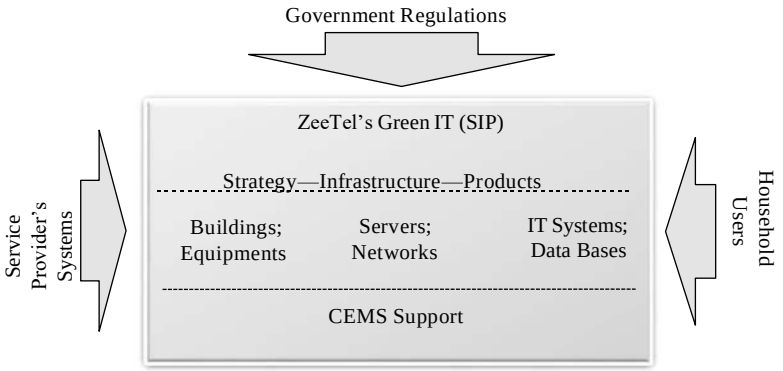


Figure 14.5 The strategy, infrastructure, product lifecycles in Green IT transformation.

calculating the reduction in emissions through GET. Ā e transformation of IT systems and resources provides opportunities to m easure the KPIs of the ZeeTel processes supported by the IT systems. Transformation of such processes also includes, for example, shifting from manual or paper based processes to electronic processes, reduction in material wastages, and automation of operational contracts. Optimization of the process also ensures cost- and time-effective delivery of services.

Training and education will lead to carbon consciousness throughout the organization. Ā is implies c lear u nderstanding a mong t he s taff o f t he m eaning o f Green I T. Ā is is particularly challenging in an infrastructure-based transformation, as the simple, operation carbon reduction through, say, switching off computers, is not sufficient. Changes to t he IT systems and applications include review of the database, setting up of integration interfaces through SOA and accurate reporting in terms of both carbon and noncarbon data.

Planning

Ā e popular business processes framework for telecommunications company, called *eTOM* provides an excellent basis for identifying and working through the focus areas for GET. Ā is eTOM framework, in the context of ZeeTel, is shown in Figure 14.5. Ā e eTOM provides an excellent and comprehensive reference model for the telecom sector. Ā erefore, eTOM is also ideal for ZeeTel's GET. A lthough Z eeTel i s n ot d irectly de aling w ith en d-customers, s till t he e TOM re ference model is helpful in separating the ZeeTel activities that deal directly with the corporate customers as against the support and supplier activities. Ā us, in Figure 14.6, the strategy and commit, infrastructure lifecycle management, and product lifecycle management are shown as the major areas of focus as ZeeTel undertakes GET. Ā e processes that support and align with these major areas are the marketing and offer management, service development and management, resource development and management, and supply chain development and management. Ā es e processes, derived directly from eTOM are supported by the various IT systems and applications of ZeeTel. Ā ese are shown on the left in Figure 14.6.

Figure 14.6 further indicates the proximity of technology-based changes with the process dimension. In large, infrastructure-based GET, such as in ZeeTel, all four dimensions are involved. Ā us , even though one dimension, such as the technology dimension, takes lead, other dimensions immediately follow and support the transformation. Ā e eTOM for ZeeTel provides optimization and reengineering

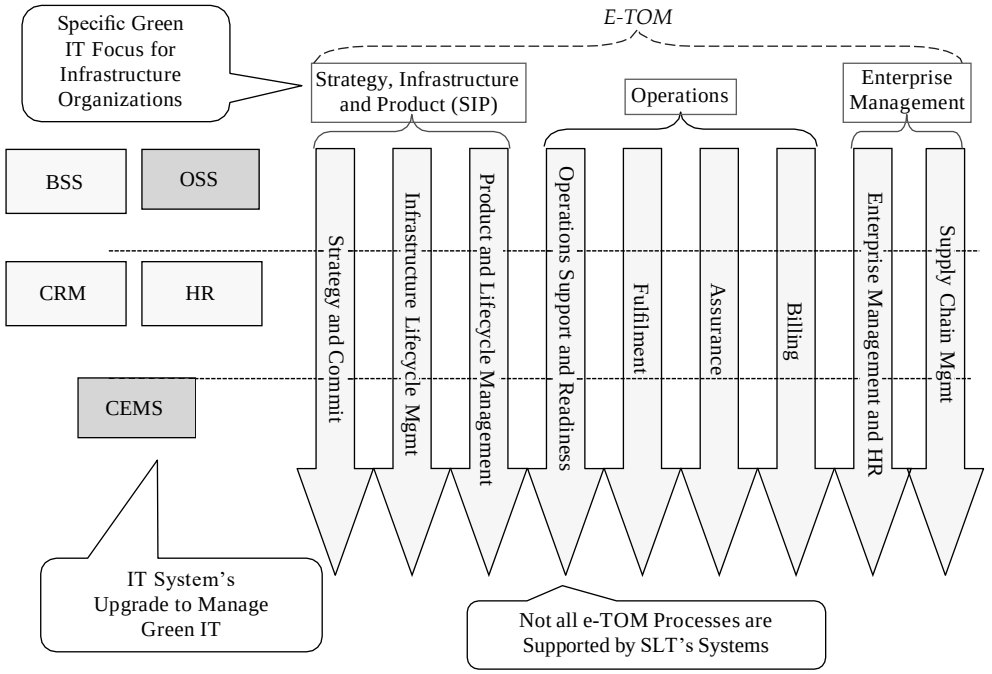


Figure 14.6 ZeeTel's focus areas for Green enterprise transformation based on eTOM.

opportunities in the business process area. Ā e ZeeTel modernization effort is aimed to not only reduce carbon but also optimize processes for its corporate customers, including content providers.

Ā e IT systems that closely support the modeling and optimization of the business processes are also shown in Figure 14.6 on the left. Planning for green process reengineering will involve grouping the processes based on the "operations" group shown in Figure 14.6. Ā e process groups formed during planning phase will continue during enactment and review.

Ā e UML's use cases and activity graphs, discussed in Chapter 7, can be used here to undertake Green BPR.

Enterprise Data Center Transformation Plan

(*Using the activities in the planning phase of the GRID, complete the following sections)*

ZeeTel has two large data centers in two major cities in the region. Both data centers operate on a 24 × 7 basis as it needs to support the corporate customers, service and content providers, as well as internal HR. Together, there are 12 high-end servers, with four additional servers as backup servers for emergency. Ā e data center does not currently have a space allocation strategy and the data and application requirements are growing at the rate of 1Gig per day. Ā e data center director has made some attempt to measure PUE (power usage effectiveness) and the results are a PUE of 2.4. In addition to the official data servers, there are a few "local" servers within the organization.

- Implementation of CEMS will include incorporation of the aforementioned KPIs that bring together carbon and measurement of IT system's performance. For example, measures that

reflect reduction in data usage, duplication, and storage will also reflect corresponding carbon reduction. Processes associated with content and service providers will enable them to use the upgraded communication platform in new and innovative ways. The Green IT strategies of ZeeTel will align the transformation to the NGN with the business strategies of the content and service providers.

- Increase in contents and demand for greater network coverage—especially on the 3G networks—implies need for high-capacity networks. NGN, providing some capacity, needs to be balanced with the carbon footprint of NGN.
- ZeeTel's cost consideration in GET project includes costs of network upgrades, costs associated with formation of the project, and cost of procuring and implementing CEMS.
- Data servers in the current setup at ZeeTel have been left running irrespective of usage. Occasionally, manual control was used to reduce their emissions when they were not in use. Post-GET server management will have to be automated through power management software. Choice of software for this purpose is GreenTrac from EventZero (www.greentrac.com).
- ZeeTel is in a position to influence handset manufacturers as well, as a part of its influence on its business ecosystem, to put together plans for take back of mobile devices. Mobile devices need to be recycled, ensuring regulatory policies that make the manufacturers responsible for taking back devices that would be e-waste.
- CEMS of choice is ecoGovernance from CA (http://www.ca.com/us/products/detail/CA-ecoGovernance.aspx).

Enacting GET for ZeeTel

Figure 14.7 shows the overall timeline for GET. This is a suggested timeline that considers two major iterations for enactment and review. The first enactment and review is around the initial changes to the network, moving to NGN. Changes to the enterprise architecture based on eTOM and the procurement and implementation of ecoGovernance (from CA) as the CEMS is

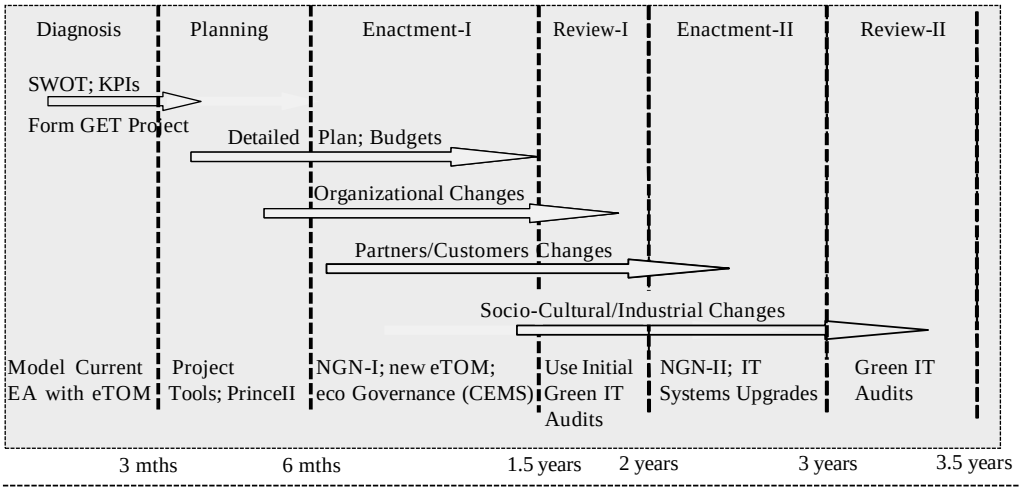


Figure 14.7 GET timelines and enactment-review phases.

also happening during this enactment. Changes to the organization and its business partners are roughly shown by the arrows on the figure.

IT systems and applications need to be mapped to the reengineered business processes—occurring in the second part of enactment. Changes to the IT applications will impact the collaborative business processes of partners such as the content and service providers.

Data Center Changes in GET

Following are the actions undertaken in the two large data centers of ZeeTel. Ā ese actions are based on the planning for GET discussed in earlier section:

- Implement integrated blade servers that will consume less power.
- All new servers that are procured will be low carbon emitting blade servers that will have inbuilt virtualization capacity.
- ZeeTel will actively seek renewable energy sources such as solar and gas, which can be combined with the current coal-based power generation.
- Integration of connectivity among the servers within and across the cities, outsourcing of some of the hardware maintenance aspects of the data center to ensure highly optimized services.
- Implement natural cooling for data center.. Ā is would require the hot-cold aisle arrangement for the servers, as also rearrangement of data storage and retrieval systems.
- Optimization of signals creating opportunities to reduce demands on the servers, which in turn would reduce power consumption for the servers and corresponding air conditioning.
- Implement eco-friendly air conditioning for the servers.

Next-Generation Networks in GET

Complete the implementation of NGN within ZeeTel's entire communications network. Ā is implementation is expected to take between 3 and 4 years to complete in the region where ZeeTel operates. Ā is change to NGN will result in strategic reduction in carbon due to improved network efficient, intelligent routing methods, and consolidation of switching centers. Ā is reduction in power consumption is envisaged to be effective even if there is increase in network traffic—as expected over the coming years. Ā erefore, the Green IT metrics used in the return on investment (ROI) calculations needs to c onsider not only the replacement costs of the network and equipments, but also the drop in emissions per user over increased number of users.

Equipment Lifecycle

Ā e en tire l ifecycle of equipments u sed w ithin Z eeTel w ill be sub ject to t he Green POD. Ā e activities re lating to m aterial and equipment l ifecycle that will undergo change include carbon reduction consideration in current POD practices within the organization.

Ā e new servers will be procured ba sed on their power consumption ratings as well as their "total carbon cost of ownership."

Ā e disposal of IT hardware is through a series of ranked options including giving it to employees, then charity, and finally for safe disposal.

Ā e business infrastructure of ZeeTel, such as its buildings and car fleet will be accounted for in the updated financial systems where Scope 1 emissions can be calculated and updated.

Enacting changes to t he procurement-operation-disposal process will be based on following considerations:

- All procurement to be based on EPEAT/energy star based ratings—especially for the servers
- Highly optimized processes that would support procurement of IT hardware as well as communications equipment
- Incorporation of carbon calculations and Green credentials to support procurement of the NGN
- Renegotiation of SLA with hardware and network equipment suppliers
- Optimized operation of network, servers, and associated IT hardware
- Apportioning operational carbon over the life of the equipment to arrive at TCCO
- Ethical disposal of existing legacy network hardware

Attitude and Training

- Creation a nd de livery o f brief 2 -hour s eminars on t he re levance o f t he Green en terprise transformation program to update the large number of employees
- Detailed 2-day training to IT managers, network managers and data center managers
- External training to Green enterprise transformation board on the transformation process
- CEMS training—configuration and use

Review and Measure

Ā ere are two specific reviews after each iteration of enactment—as shown in Figure 14.6.

A significant learning that has happened is the need to understand the politics and underlying motivation of individuals participating in the transformation project. Ā e age-old management understanding of the risks associated with change hold utterly true in this transformation. Quality assurance and testing activities were also required to be formally carried out on the new and integrated IT systems and content management.

Conclusions

Ā is chapter described the Green enterprise transformation process as applied to a infrastructure company. ZeeTel from the telecom sector was used as an example. Ā ere is significant focus in an infrastructure company on the upgrade of networks, procurement of new servers and creation of new buildings.

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GREEN COMPUTING

UNIT - II

Green Assets

- The green assets and infrastructure comprise substantial part of that long-term approach to managing the carbon performance of the organization
- Three major activities relating to the infrastructure assets has the following carbon consequences:

Establish (Procure)

- It deals with the green credentials of the asset in terms of its design and development.
- It is a one-off decision-making process that decides on the carbon efficiency of that assets design.

Operate (Run):

It is the manner of operation of the asset has a bearing on the total carbon contribution of the organization

Dispose (Demolish):

It is the organization's approach to disposing or demolishing the asset. It is also a onetime decision-making process with long-term effect on the environment.

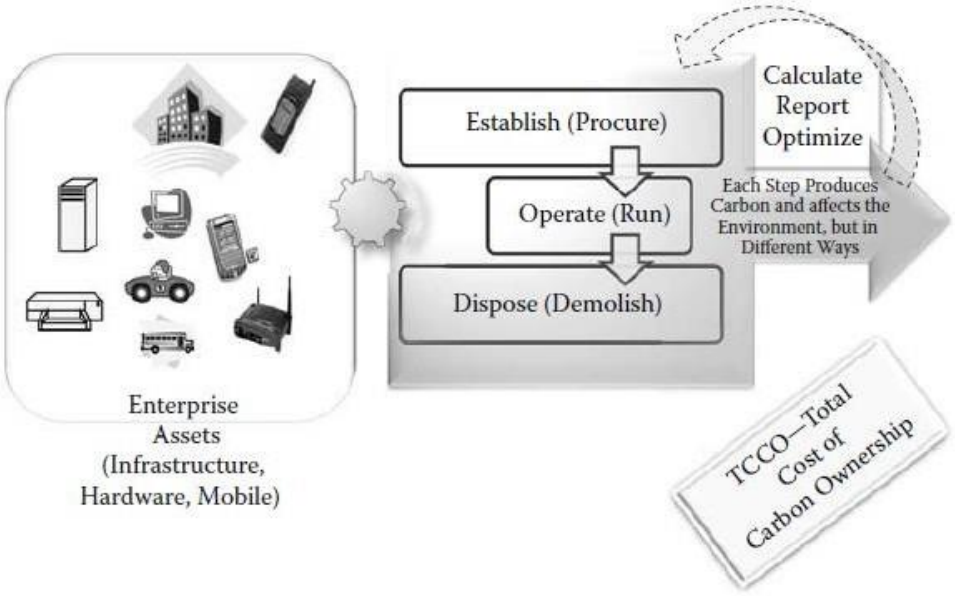


Figure 4.2 Green assets need to be organized in an efficient way throughout their lifecycle.

Types of Assets (Categories) and Their Impact on the Environment

Type of Assets	*Impact on Environment*
Buildings and Facilities (e.g., offices, meeting rooms, training centers, social rooms, sports facilities)	Long-term impact as major environmental considerations should be during architecture and construction. Purpose of buildings, people movements, geographical locations (weather), and durability of the building impact their overall carbon contribution. Examples of one-off decision making in design include the materials used in the construction, the extent to which the building is facing the sun, the wind directions, and the way in which these natural light and natural cooling are put together to reduce energy consumption.
Data Center (as separate, dedicated buildings to house servers)	This is a special purpose building to house data servers. In addition to the standard building considerations, the ratio between power usage by the servers versus the rest of the power is a popular environmental consideration. CRAC (Computer Room Air Conditioning) is a discipline in its own right that separates the cooling of the servers from the air conditioning required in rest of the building. Thus, building technologies together with data server technologies are put to use here to reduce carbon.
Devices (e.g., laptop, mobiles)	Design, development, procurement, operation, and usage of devices is considered here. Example of this includes low-power consuming design for laptops and mobile devices, efficient batteries for them, carbon-conscious electronic chip design, biodegradability of materials used, and so on. Apart from the operational carbon generated by these devices, their disposal itself is an important issue.
Vehicles (e.g., cars, trucks, corporate vans, and buses)	Direct fuel emissions, pollution level of the type of fuel, design of the engines, and so on. Procurement, operations and disposal activities apply to vehicles used by the organization. These vehicles produce the Scope 1 emissions. Fleet maintenance systems need to be updated with carbon calculations. The kind of vehicle, its design, how long it will be operated, and the method of its disposal has to be considered. Vehicle emission consideration is vital when considering the entire organization. This table lists vehicles as an important reminder. However, detailed discussion on vehicle emissions is out of scope for this chapter.

Building and Facility Management

- The physical buildings and facilities belonging to the organization form the heart of its nonmovable assets
- Buildings, while usually not a part of IT directly, are still a major contributor to the organization's carbon footprint.
- The carbon generation from buildings, depends on the material of the building itself, its air conditioning, and related operational features such as lighting and ventilation.
- Building and Facility Management issues such as the type of insulation used, facilities to recycle water, and the use of natural light in determining the TCCO for that building.

- In addition to the office buildings and relevant manufacturing facilities, when it comes to buildings that house the data centres of large organizations, the entire perspective on their carbon productions shifts to being IT specific.
- Therefor the data centre aspect of Green IT relates to both building management and IT management.

Green IT Hardware

- The hardware aspect of Green IT deals with the architecture and design of IT hardware, the manner in which it is procured and operated.
- While operational energy consumption is increasingly an important issue for computer manufacturers, what is even more interesting is the impact a good, energy optimum design can have on the overall energy consumed by a piece of hardware over its entire life.
- A purpose-built computer chip, or an effi cient laptop battery design has potentially greater impact in reducing carbon emissions over its lifetime than its operation would have.

Rating Building Features to Environmental Factors

Building Features	*Environmental Relevance*	*Comments and Actions*
Location	Use of geographically specific natural resources such as cool weather, natural sunlight.	Locating a data center in Iceland can reduce the cooling costs, effort and corresponding carbon.
Architecture and design	To maximize the use of available natural resources for the building.	Windows facing sunlight; cross-ventilation; air and water cooling of data centers.
Construction	Use of material (concrete, carpets, terracotta) to compliment the location and design to ensure that the material reduces wastage and maximizes natural resources.	Use terracotta roof instead of concrete.
Livability (occupancy)	People friendliness of the building/ facility that has health as well as aesthetic benefits.	Optimizes the way in which people use the facilities. A naturally lit, cheerful building will need less power.
Visibility	Promoting the physical building as a place of attraction adds marketing value, as also improved asset value.	Ivy's climbing on the walls. Terrace gardens.

Following is a more detailed description of these IT hardware assets of an organization:

Data servers—deals with the physical machines and the specific buildings in which they are housed. The servers also have both wired and wireless networks and corresponding communications equipment associated with them that are directly emitting carbon.

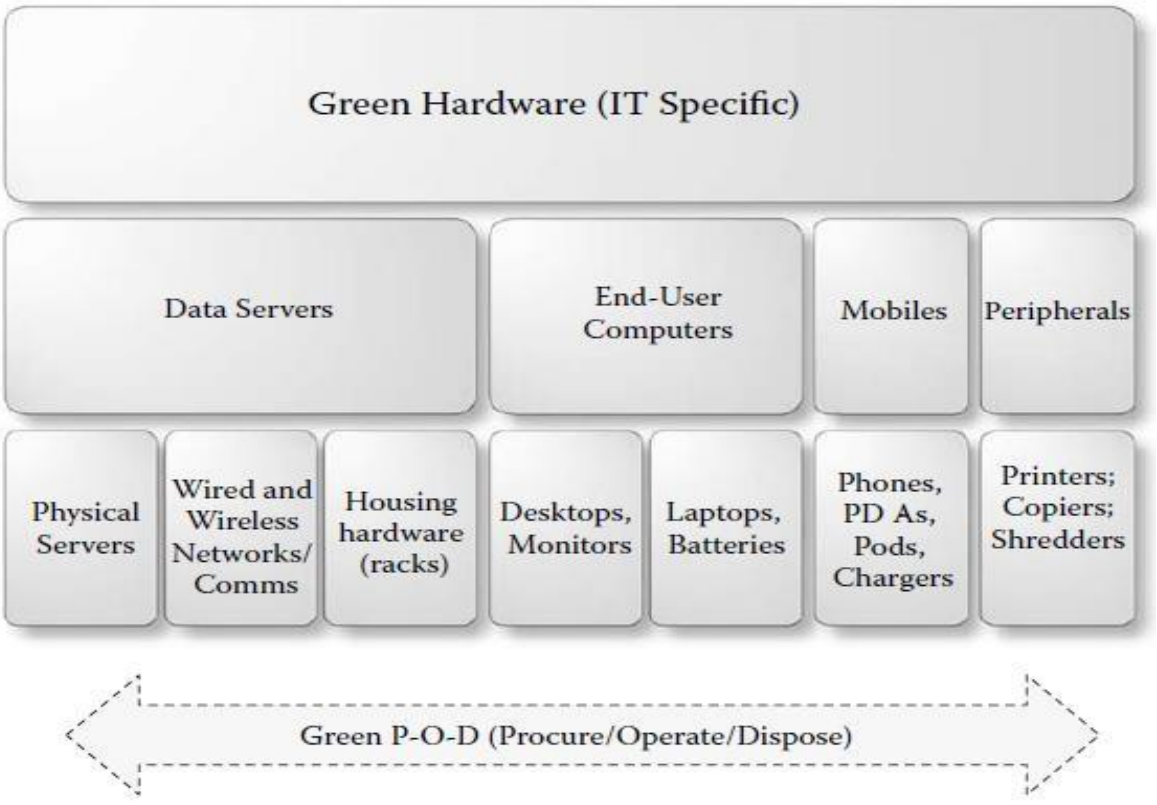
End-user computers—laptops, desktops, their capacities, operational efficiencies, and their disposal (especially as the lifecycle of a computer is getting shorter by the day) need to be discussed from their P-O-

D viewpoint. While the efficient design and manufacturing of these end-user devices remains the perceiver of the hardware manufacturers, the efficient operation and disposal is with the user organization

Mobile devices—the mobile devices and associated hardware (e.g., extension leads), their batteries including the recharging mechanism and disposal of the batteries and the policies and actions when the devices become outdate (quickly).

Peripherals—printers, photocopiers, shredders, and so on. The electronic gadgets are of immense interest in Green IT due to their large numbers, their potentially unnecessary overuse, the operational waste that is generated as a result (such as paper, ribbons, and ink), and the carbon associated with the eventual disposal of these "fast moving" items

- The carbon emissions from each of these Green IT hardware group mentioned above is affected by its procurement, operations, and disposal (Green P-O-D) phases in its lifecycle
- Procurement focuses on well-designed, low-carbon emitting data servers or monitors, buying it from a green supplier and using the most efficient means of packaging and transporting the equipment
- For example, the energy efficiency incorporated in the design of blade servers would be a one-off factor influencing the carbon emission of that server over its lifetime.
- Operation is the on-going use of hardware in an efficient and effective manner.
- Attitude of the end-user, affected usually by visible metrics, plays a significant part here. And finally, disposal of IT equipment requires due considerations as well



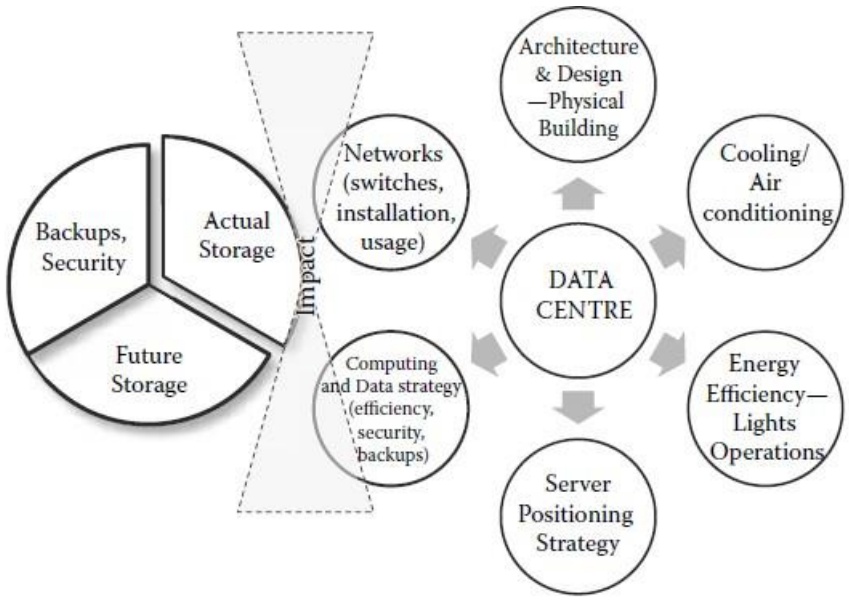
Range of Green IT hardware generating carbon.

Green Data Centres

- As mentioned earlier, data centers form the major chunk in the overall Green IT hardware assets of an organization
- It is house of large computers and associated networks of the organization, forming the "heart" of most businesses
- They hold the data and information residing in the organization's data warehouses that are residing within these data servers, which in turn, are placed in the data centers.
- Data servers, in practical terms, can be seen as powerful computers that have the capacity to store as well as process vast amount of multi formatted data.
- The growth in demand for vast amount of data storage coupled with corresponding demand for increasingly fast processing resulting in carbon emissions
- As Cloud computing makes rapid steps, data, in its countless multimedia formats will have to be stored and instantly made available upon request.
- Consumers of these data also range from school students doing their projects, doctors exchanging new techniques in treating patients, and social users loading and watching video clips on YouTube.
- As a result the demand of storing and processing of data is un abating.
- Therefore, businesses that particularly deal with contents (e.g., entertainment, news) have to improve the energy efficiency of their data centres through innovative strategies in data management that is means finding efficiency even in complexity
- The data management solutions need to be active so as to cater to rapidly changing data needs.
- Dynamic and active data management implies ability to modify, update, backup, and mirror data even as the organizational needs of the data keep changing
- Costs and carbon emissions are also closely tied together in case of data centers. Green data centers include the architecture, design, construction, operation, and decommissioning of buildings specifically used for housing servers.
- Green data centers also include the architecture, design, development, production, procurement, installation, operation, and disposal of the data server machines and their associated equipment such as monitors, printers, storage devices, and networking and communications systems

Data center design, layout, and location—Physical building in which the data center resides. It can be one building, or multiple buildings that house the machines but are themselves spread across geographical regions. Architecture and design of the building, geographical region, and the material used in construction of the building. The size and design of rooms in which servers are housed and also the location of the server rooms within the data center can play a role in carbon reduction

Cooling, air conditioning, power source and power consumption. It includes the cooling strategies of the servers; and the air conditioning relating to the actual building. Also wherever choice permits, this also includes use of green energy sources (such as wind or solar). Furthermore, the impact of the physical location of the rooms to be cooled, that are housing the servers.



Green data center influencing factors.

Power management lights and operational aspect. Number of people working, opening and closing of doors. It includes procurement and installation of green products (such as LED light bulbs) and use of green services.

Servers—their numbers, their positioning and corresponding energy efficient computing . Physical location of the racks, their positioning (hot isle/cold isle). Architecture and the physical rooms in which they are placed. Design of each server may be water cooled, air cooled, and other efficiencies are also to be considered

Data strategy including security and backup. Virtualization within each server, and combined virtualization Organization of a cluster of servers—private cloud. Space storage and usage strategy. Virtualization aims to pool resources together to deliver data center services by pooling resources that may be otherwise underutilized.

Networks and communications equipment, made up of land-based as well as wireless communications such as switchgears, routers, and modems

Green Business Process Management

- Green BPM is an overall approach to modelling, optimizing, consolidating, and executing business processes of an organization from a carbon perspective.
- BPM can be understood as a discipline of modelling, realizing, executing, monitoring, and optimizing business processes.

Green Reengineering

- Green BPM includes reengineering of business processes to optimize their emissions.

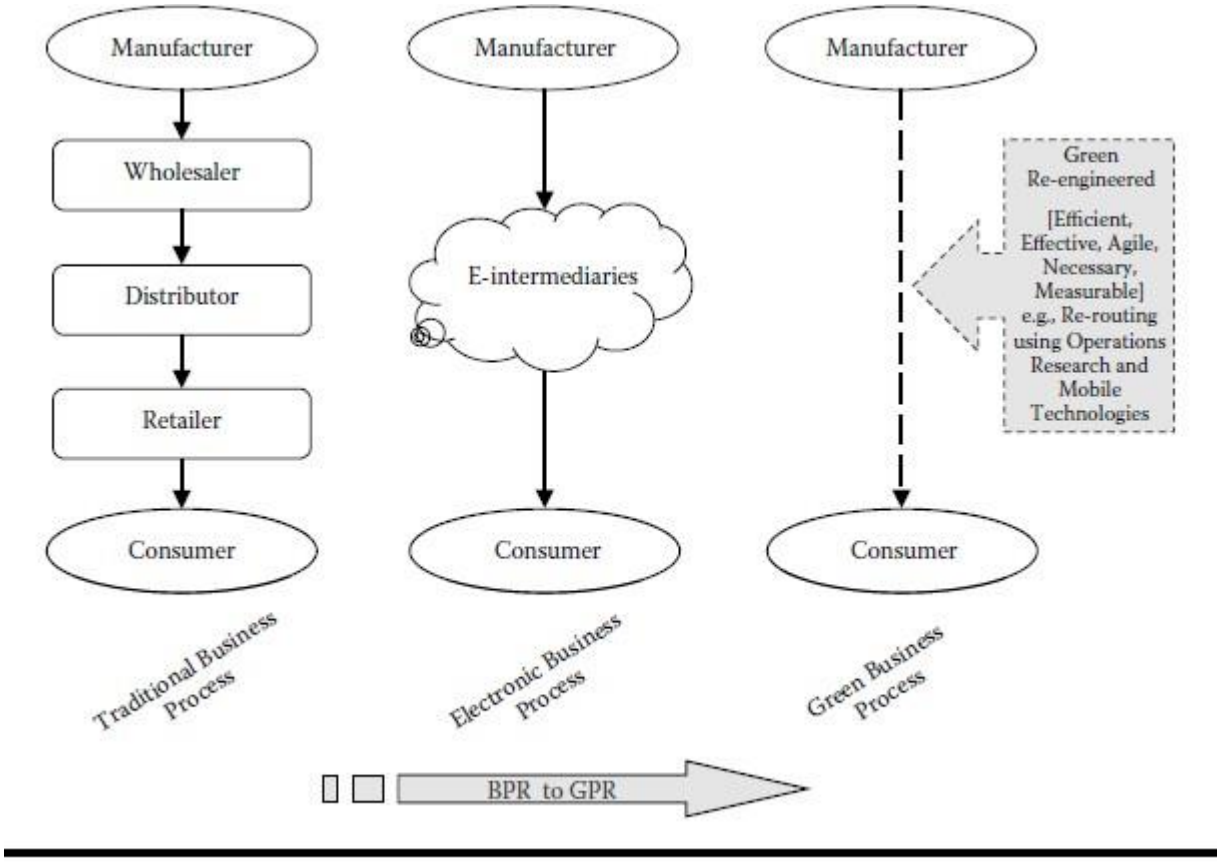


Figure 5.1 Core concept of GPR—a distribution example.

- The first part of the above diagram shows a manual distribution process, with steps leading from the manufacturer through to the warehouse, retailer, and the end-user
- The second part is electronically enabled process that will provide business efficiencies and effectiveness in terms of the distribution network.
- Such efficiencies are typically achieved by displaying the product on an organization's web site and enabling the consumer to order it directly from the web site.
- With such reengineering, the steps associated with the wholesaler and the retailer can both be avoided although the intermediaries can be the technology service providers and content managers
- However, the third process model is aiming for yet another alternative. Ā is reengineered process is efficient and effective from a cost and time viewpoint, and also from a carbon viewpoint
- For example, the third process model will aim to completely eliminate the E-intermediaries. Customer driven reengineering will optimize collaborative business processes to eliminate steps that were required only because of lack of alternative technologies
- Location-sensitive mobile technologies can improve the carbon performance by eliminating intermediary steps that result in carbon
- Green metrics help in understanding the effects of reengineering

- For example, green reengineered process can be measured for the total carbon content of the production process, the carbon generated by customer searches, and the overall carbon produced in ordering, packaging, and distribution to the consumer
- In addition to lean and reengineering, it is also worth considering TQM (total quality management) and its impact on the green process dimension of an organization. TQM brought about significant changes to the way an organization operated
- The resultant improvement in quality leads to reduction in rework. The reduced rework can be directly correlated with reduction in carbon. A process that achieves its goal by a single attempt for each process cycle is, by implication, going to generate less carbon as compared with the same process attempted more than once for a particular cycle

Green Processes: Individual, Organizational, and Collaborative

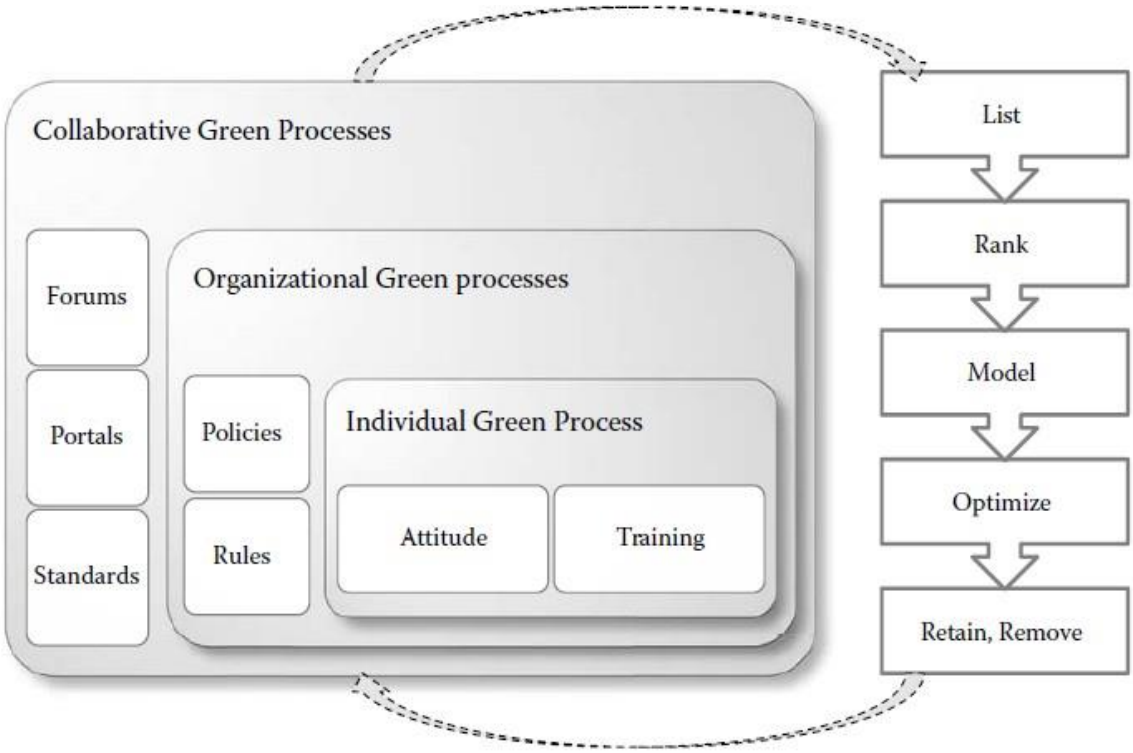


Figure 5.2 Individual, organizational, and collaborative green processes and their reengineering.

- Above figure shows the various levels of processes within an organization and their corresponding key factors.
- These are the individual, organizational, and collaborative processes that need to be considered in detail during GPR.
- Changes made can be either tactical (bearing immediate results) or strategic (longterm results).
- In general, individual processes tend to be planned and tend to provide quick-wins, such as individuals switching off their computers when not in use.

- Changes to collaborative processes tend to deliver longer-term results. Modelling and optimization of the collaborative processes requires more time and effort and include more players and multiple systems.
- Modelling and optimizing core processes from a carbon perspective has higher risks than peripheral.

Listing

- It is a process within an organization. It is an initial list, which will be refined as this green transformation exercise proceeds.
- A list can be created based on the value creation of the organization and which can be categorized into primary, secondary, or supporting processes based on major functions of the organization such as production, inventory, supply chain, customer relations, finance, and HR.
- Each group of processes can again have levels, such as end-to-end processes, sub processes, activities, and tasks.
- Each process within the list can have a description of what it provides or which goal of the organization is served by the process.

Ranking

- It is a process within the process list can be undertaken based on the carbon criteria.
- The ranking is meant to provide an understanding of which particular processes should be given highest priority in terms of green reengineering.

Modeling

- The process reengineering requires accurate modeling of those processes.
- If an organization has already undertaken a BPM exercise, process models for all major processes should be
- If not, the green transformation project can start by modeling the processes that are ranked high in the previous step.
- Process modeling in itself is a vast topic; however, here it has been discussed within the narrow context of Green BPR available.

Optimizing

- This step is the study of the processes that are modeled from their carbon impact and each activity within the process model can be studied and the carbon generated within that activity ascertained
- The activity can be modified to reduce its carbon, supported by technologies and systems to again reduce its carbon, or eliminated if found to be unnecessary.

Retaining

The processes that are modeled and optimized will reduce their carbon contribution. These are the processes that can be retained and placed in a continuously optimized mode

Removing

The BPM exercise will also identify processes that are either redundant/duplicated or are so excessively carbon inefficient that they have to be replaced.

Green Business Analysis

- The role of a Green BA can provide analytical help and support for green business process modelling. BA is the role that owns and models the requirements of the project
- Green BA is involved in understanding and documenting the use cases
- BA is also responsible for working with the key business executives and users to determine the goal and expectation of the business process.
- The BA is in an excellent position to start incorporating green business goals in the modeling of business processes. A Green BA will also aim to create flexible green processes. Similar to any normal business processes, the green business processes should also be flexible and continuously evolving.
- The flexibility allows the processes to be adaptable to different contexts in which they are being used. Changes to green business requirements are rapid and should be incorporated immediately in the green business processes.

Green Requirements Modeling

- One of the major responsibilities of a Green BA is to undertake modeling of requirements for a green process or system.
- It can be considered as a sub discipline of systems engineering that is concerned with the behavior, quality attributes, and also technical constraints.
- Green practices can affect requirements related to hardware, software, and business processes. A requirement may establish, for example, a solution that must not only full fill business goals, but also measure and report energy improvement over previous generations.

Functional requirements, the most well-known type of software requirements, describe the behaviour that the software will have and the information the solution will manage. Functional requirements are associated with the required behaviours and operations of a system, defining its capabilities in terms of actions and responses. Functional requirements are frequently captured in the form of use cases.

Green Enterprise Architecture

- The aim of a GEA is to develop an understanding of different viewpoints of business, technology, and the environment in which the business exists.
- The understanding also reduces the risks associated with the green transformation. Developing such an EA would imply an understanding and modeling of the business as well as technology space of the organization.

- Developing such an EA would imply an understanding and modeling of the business as well as technology space of the organization. For example, an EA would include a model of the way in which information is used by the business.
- For example, an EA would include a model of the way in which information is used by the business. The Model can be a process flow or, at an abstract level, even a simple block diagram. Similarly, the solution architecture would model the technology space in the organization.
- The solution model would incorporate the Green resources, networks, their speeds and bandwidths, and the contents and applications
- The GEA can thus be made up of well-defined and reusable business and technical components that are put together to handle rapidly changing external business.
- GEA-based approach to Green IT is particularly helpful in understanding and integrating heterogeneous enterprise applications.
- The results in data integration, process integration across multiple systems, collaboration amongst internal and external business applications, and extension to real-time information using mobile technologies and systems.
- The end result is a unified view of the business that can be updated and tuned for a green enterprise.
- A GEA also incorporates interfaces to the organization's customers, suppliers, and other trading partners
- It uses the interfaces include the technical interfaces (Green web services) as well as people-to-people interactions (between business leaders, and also workers).
- Suppliers and partners of the organization need to comply with all environmental laws and regulations as much as the organization itself.
- However, sometimes it can become challenging for an organization to enforce compliance on its suppliers. A GEA can be used as a basis for technical assistance (e.g., training, CEMS implementation, policy interpretation) that can help suppliers to conform with the regulations and standards.
- Similarly, a good GEA also helps the customers by providing them with the necessary Green web service interfaces, promoting the organization to them and assisting the corporate customers to setup their own GEA.
- GEA is also crucial in providing technical basis for development and implementation of a GIS.
- The use of GIS provides the organization with software system level support in measuring, monitoring, and reporting carbon data.
- However, in most cases especially with large organizations GIS are a combination of implementing a new software system, together with significant upgrade of and integration with existing systems.

The following activities are undertaken, with help and support of a GEA when it comes to GIS in an organization.

- ✓ Integration of new systems with existing organizational systems (typically ERP packages, CRM) using SOA-WS interfaces
- ✓ Modification of existing data structures to accommodate new carbon data elements and related contents associated with a Green IT hardware and other carbon-emitting assets
- ✓ Conversion of existing organizational data in a new format that will enable use of that data in calculating carbon emissions after the organization has transformed
- ✓ Populating parts of data and systems with external carbon data (such as regulatory requirements/standards/benchmarks)
- ✓ Evolution of existing decision support and knowledge management systems toward environmentally intelligent systems
- ✓ Creation of a suite of green services using SOA and WS.

Views of Green Enterprise Architecture

Green information architecture (GIA)

- ➢ Primarily deals with the models of information capture and information provisioning to both external and internal parties in the business space.
- ➢ The information architect and the business analyst work in this space identifying and modeling the information requirements
- ➢ The GIA identifies the basic functional requirements. that are modeled in the context of the Green IT strategies, processes, applications, and IT governance of the enterprise
- ➢ It would result in a prioritized suite of functional and operational requirements that become part of the green transformation program.
- ➢ Green solution architecture appearing in the lower half of the architectural spaces, deals with the design and development of systems from a technical perspective

Solution Architecture Model:

- ➢ The Solutions architecture primarily handles models and implementation of contents, networks, applications, their testing, and deployment
- ➢ The solution architect predominantly works in this space supported by the systems analysts and developers
- ➢ The GEA also influences both the information and solution architecture models.
- ➢ The overall GEA encompasses all of these architectures and provides constraints, limitations, and requirements for each of these architectural domains

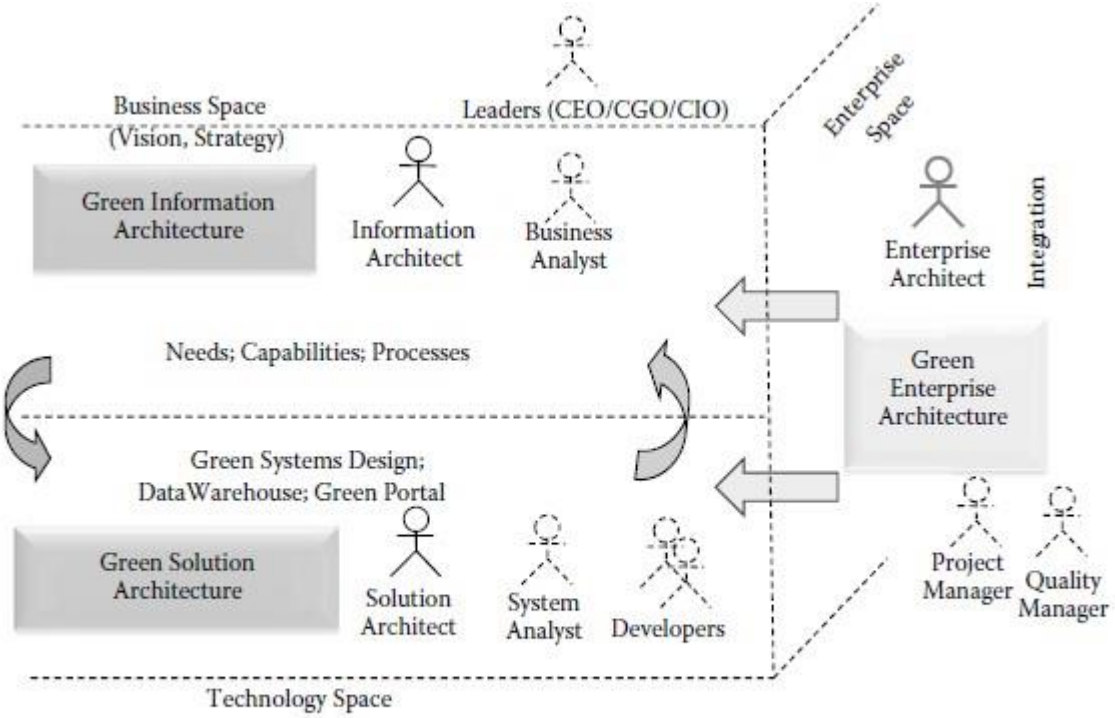


Figure 6.1 Various views of a comprehensive Green enterprise architecture: Business, technology, and enterprise spaces.

Green Enterprise Architecture—Categories of Requirements

- The below figure expands and groups the various activities that form part of the overall green architecture of the enterprise.
- The activities that deal with the business and information aspect of the organization are primarily the requirements; the ones that are in the solution space are related to the data and applications; and the overall GEA that provides the constraints and is in the background space.
- The GIA provides the basis for using enterprise applications, processes, and contents. The semantics for the master data including the green data are defined and the operational and analytical information is modeled in this architectural space.
- The requirements that influence the information architecture come from the business, information, and enterprise domains.
- The information architecture provides the context for facilitating integration across various applications.

- The information architecture also outlines the processes for capturing and modeling requirements. The information architecture also contains a repository of overall applications and their interrelationships.

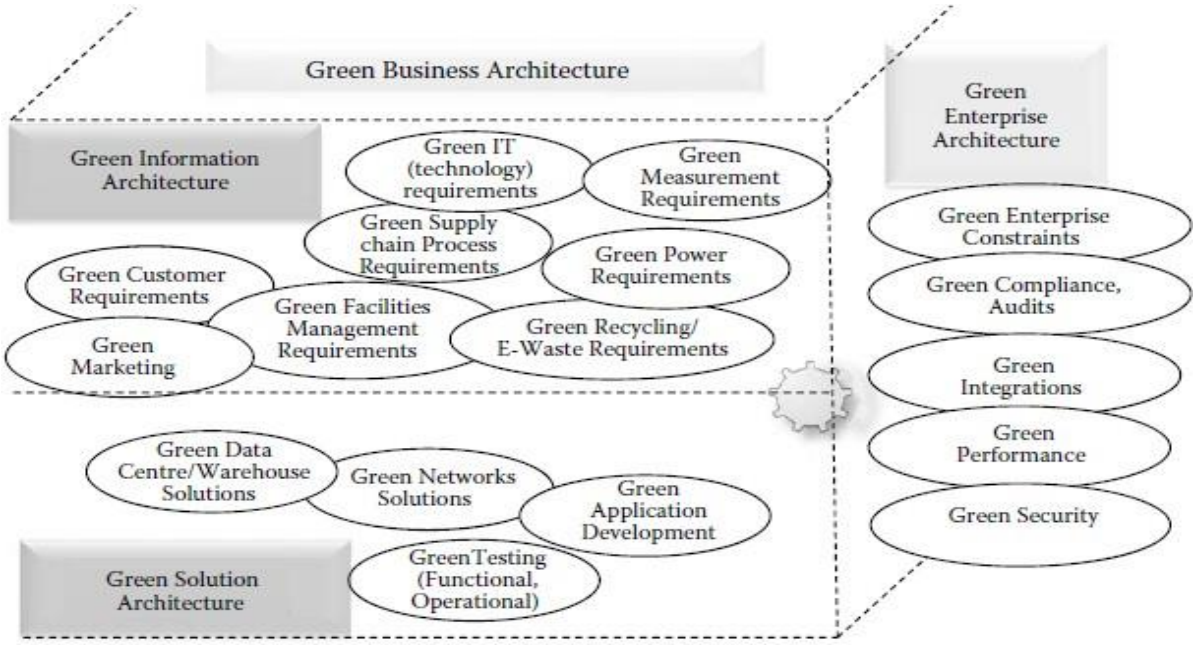


Figure 6.2 Categories of requirements in the various green architectural spaces.

- ✓ The Green customer requirements that are based on the demands of the customer for green products and services.
- ✓ Green marketing requirements that promote the organizations green products and services.
- ✓ Green supply chain process requirements that interface with the suppliers systems.
- ✓ Green technical requirements that are specifying the technologies that are needed to handle the Green IT initiative.
- ✓ Green facilities management requirements that describe the building and facilities infrastructure and the approach for measuring and reducing their carbon.
- ✓ Green metrics and measurement requirements that specify the elements to measure and report.
- ✓ Green recycling and e-waste management requirements that deal with the one-off disposal of assets.
- ✓ The Green data center design and solutions relates to the building and facility requirements that
- ✓ are IT specifi c.

- ✓ Green content strategies that are infl uenced by the backup, mirroring, and so on.
- ✓ Green networks and architecture solutions that provide the communication hardware.
- ✓ GIS programming solutions that relate to green information and solution

Aspects of Green Solutions Architecture

GSA brings about a synergy of technologies that can enable efficient use of IT resources

Technologies are further expanded below:

Cloud Computing

- Cloud computing is already in use and, yet, there are many emergent aspects of it. Identification and incorporation of Cloud-based solutions bring about immediate change in the carbon emissions of large data centers.
- Through the use of the Cloud, data and applications that were stored and executed within the data servers now transcend the organizational boundaries
- The organizational data together with the new and updated green solutions data is stored and executed externally. Cloud computing in the solution space leaves the organization to deal only with the remaining end-user computing devices and therefore limited carbon responsibility.

Virtualization

- As a part of the solutions architecture, however, virtualization provides the basis for consolidation of the data center's hardware that reduces the overall carbon emissions of the organization.
- Virtualization, as its name suggests, creates multiple operating views on the same physical machine resulting in much reduced use of hardware than if the servers were all physical.

Smart Networks

- Smart networks and their management make use of automated devices, sophisticated switch management, optimized network operations and real time reporting of the network performance.
- Efficient network operations assure delivery at lower cost and improved environmental footprint.
- Incorporating the self-healing capabilities of the networks in the green solutions space creates opportunities for network efficiencies in operations and thereby, reduces the overall carbon emissions of the organization.

Real-Time Decision Making

- Real-time decision making in the solution space is based on availability and delivery of information precisely and in the context of the need of the user.
- Such real-time delivery of information is primarily achieved through mobile technologies, devices, and applications

Optimization

- Optimization is closely associated with alignment and deals with the alignment of the solution technologies such as the servers, applications, and databases.
- Optimization, in the GSA, is the choice amongst possible alternative solutions that are aligned with the carbon footprint minimization objective of the organization.

Integration

This is a major activity in the green solutions space that works across two technological areas:

(a) Integration of carbon data with green services and interfaces within an application; and

(b) Integration amongst the different applications themselves.

Integration in the GSA is a detailed activity that requires independent discussion as undertaken next

Green supply chain management

- The term 'Green supply chain management' (GSCM) refers to the concept of integrating sustainable environmental processes into the traditional supply chain. This can include processes such as product design, material sourcing and selection, manufacturing and production, operation and end-of-life management.
- Instead of simply attempting to mitigate the environmental impact of the supply chain, GSCM involves driving value creation throughout the supply chain organisations to reduce total environmental impact.
- While the specific goal of GSCM is often the reduction of CO2 emissions, other tangible benefits for an organisation include; greater efficiency of assets, less waste production, greater innovation, reduction of production costs, reuse of raw materials, increased profitability, perception of added value to the client base, and so on.
- Integral to the success of GSCM is the approach taken by each party to their upstream and downstream partners in the supply chain. A much greater degree of collaboration, transparency and integration of supply chain processes and systems is required for the initiative to be effective.

Green Information Systems

- GIS is a system that is dedicated to management of carbon data. Therefore, a GIS forms the basis for measuring, monitoring, and reporting on the carbon data of the organization
- A GIS (or a CEMS or EIS) is a software system that provides support to the business to implement its environment responsible business strategies (ERBS).
- This system has to cover the length, breadth, and depth of various structural and dynamic aspects of the business.
- GIS system is the software with the functions for measuring, monitoring, and performance checking of the various emissions generated by devices employed in the business activities. Organizational emissions values are computed by the system

Phases in a GIS Development and Deployment

Develop—GIS needs to be developed by following agile practices and considering the important phases of a SDLC starting from requirements, analysis, design, and code to testing. Development has to consider issues of deployment, integration, and operations. Analysis and design of the system is undertaken using the unified modeling language (UML) diagrams that helps in modeling the problem space and develop a solution in design space

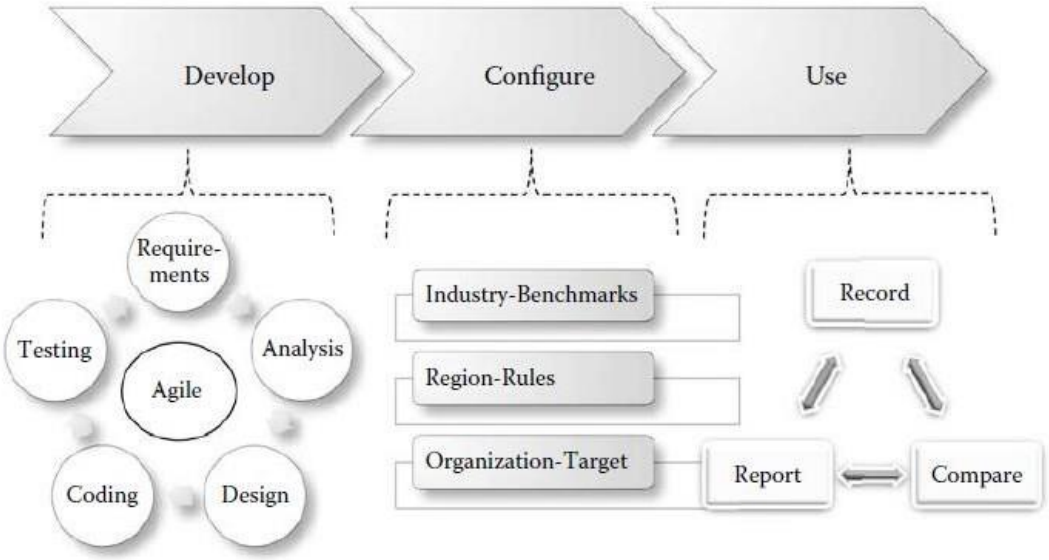


Figure 7.1 Major phases in GIS: development, configuration, and use.

Configure—Configuring GIS according to benchmarks and rules of organization. It would be an activity specific to each organization within each industry sector.

Use—Use of GIS will lead to on-going recording of carbon data creation of reports as well as comparisons

Features of GIS

- GIS are required to have all relevant features for supporting the organization in its green initiative
- Collecting environment-related data in real time. The GIS has to be geared to collect data such as number of devices in use and on standby. Mobility further enhances this data capture ability and makes it real time. GIS has to also relate this data to other business applications.
- Providing querying tools, key performance indicators (KPIs), and business analytics to field workers and decision makers in the area of EI. Availability of querying mechanisms can provide information that enables closing down of unused servers, desktops, and other equipment.

- GIS substantiates the green effort of the organization through the metrics, thereby providing positive feedback and impact on the employees' job satisfaction
- GIS can continuously identify and upgrade business processes and business practices in manufacturing, sales, and field support operations in order to make them environmentally responsible.
- Aligning office and home activities through GIS can be a tremendous boost to the organizational effort in improving its green credentials.
- GIS provides the business with the ability to sustain itself for a long time. An environmentally responsible business and a sustainable business are complimentary

Modeling and Architecting GIS—Requirements, Design, Implementation, and Testing

- UML has been used in presenting the models of the GIS. These modeling constructs of the UML that are used in this chapter are as follows
- Package diagrams—Used to create and model subsystems/Green information portals. Packages can also be used to create increments and sprints in an agile development approach.
- Use cases—Used to show functionalities and business processes from a user's point of view. It is the expected behaviour of the system documented as interactions.
- Use case diagrams—Provides a model describing all the related business processes/functionalities of a particular package. The use case diagrams also provide the scope of the system.
- Activity graphs—Provides a detailed view of every step of a business process. They provide the flow within a use case or a package of GIS.
- Class diagrams—Provides a static model of GIS based on its key business entities. This is diagrams can also be used to model underlying carbon data warehouse.
- Sequence diagrams—Provides a model for the interactions between objects and also rules for these interactions that are architectural decisions
- State Machine diagrams—Provides a view in which a particular entity passes through different states as a business process is executed.
- Component diagrams—Used to show the interaction of every component with each other.
- Deployment diagrams—Used to show the way application will be deployed including hardware and related infrastructure.

GIS Requirements

- Green ICT is developed to measure only energy consumption and environmental parameters such as carbon emissions, chemical wastes, and other office and industrial wastes.
- The Department of Environment, a government agency, is responsible for monitoring the carbon footprint of all the companies.
- The document will concentrate on process of gathering requirements, the resources needed to build the standards module of the project, and monitoring the progress of the project through a Gantt chart

- Green ICT system analysis and design is performed using the UML. UML diagrams such as use case, class, sequence, activity, state machine, package component, and deployment diagram are used in modeling the problem space and in designing of the system
- Typical GIS would involve two subsystems:

  Green organizational portal (GOP)

  Regulatory standards portal (RSP)

Green Organizational Portal

GOP is made up of organizational data on its "green" performance. These data are updated by the organizational representatives on an on-going basis.

These data record the organization's pollutant performance such as

(a) Heat generated by the desktop machines, data centers and network equipments within the organization,

(b) Carbon emissions in the petrol/diesel consumed by the organization, and

(c) Hazardous materials produced by the organization's activities such as lead in batteries and mobile phones

Regulatory Standards Portal

- RSP is a large portal that will be maintained by the government agency responsible for emission control within a country or region
- RSP will have to have detailed and continuously updated information on the pollutant categories that are producing the carbon emissions
- There are a large number of pollutant categories, which are also growing as new pollutants of the environment get recognized and added to the list. RSP is made up of thousands of units of data, examples of which are as follows:
  - ✓ Various types of pollutants that may not be directly related to IT such as petrol fumes from vehicles.
  - ✓ Pollutants that are related to IT equipment and consumables—such as monitors, printer ink, and lead batteries.
  - ✓ The approved standard for each of the pollutants—for example, 0.03 mg carbon per liter of petrol, and 0.05 mg of carbon per cartridge of printer ink.
  - ✓ The variations to the pollutants depending on the type of industry. Currently, RSP supports hundreds of industries such as airline, hotel, car rental, packaging, computer manufacturers, restaurants, farms, and so on.

Databases

Ability to identify polluting equipments, materials, and other a ssets of the organization

- ✓ Ability to store the relationship between assets and corresponding pollutions

- ✓ Storage of various types of GHG emissions on a time-period basis
- ✓ Ability to confi gure and create various dashboards and pollutant performance reports from within data available for pollutants
- ✓ Creation of various pollutant types and storing them in a reference table
- ✓ Storing energy rating of all assets (devices)
- ✓ Storing of benchmarks/standards for each polluting asset
- ✓ Ability to search for diff erent assets, polluting gases, and across various time periods
- ✓ Storing of trends for pollutants, assets, and time periods
- ✓ Storage and management of user accounts

UNIT – III

GREEN COMPUTING LECTURE NOTES

Introduction

- The data centre consumes the power that can otherwise be used to power thousands of homes, that huge level of power consumption is what makes data centre and environmentalists look for ways to reduce power usage and make data centres for more energy-efficient than they currently are.
- Virtualization is the answer to resolving the power consumption of data centres. One of the primary goals of almost all forms of virtualization is to make efficient use of resources including energy.
- Simply defining virtualization is to make a single piece of hardware function as multiple parts.
- Different user interfaces isolate different parts of hardware thereby making each one behave and function as an individual, separate entity
- In the context of data centres, virtualization is installing virtual infrastructure that allows several operating systems and applications to sum on a lesser number of servers, helping to reduce overall energy used for data centers.
- Once the number of servers is reduced it also means that data centers can reduce the building size as well.
- Some of the advantages of virtualization which directly impacts efficiency and contribute to the environment include:
    - ✓ Planned downtime is eliminated by migrating a virtual machine from one physical server to another.
    - ✓ Dynamically balanced workloads across a server group and provide automatically failover for virtualized applications.
    - ✓ Resource allocation is better managed and maintained.
    - ✓ Virtualization exponentially increases a server group's ability to share utility.
    - ✓ Server utilization rates can be increased by up to 80% as opposed to an initial 10 to 15%.
- The energy saved per server would translate into approximately 700 kilowatt-hour per year which is big with such tremendous potential for energy saving, virtualization is the best to practice green computing especially data centers in India.

Virtualization

- It allows a logical and abstract view on the physical resource and individual server, datastore, network, and software.
- The basic concept of virtualization is to pool physical resources and manage them in a single unit. Simply, we can say that virtualization is the process that provides the facility to create different views of the services available to a different user.
- Types of Virtualization

- Virtualization process can be classified into 5 types:

Operating System Virtualization

- The use of OS virtualization is to help solve security problems. For this type of virtualization, the OS plays a major role, in these multiple identical systems that can run under one OS kernel.

Platform Virtualization

- This type of virtualization allows us to run any desired OS and application in a virtual environment. There are two different methods for platform virtualization:
- Full Platform Virtualization: In this underlying hardware is completely simulated. This modification is not required by guest software.
- Para Platform Virtualization: In this underlying hardware is completely simulated. In this own isolated environment are run by guest software.

Storage Virtualization

- Cloud systems also offer dynamically scalable storage space as a service. In this context storage virtualization has several advantages. To separate the datastore from the classical file server and to pool the physical storage system is the basic criteria of storage virtualization.

Network Virtualization:

- The technique such as load balancing is required in this environment because it must be possible to dynamically scale the services offered. Network Virtualization is also used by local networks and virtual services.

Application Virtualization:

- It encapsulates computer programs from the underlying operating system on which they are executed. Its advantages are:
  - ✓ Compatibility.
  - ✓ Local availability.
  - ✓ Automatic management for updates.

Benefits of Virtualization

Resource Usage: Physical servers are rarely working to the capacity because these operators usually allow for sufficient computing resources to cover the maximum use if the virtual machine is used than any load requirement can be satisfied from the resource pool. In case of demand increases then it is possible to delay the request made by the user.

Management: It is possible to manage the resource pool automatically. A virtual machine can be created and configured automatically when it is required.

Consolidation: Consolidation is done to run various applications on a smaller number of physical components.

Energy Consumption: As the consolidation, reduces the number of physical components then simply it reduces energy consumption.

Less space required: Every part of data center space is very expensive nowadays with the consolidation process the same performance can be obtained on a smaller footprint and costly expansion of an existing data center can be avoided.

Drawbacks

- It can have a high cost of implementation.
- It creates a security risk
- It creates availability issues in case the assets are not available to perform a task.
- It creates a scalability issue as many entities share the same resources, thus growth creates a lag within a virtualization network.
- It takes time as there are extra steps that need to be followed to generate the desired result.
- It requires several links in a chain that must work together cohesively which is not the case when you have local equipment where you are in full control of what you can do.

Telecommuting

- Working at home or working remotely, for a company also called telecommuting
- For most people in midsized companies a little more than a decade ago, working at home was a bit of a challenge.
- Sure, computers and the baby Internet made it possible to connect, trade files, and work on things here or there.
- But unless you were a one-person team or an entrepreneur, collaboration was heavy and managing all the files you needed is very difficult.
- Today everything's different. With the advent of blossoming and always-on Web technologies that make teleconferencing, instant communication, and data warehousing easy and intuitive, you never have to feel out of touch with anyone.
- Whether you're working in the office or out, tools are available to keep you in continual contact, provide you with the data and processing power you need, and enable you to complete the tasks you're charged with completing, whether you work in an office down the hall or in a house across town.
- The green aspect of telecommuting makes it an even more viable option for employees: It's a greener way to work. Here are just a few of the big-ticket savings that telecommuting offers individuals and businesses

  Saves time: Americans in cities of all sizes across the country lost more than 4.2 billion hours waiting in traffic in a single year!

Saves energy: The amount of energy you use getting to the office, powering up your system, flipping on all the lights, and warming (or cooling) yourself with the climate control system, staying in one place is less of a drain on energy resources

Reduces CO2 emissions: Cars on the road are a huge contributor to the gasses that are causing the greenhouse effect around the planet. The logic is simple — reduce the number of cars on the road, reduce the CO2 emissions

Reduces in-the-office resources: You may not think you take up a lot of space or use a lot of electricity (or oil, or coal, or water) in the office, but if you're there, you're leaving a footprint.

How Telecommuting Works ?

- Rather than traveling to the office, the employee uses telecommunication to keep in touch with coworkers and employers. These can include telephone, online chat programs, video meeting platforms, and email.
- For office workers, technology (such as Slack and Zoom) has made working from home easier. Access to WiFi can help make communications virtually seamless.
- The worker may occasionally enter the office to attend meetings in-person and touch base with the employer, however, with many options for distance conferencing, there's sometimes no need to visit the office.
- Some employees telecommute full-time, while others may work remotely for part of the week and go into the office for the remainder of the week.

Managing the Challenges of Telecommuting

Some of the big challenges you're likely to encounter as you begin to telecommute for the first time include these

- ✓ Setting up expectations
- ✓ Managing your time effectively
- ✓ Setting up boundaries while everyone gets used to the new routine
- ✓ Staying in the loop
- ✓ Demonstrating your value
- ✓ Being on the radar for promotions

Table 13-2 Pros and Cons of Working at Home

Pros	*Cons*
Won't need to drive to the office Mondays and Fridays	Will miss special lunches with staff every other Friday
Can use my green laptop to access my work files remotely	Will need to schedule database work for Tuesday–Thursday, when I'm in the office
Better use of time for creative projects	Will be able to meet with vendors only on Tuesday–Thursday
Easily accessible via remote access, IM, and cellphone	Won't be there for quick meetings on work-at-home days

Managing time effectively

- It is necessary to stay in sync with life at the office. Here are a few ideas to help you do just that
- If you are able to remote in to your office system, keep your daily calendar up to date and share it with others on your team. This helps them see what you have planned for your time at home. You can also use a simple Web-based calendar in a tool like Microsoft Office Live and enable others on your team to have shared access to it.
- Send an e-mail message to your team leader or supervisor in the morning to give a quick update on your projects and let him or her know what you're focusing on that day at home
- Let team members who are waiting on items from you know instantly when you send something in. You can send an e-mail message or ping someone with an instant messaging program such as Windows Live Messenger or AIM
- Participate in conference calls, interviews, and any other group or leadership event remotely
- Keep track of the fuel and CO2 you're saving as you work at home.

Pros of telecommuting: Here are some of the reasons why you or your employer might prefer to work from home instead of in a traditional office or other workplace setting.

- ✓ You do not have to spend time commuting back and forth from work.
- ✓ It is easier to focus without the usual workplace distractions.
- ✓ There are no transportation costs.
- ✓ It can provide a better balance of work and personal pursuits.
- ✓ Employers may save money on real estate and other overhead expenses.
- ✓ It has shown to be more productive for many employees.
- ✓ People can work at their own pace without pressure.

Cons of telecommuting: Conversely, telecommuting is not beneficial for everyone concerned. Here are several negative aspects to consider.

- ✓ The employee has less personal contact with managers and co-workers, delaying communication.
- ✓ It can be more difficult for managers to supervise someone working from home.
- ✓ The worker may have more disruptions at home, resulting in reduced productivity.
- ✓ You might miss the social aspect of working with peers.
- ✓ Having a remote workplace could jeopardize security for the company.

Tracking Your Green Savings

- Their employees saved $1,700 per year in gas and vehicle maintenance by working at home 2.5 days a week.

- They consumed less energy because equipment in the office drew two times the amount of energy (130 watts per hour compared to an average of 60 watts per hour).
- The savings in the footprint size for the employee was enormous, reducing 98 percent of the employee's carbon footprint for work.
- Each employee reduced energy normally used at work by 5,400 kWh (kilowatt-hours) each year.
- Working from home saved employees 2.5 weeks of commute time in a single year.

Figuring Out What You Need to Work Efficiently

- ✓ E-mail and Web research
- ✓ Writing and editing documents
- ✓ Talking with customers and vendors on the phone
- ✓ Graphic design and layout
- ✓ Designing and offering Webinars for clients and colleagues
- ✓ Proofreading legal documents
- ✓ Designing new product prototypes
- ✓ Managing accounts
- ✓ Doing book keeping tasks
- ✓ Creating media — audio and video — productions

Choosing Your Office Location

You don't need a huge space for a green home office

- ✓ In general, as you choose the spot for your workspace, keep these ideas in mind:
- ✓ Your computer and peripherals need access to power, a router (Wi-Fi or wired), and each other.
- ✓ Your work area should be off the main traffic flow of the house so that contracts don't get mixed in with coloring pages.
- ✓ If your workspace is part of another room, consider using a credenzaor creating shelves with cabinet doors so you can put away your work when you're not working.
- ✓ Create your workspace in an area that is well-ventilated and gets fresh air whenever possible (your technology will thank you).
- ✓ If you have an extra room or want to create a space for your home office, plan to go as green as possible with paint, lighting, floor and window coverings, and furnishings

Talking Green Furnishings

After you know the general layout of the room and have checked out where the outlets are, how the traffic flows, and where your sources of natural light come from, you can start to think about what kinds of furnishings you need.

Depending on how you like to work, you're probably looking at the following pieces:

- ✓ A desk, a chair, and maybe a bookshelf (or two)
- ✓ A small printer/router/miscellaneous table
- ✓ An additional table for spreading things out
- ✓ Other seating, if you think you'll have visitors
- ✓ Lighting
- ✓ Window treatments
- ✓ Stuff for the walls

Lighting

- ✓ Using natural blinds both helps reduce glare and reflect light into the room.
- ✓ Painting the walls a natural, light color helps brighten the room and makes better use of natural light.
- ✓ Positioning your desk so that it receives reflected — not direct — sunlight reduces monitor glare and makes reading easier

If you don't have natural, your next greenest option is using CFL (compact fluorescent light) bulbs. Get rid of those incandescent bulbs once and for all. CFLs are just a little more expensive upfront and last more than 10 times longer.

Circulation and temperature controls

- ➢ If you need to do something to manage the temperature of your work environment, use these tips to make low-footprint changes:
  - ✓ Start with what you're wearing. Add a sweater or take one off.
  - ✓ Block out the heat by closing blinds or curtains.
  - ✓ Increase the temperature of a room by opening curtains wide on a sunny day.
  - ✓ Make sure windows are well caulked so that drafts aren't getting in — or out.
  - ✓ Open windows whenever possible — in the cool of the day, for example — to get fresh air flowing into the space and even out the temperature.

- ✓ Use air flow from the rest of the house to keep the temperature more constant. You can do this by thinking of the air circulation patterns in your home now and making sure vents and doors help bring the air to where you're working.

Sustaining Green Practices

- As you begin to work in your home office, think about the green aspect of common work practices to help give yourself a green guide to energy and resource-friendly approaches. Here are a few ideas to get you started
- A print plan: Only print items that you must review on the page and only use paper with a high percentage of post-consumer recycled material. When you do print, print double-sided, use all the scrap pieces you can, and go electronic wherever possible
- An energy use plan: Know which items you want turned on as a matter of course in your office and which should remain unplugged until you need them. Set your computer and all peripherals to shut off instead of hibernating or sleeping if you plan to be gone for more than two hours.
- An energy acquisition plan: Buy renewable energy if you can your local utility company may have an option that enables you to purchase a certain amount of your electricity from renewable resources. The costs are just a little higher than normal utility rates and, well, it's green.
- A resource use plan: Bottled water. Use an earth-friendly refillable bottle. Another resource savings — use rechargeable batteries whenever possible for devices, mice, keyboards, and more

Requesting Your Virtual Presence

- Technology has come a long way since the early days of closed-circuit televisions, when, in order to take a distance learning course, you had to drive 30 miles to a central location (perhaps a school or an office) and sit in a room with a bunch of others, staring at a television on a cart while a talking head lectured you.
- Today, easy-to-use software makes telepresencing the ability to be in another location and participate fully, almost like you would if you were in the room a real possibility and an affordable option for people all over the world.
- Telepresence works best when participants feel engaged in more than one sense sight and hearing, for example is involved
- Telepresence it is the ability to communicate in real time, as fully present as possible — is synchronous conferencing, meaning that all participants are in contact with each other at the same time.
- A two way communication using electronic equipment between students who are located at separate locations and teacher in a studio can be called "teleconference".
- Such communication is facilitated by a combination of electronic equipment and communication channels.
- The communication channels can be simple telephone networks to satellite links. Interaction between teacher and student is achieved by different type of technologies.

- These technologies are divided as synchronous and asynchronous depending on the nature of communication either live or recorded
- Conferencing helps in the following manners:
  - ✓ Provides equitable access to resources to learners especially to those in rural and remote places.
  - ✓ Facilitates rapid access to information.
  - ✓ Makes learning interactive, participatory and dialogue based.
  - ✓ Facilitates collaborative learning through exchange of information , sharing of resources, team work .
  - ✓ Provides a virtual learning environment when access to real experiences is not feasible.

Reducing Your Carbon Emissions with Free Phone Service

Getting started with Skype

Here's how to set up Skype. (It takes about 15 minutes.)

1. Go to www.skype.com and download the version of Skype that matches your operating system
2. When the software prompts you, start Skype.
3. In the Welcome Screen, click the Check Your Sound Works option.
4. Click Call.
5. When prompted, speak into your microphone.

Calling all Skypers

1. In the Skype window, click Contacts.
2. Click Import Contacts.
3. Select the check boxes of the program contacts you want to import, and click Search E-mail Contacts
4. To add those people as contacts in your Skype list, click the check box to the left of each of their names and click Add Contact. If you don't want to add them, click Skip
5. Customize the e-mail message Skype drafts for you, select the check boxes of the people you want to send it to, and click Send.

Presenting via Webinars

- Webinar is one example of a simple tool you can use to deliver all kinds of content in a collaborative Web format.
- You can create Webinars on the fly that include up to 200 people, or you can schedule larger events of up to 1,000 participants. This particular Webinar tool (the capabilities may vary with other products) makes it easy for you to

- ✓ Make presentations in a media-rich format.
- ✓ Record the presentation as a podcast.
- ✓ Moderate discussions.
- ✓ Lead training sessions.
- ✓ Make transcribed notes and documents available automatically to all participants

Setting up a Webinar can be as simple as rolling out a new sales program to inspire your field sales reps

Here are the steps:

1. Go to www.gotoWebinar.com and create a free trial account
2. Log in using your e-mail address and password
3. Click Schedule a Webinar.
4. If you plan to share the Webinar with other presenters, click Specify Panellists.
5. Click Save and Continue.
6. On the Branding and Theme tab, you design the look of your Webinar.If you like, click Upload Logo to add your company logo to the site.
7. Click through the themes and choose the one that best fits the look you would like to convey
8. Click Upload Custom Image if you want to add your own photos or artwork to the page
9. Choose the color for your Webinar waiting room (where participants gather before the Webinar begins).
10. Enter the presenter name, presentation title, and the company name
11. Type a message in the text box to welcome participants when they arrive.
12. Preview the Webinar by clicking first Preview Theme and then Preview Waiting Room.
13. Click Save and Continue

Remote Desktop Services

- ➢ Remote Desktop Services (RDS), known as Terminal Services in Windows Server 2008 and earlier, it is one of the components of Microsoft Windows that allow a user to take control of a remote computer or virtual machine over a network connection.
- ➢ RDS is Microsoft's implementation of thin client architecture, where Windows software, and the entire desktop of the computer running RDS, are made accessible to any remote client machine that supports Remote Desktop Protocol (RDP).
- ➢ User interfaces are displayed from the server onto the client system and input from the client system is transmitted to the server - where software execution takes place.

- This is in contrast to application streaming systems, like Microsoft App-V, in which computer programs are streamed to the client on-demand and executed on the client machine

Materials recycling

- Recycling computing equipment can keep harmful materials such as lead, mercury, and hexavalent chromium out of landfills, and can also replace equipment that otherwise would need to be manufactured, saving further energy and emissions.
- Computer systems that have outlived their particular function can be re-purposed, or donated to various charities and non-profit organizations
- If the computer you put out with the trash actually makes it to the landfill, it leaks hazardous chemicals into the ground, and those toxins eventually find their way into the water supply for surrounding areas. Here are some of the problems with the various computer components that are shoved into landfills and covered with dirt

Lead: Cathode-ray tube (CRT) monitors contain lead and other hazardous metals. The glass of the screens, when broken, releases a dust that is harmful as well. Lead in the environment can cause respiratory problems and cognitive-development issues

Mercury: Liquid-crystal display (LCD) monitors contain mercury (also used in cellphones, MP3 players, and television sets), which can damage the brain, nervous system, reproductive system, kidneys, and lungs

Copper: Computers contain copper. The process of creating usable copper and etching the wires on the computer boards adds to acid rain and contributes to global warming. High doses of copper can cause headaches, stomachaches, dizziness, vomiting, and diarrhea. It can also cause liver and kidney damage

Chemicals: Each semiconductor used in computer chips includes hundreds (no kidding) of hazardous chemicals, which can contribute to a variety of physical problems in children and adults.

Plastics: The treated, flame-retardant plastics used in computers, called polybrominated diphenyl ethers (PBDEs), can contribute to neurodevelopmental problems and some cancers.

Exporting the e-Waste Problem

Around the world, e-waste is a problem of massive proportions. The export business is alive and well, with e-waste being shipped to developing countries such as China, India, and Nigeria, where labour is cheaper and there are fewer restrictions on working conditions than in the United States.

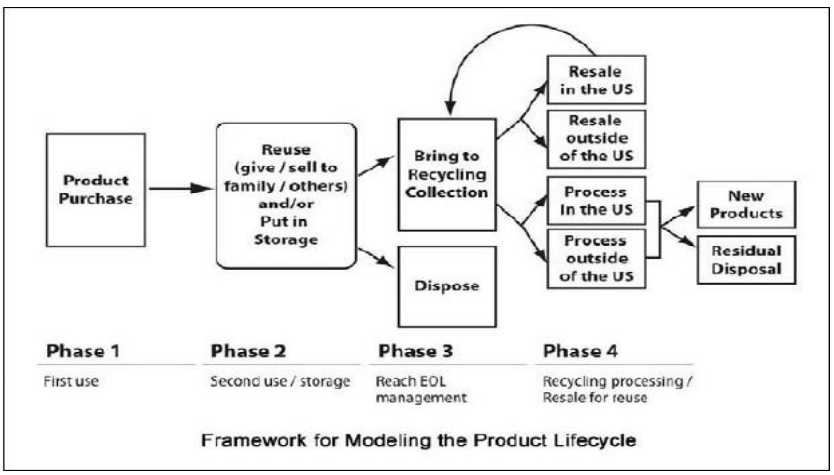


Figure 8-1: What really happens to your computer after you let it go?

- The computer may be resold in the United States
- The computer may be resold outside the United States
- The computer may be processed (broken down into its parts) and recycled in the United States in such a way that new products are created and the unusable components are disposed of responsibly
- The computer may be processed outside the United States. In this case, fewer safeguards are in place, and the system may wind up being burned for scrap metal in China, India, or Kenya

Reasons to Recycle Computers

- In the reduce, reuse, recycle mantra, recycle may sound like the end of the line, where the computer moves beyond your concern and becomes somebody else's problem.
- Wonder what the difference is between refurbishing and recertifying?
- A refurbished computer has parts that someone has fixed or updated to make the computer ready to rock again.
- A recertified computer gets similar treatment, except the manufacturer takes a look and gives it the thumbs-up if it meets the manufacturer's standards
- When you decide to recycle a computer, you might?
- Donate the computer to a not-for-profit organization, school, or person who needs it
- Give your computer to a recycler in your local area
- Take or send your computer to a manufacturer's or retailer's recycling program.

Wiping Your System Clean

Delete and overwrite sensitive files. If you have tax documents and other sensitive files, make sure you delete these files with specialized software designed to meet government standards for secure deletion. For Windows PCs with hard drives try File Shredder (free). For older Macs with hard drives (pre OS X El Capitan or OS 10.11) you can choose the Secure Empty Trash option after deleting your files

Deauthorize your computer. Some programs, such as iTunes and Microsoft Office 365, only allow you to install software on a limited number of computers or allow a limited number of computers to access your files. So be sure to deauthorize your old computer with your accounts - before uninstalled your program

Delete your browsing history. Most browsers save information about your browsing history and, depending on your settings, can even store your user names and passwords various sites. Obviously, you don't want a stranger having access to this information

Uninstall your programs. Some programs, such as Microsoft Office, may contain personal information such as your name and address or other details. So be sure to uninstall any programs before disposing of your compute

Consult your employer about data disposal policies. If you use your computer for business purposes, check with your employer about how to manage business-related information on your computer. The law requires businesses to follow data security and disposal requirements for certain information that's related to customers

Best ways for Green PC

Manage the Power

- No matter what kind of computer system you're using, your operating system has some kind of system to help you manage the power you use.
- Choose or create a power management plan to suit different needs
- Change the way your power buttons act
- Customize when your computer goes to sleep

Buy Power Strips or Unplug Devices

- Many of the devices and appliances we use every day -- SmartPhones, laptops and -- drain a steady supply of energy, even when the device isn't in use. This is known as ‒phantom‖ energy, but the costs are very real.
- ‒Staying unplugged not only this reduces energy consumption, but it also saves on energy bills,‖ said Torti. He also suggested using an energy-monitoring power strip to see which devices hog energy and how much it's costing you.

Consolidate Servers and Save Energy

- Also known as virtualization, this basically means to run more than one application – e-mail, productivity, databases, for example -- on a single server. ‒Virtualization reduces server hardware needs, lets small businesses do more with less, and it can reduce energy use by up to 90 percent,‖

Go to Sleep at the End of the Day

Turn on your PC's sleep feature so that when you walk away from your desk, your PC will use less energy.

Boost Your RAM

- More RAM helps speed your computer's processing power, which means less chunking to the hard disk and smoother processing all around
- Find out how much RAM you already have by right-clicking Computer and choosing Properties. The System Properties dialog box opens, and the amount of RAM on your system appears at the bottom of the General tab. On a Mac, click the Apple menu and then click About This Macintosh; the number in the Total Memory line tells you the amount of RAM in your system

Increase Air Flow, Reduce Heat

- Your computer will thank you for the same kind of treatment. Make sure that your computer is well aerated. Here are a few ways to do that

For your desktop computer:

- Allow several inches of ventilation space between the system unit and the back of your computer cabinet.
- Clean the back of the fan and dust around the back of the computer regularly.

- Make sure cables are organized and out of the way of the air flow.

For your laptop computer:

- Get your laptop up off your lap (or bed, or footstool).
- Use a laptop tray, such as the Futura laptop desk from Lapworks, with ventilation slots to reduce system heat by up to 20 percent
- Make sure the AC cord and other cables don't block the small fan outlet on the back or side of your laptop

Recycle Responsibly

- The last item in reduce, reuse, recycle is an important step that many people
- Because toxic chemicals are still used in the manufacturing of computer plastics, boards, and capacitors, just putting a system in a trash bag and setting it out by the curb is a dangerous thing to do to the planet.
- Not only does the toss-it-out-with-the-trash method run the risk of seriously polluting your local environment, but it has global ramifications as well.
- Most of the big computer manufacturers offer recycling programs so that you can easily return the computers and equipment you no longer need or use

Green Grid Framework

- The Green Grid is a non-profit, open industry consortium consisting of end users, policymakers, technology providers, facility architects and utility companies. It is a joint collaboration that aims to improve the energy efficiency of data centers and business computing systems.
- The Green Grid attempts to connect global industry efforts, develop a standard set of metrics and prepare technical resources and educational tools to achieve its goal.
- Data centers have changed substantially with the evolution of IT. The number of data centers has increased drastically in response to increasing business demands, resulting in a large number of these high-energy centers.
- As of 2011, IT equipment was estimated to account for 2% of the world's carbon emissions.
- As a result, data center managers are keen on developing strategies to make data centers as resource efficient as possible.
- The Green Grid aims to become a global leader in making resource-efficient data centers and business computing systems.
- The Green Grid has developed a data center maturity model that includes levels 0-5, where Level 2 indicates the current best practices in data center efficiency, while Levels 3 -5 are designed to provide guidance to companies that are about to build new data centers.
- The Green Grid provides a common road map for all the data enter managers, designers and vendors.

- The model can be seen as a tool to provide high-level descriptions of technologies and plans for data center owners and operators to improve energy efficiency.

Green Data Center

- A green data center is an enterprise class computing facility that is entirely built, managed and operated on green computing principles.
- It provides the same features and capabilities of a typical data center but uses less energy and space, and its design and operation are environmentally friendly.
- A green data center is built to have a minimal effect on the natural environment.

The following are primary green data center features:

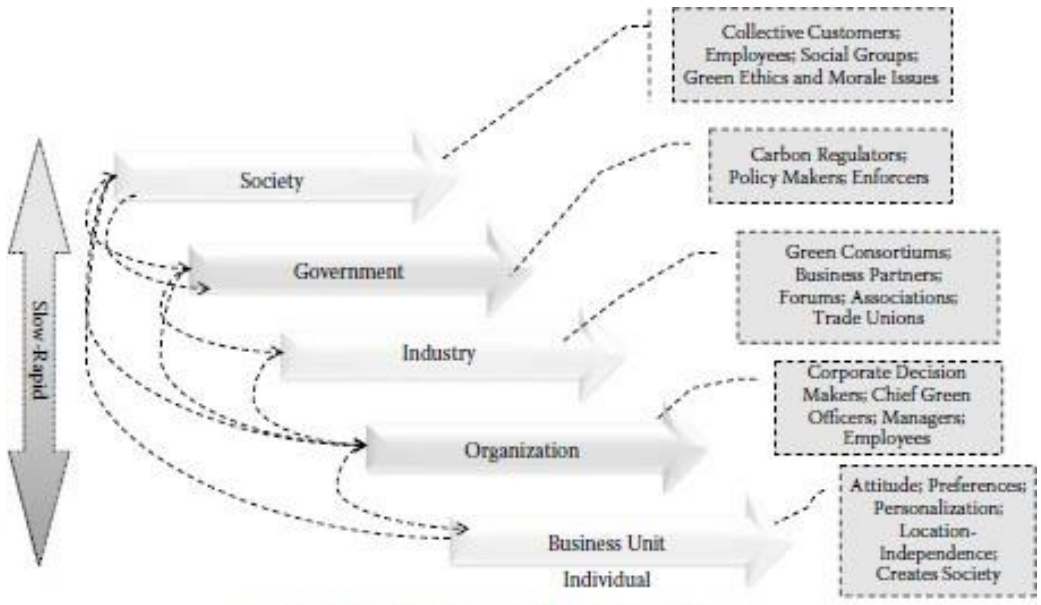
- ✓ Built from the ground up in an environment friendly facility
- ✓ Consume minimal power resources for operation and maintenance - both for the primary computing infrastructure and supporting electronic resources, such as cooling, backup and lighting
- ✓ Typically operate with green or renewable energy, such as solar, wind or hydel power
- ✓ Entire infrastructure is installed with the lowest power and carbon footprint
- ✓ Minimal e-waste with recyclable or reusable equipment

GREEN COMPUTING

UNIT - IV

Socio-cultural aspects of Green IT

- Sociocultural and political issues are one of the six crucial drivers of Green IT
- As the organization transforms itself into a green organization, the social dynamics of the organization changes to match the green working lifestyle and a green attitude
- These social dynamics also influence individuals beyond their workplace and go into their associated personal/family lifestyles
- It impact on the working lifestyles of the employees that goes beyond their immediate place of work
- The society, government, industry sector, and the organization are all involved in and affected by the changes resulting from Green IT at different levels and at varying speeds
- Green transformation of an entire society involves green ethics, morals, value systems, and attitude across multiple layers of people, it makes environmental changes for the society even more complicated than organizational and governmental changes
- The government can bring about changes through approval of agreements and converting them into law, the changes in the society are based on protocols and understanding that is —in grown
- While the industry sectors and the market can determine the best solutions, government help and support can influence the subjective aspect of those solutions in a positive way.
- Training and awareness associated with the Green IT issues can play a key role in handling the subjective nature of green transformation



The slow moving society has a much more compelling influence on the greening of the organization; society influences governments; governments in turn, influence industry and the organization; organization undertake or are "forced" to undergo green enterprise transformation. Ultimately the individual is affected.

Green IT's Social Impact

- Discussions of the social aspects of Green IT involve individuals, government, and society. Individuals, however, operate in several roles, as the individual, as member of a family or social group, as a member of an organization (business, academic, government), and as decision makers.
- There is a growing interest by individuals to understand the organizations they are associated, its values and its performance in terms of the environment.
- Environmental responsibility affects the structure and operation of the organizations and the society in which it exists.

Green Social Stakeholders

- One of the important ways to handle cross-cultural issues in long-scale green transformation is by increasing and enhancing the opportunities for physical (face-to-face) communications amongst the diverse stakeholders.
- While increasingly challenging, physical communications can help handle cross-cultural issues, especially when the transformation plan is implemented.
- Information flow between various groups of employees in diff erent regions supported by the organizational change management is required for successful transition to a green organization
- The collaborative groups of people and organizations need to be considered in global green effort. These issues include their individual preferences, corporate policies, government regulations, social norms and practices, and ethical codes of conduct.
- In fact, even different age groups, their preferences as customers, employees, and regulations, and their sociocultural background influence the Green IT initiative.

Views of Various Cross-Sections of Society (Children, Elderly, Tax Payers, Households, Sports People, Defense, etc.) on Environmental Initiatives

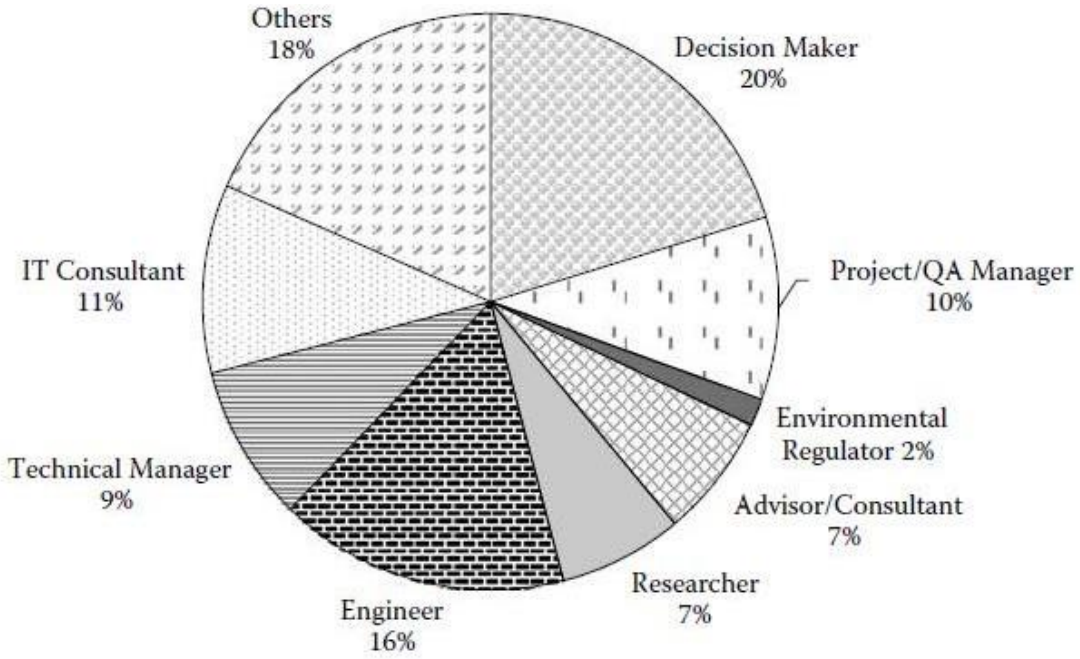
Categories	*Activities (Typical)*	*Green Viewpoint (Typical Examples)*
Children	Playing games Being entertained Being monitored	Carbon emission due to use of electronic gadgets, TV, and computers Usage not controlled and financed by actual users
Adolescents	Games Entertainment message Exchange (IM, Email)	Carbon emissions resulting from gaming gadgets Increased electronic storage and use of Internet-based communications for group games
	Study activities (education)	Reduced outdoor activities Reduced activities with paper and pen Reduced readings from books and journals (and therefore, less visits to the library, for example) Desirous of faster results

Categories	*Activities (Typical)*	*Green Viewpoint (Typical Examples)*
Patients in hospital	Social networks Email/news finance	EPR storage, improved health, increased carbon
Sports people	Search engines Social networks	Enhanced competitive performance Training
Defense personnel	Information Communication Protection/security	Increased storage of data More data servers Communication equipment Improved security and surveillance but also increase in carbon
Adults	Social networks Email/communications Learning Banking/finance Work related Search engines	Concerns about the environment from futuristic viewpoint (what will happen to my children and their children?) Reduction in travel through—telecommuting Capable of influencing policies and regulations
Elders	Increase in social networks Health	Skepticism and inhibition in using IT
People with special needs	Online facilities Communication Search engines	Ease of movements Hiring of experience

Role-Based View of Green IT

- Green IT initiatives and their subjective interpretations are based on various roles.
- Typical roles within the society in general were discussed in the previous section and highlighted in the above Table
- When it comes to organizational stakeholders, these roles within an organization require detailed study.
- The reason for this role based study is to understand the subjectivity as well as the personal interests these roles would have in undertaking and supporting green transformations.
- Below figure shows the various roles that participated in and were studied as a part of the Trivedi and Unhelkar (2009) survey
- It is observed that the viewpoints on Green IT change depending on the industry sectors

- Green IT initiatives thus continue to have a wide-ranging subjective impact on the individuals and roles they play at work It is, in turn, also affects the way people are organized and operate within organizations

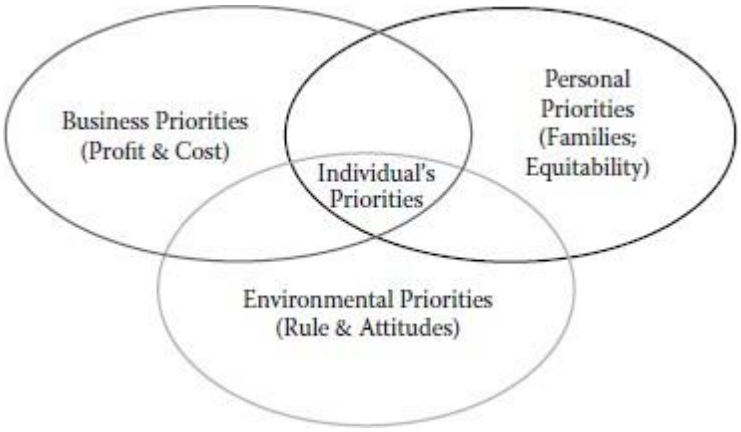


Role-based view of Green IT.

Table 8.2 Roles within Organization and Their Subjective Viewpoint

Role	*Green IT Subjective Viewpoint*
Decision maker (20%)	Major interest in the ROI, as that justifies their actions. Legal, compliance requirements, however, change the balance of their ROI metrics. Green IT strategy formulation, policies. Participation in consortiums.
Project manager/quality assurance manager (10%)	Interested in the implementation of the green program, the steps to be taken for that implementation, and the successful review at the end of the project. Aims to complete the project with minimum time and budget.
Environmental regulator (2%)	Creation of regulatory benchmarks. Compliance metrics, their measurements, reporting of that carbon data. Interested in issues arising out of noncompliance. Participation in standard creation.
Advisor (management consultant) (7%)	Analyses of the organization business processes in order to introduce green environment. How to reduce risks in implementing Green IT. Lean process. Participation in standards compliance.
IT consultant (including Green IT) (11% + 7%)	Model processes, optimize, smart networks, green enterprise architecture (ISO standards).
Engineer (manufacturing/ production) (16%)	Optimize production, improve design.
Technical manager (9%)	Focus on technologies for carbon reduction (as against economy and services).
Researcher (7%)	Undertaking Green IT investigation, pure and applied research. In any or all four dimensions of Green IT.

Attitude and Subjectivity in Green IT



- The above figure highlights the source of this subjectivity from an employee's viewpoint.
- The business priorities, the environmental priorities, and the personal priorities of individuals are many times at odds with each other.
- For example, an employee has a business priority to provide excellent service to a customer, but the environmental priority requires that the service be provided with a shorter time period and with minimal opportunity for a social interaction.
- These two priorities can not only be at odds with each other but can also be at odds with the personal priority that includes family time, personal interests, and the desire to be treated equitably.
- The area of intersection of these three priorities needs to be studied under the social aspect of Green IT

Green IT Ethics and Code of Conduct

- Green IT code of conduct can augment and support the expectations and behaviours of individuals operating as employees and consulting professionals as well as the organizations that subscribe to that code of conduct
- This is particularly helpful in a new domain such as that of Green IT, where issues can rise and proliferate around the validity of carbon data and mechanisms of communication surrounding Green IT.
- The tiers of audience for Green IT communications are wide ranging—from the general public, school going children, and likes through to a data center director. What is being discussed, debated, and researched in terms of a clean energy economy also needs to be communicated with authenticity.
- This honesty in communication and reporting is another area wherein a Green IT ethical code of conduct can provide a good starting point.

- This need to understand the terminologies such as energy efficiency, renewable energy, and carbon neutral and explain them in layman's terms is vital
- Similarly, the need to isolate conferred interest groups who may launch into a potential misinformation campaign is also vital.
- Ethics and code of conduct for Green IT can control such activities and bring in clarity and positive focus—resulting in reliability and trust in green data, information, and knowledge
- From the ethical point of view, Green IT needs to ensure that the transformation of the organization to a green organization contributes to society and human well-being
- Furthermore, such a code of conduct provides the organization that subscribes to it with guidelines and direction to remain compliant. Green transformation process must ensure on going compliance while evaluation of IT systems, analysis of possible risks, and their impacts are considered
- Following are the statements and potential advantages of having a Green IT code of conduct. Organization following the Green IT code of conduct will:
  - ✓ Agree to a fundamental obligation of businesses to reduce carbon emissions in all their activities.
  - ✓ Conform to total honesty in recording, analyzing, and reporting of carbon data—both manually and through IT systems.
  - ✓ Ensure that the effort to reduce carbon is undertaken in a socially responsible way and with no harm to people involved in the reduction attempt (this is particularly important in the hospital sector).
  - ✓ Ensure on-going eff ort at all levels of IT—architecture, design, development, testing, deployment, and maintenance—of hardware, software, and networks—to reduce their carbon emission (this code goes beyond the operation and maintenance and also focuses on the design aspects of IT hardware and systems).
  - ✓ Ensure on-going effort to reduce carbon in procurement, operation, and disposal.
  - ✓ Promote confidentiality and integrity within the organization and the IT profession
  - ✓ Maintain security and confidentiality of carbon data and information
  - ✓ Make the carbon data available publically.
  - ✓ Avoid green washing or incorrect promotion of the organization's carbon reduction effort.
  - ✓ Contribute toward development of Green IT standards worldwide and their application in practice.
  - ✓ Ensure participation in industry and research surveys including workshops to increase the overall body of knowledge
  - ✓ Ensure high level of competency in all carbon-related activities of the organization such as measurement and reporting of carbon data.
  - ✓ Honestly represent ―skills, knowledge, service and product‖ relating to carbon.

- ✓ Endeavour to interact with other disciplines within the organization to reduce the overall carbon footprint

Privacy and Security of Green Information

- The transformation of an organization to green enterprise also needs to consider the privacy and confidentiality of the information that is generated in the process
- The increasingly sensitive nature of the carbon data requires careful control, secured storage, and relevant reporting.
- Management has to take responsibility in protecting this data as the firm undergoes green transformation and later, as the data gets stored in the organizational systems.
- The Carbon data can include the emissions data pertaining to an individual, a department, or an organization
- This data can include time span—such as for a day, a week, or a year. Furthermore, through web services, the organization is likely to compare its carbon performance against the permissible government regulatory limits in a real-time basis
- A small organization may be able to protect the privacy and security of this data in a relatively easy manner
- For a larger organization, especially with multiple geographical regions, maintenance of carbon data can be more challenging
- Elements of enterprise data architecture, principles of backup and security of data, and risks associated with maintenance of data need to be applied to carbon data as stringently as it is applied to cash-flow data
- Furthermore, when smart metering is used for automatic recording and analysis, stricter security measures are required to protect data
- For example, carbon usage by the employee has the possible side effect of decreasing the trust between managers and employees. Therefore, security policies of an organization must specifically include sections to protect carbon data.

Green Washing

- Claiming something that is not entirely accurate in terms of carbon emissions and the overall carbon footprint of the company is ―green washing‖
- Green washing results from overenthusiastic desire to capitalize on an organization's environmental and sustainability initiative.
- For example, green washing is said to have occurred with terminologies such as carbon neutral, energy efficient, fuel efficient, low carbon, and environmentally friendly have been used carelessly and without due consideration to the underlying standards and definitions.
- The complexity of terminologies and lack of commonly accepted standards for those terms is a contributor to the phenomena of green washing, this phenomena result in public mistrust and suspicion of any claims by organizations in reducing their carbon footprint.

Communications in Green Transformation Projects

- Green transformation also involves interactions amongst people, departments, organizations, and governing bodies. Communication is required between internal departments of organizations to relate corporate philosophies, encourage teamwork, and develop strong relationships within and outside of an organization
- The internal communication of the organizations includes instruction in the development and maintenance of transformed green process
- Enhancements to the processes and the green knowledge management systems also need to be communicated.
- Good communication will socialize and support employees and customers in understanding the reality of Green IT within the organization.
- Effective organizational communication, from a green viewpoint, focuses on creating an understanding of the technologies and process that are explicit and the green attitude that are implicit.
- There are two major important areas of communication:
    - ✓ **Within the organization —** between managers and employees.
    - ✓ **Outside of the organization —** the customers, partners, and regulators.
- The Communication within the organization can be directed by the management. These communications include standard documents, emails, verbal phone, and so on.
- This communication is meant to encourage employees to the regulations. Internal communication of the Green IT initiative is a combination of formal and informal communications.
- Communicating outside of the organization has to be more formal. Regulations also dictate the format, frequency, and style of communication

Green IT Project—Channels of Communication

- Communication can be through various channels in a Green IT transformation program.
- This will ensure that all participants involved in and affected by the project have a clear understanding of the organizational strategies and project goals
- These is important parts of a transformation project need to be explained in the most clear and understandable way.
- Green IT terminology can be a challenge in this communication and needs to be articulated correctly.
- The channels for communication need to be available to the team members to contact each other especially in a global organization where members may not be in physical proximity.
- Following are the categories of communication channels as shown in Figure 8.7 that need to be considered in a Green IT project:

Personal—the face-to-face communication that occurs when the green transformation program is underway. This can be a one-on-one or a one-to-many communication that presents the arguments, approaches, strategies, and policies of green enterprise transformation.

Collaborative—this is the group-based electronic communication mechanism like wikis and blogs, as also the rapidly ascending social network media.

Mobile—through phones and SMSs that enable context-based communications

Asynchronous—electronic communication that can be uploaded on the organization's site and then accessed by employees and users at their own convenience

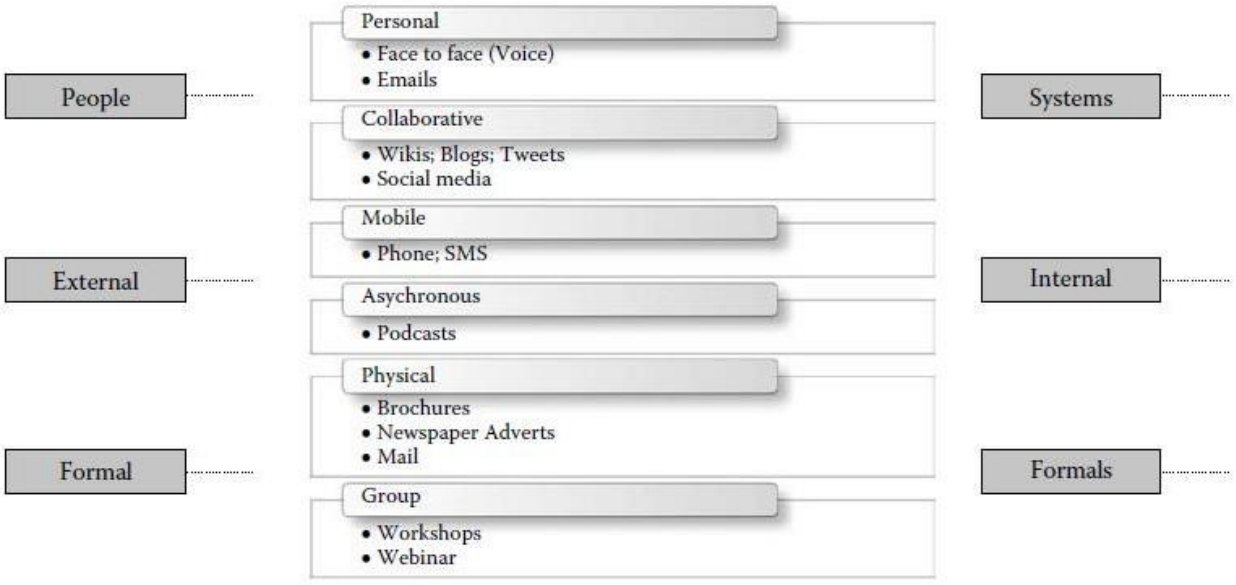


Figure 8.7 Channels of communications in Green IT projects.

Physical—this is the age-old communication medium making use of paper; unlikely to be very popular in a green enterprise transformation yet may have a role to play.

Group—that makes use of electronic as well as physical communication facilities (e.g. Webinars, seminars, workshops).

Green Enterprise Transformation Roadmap

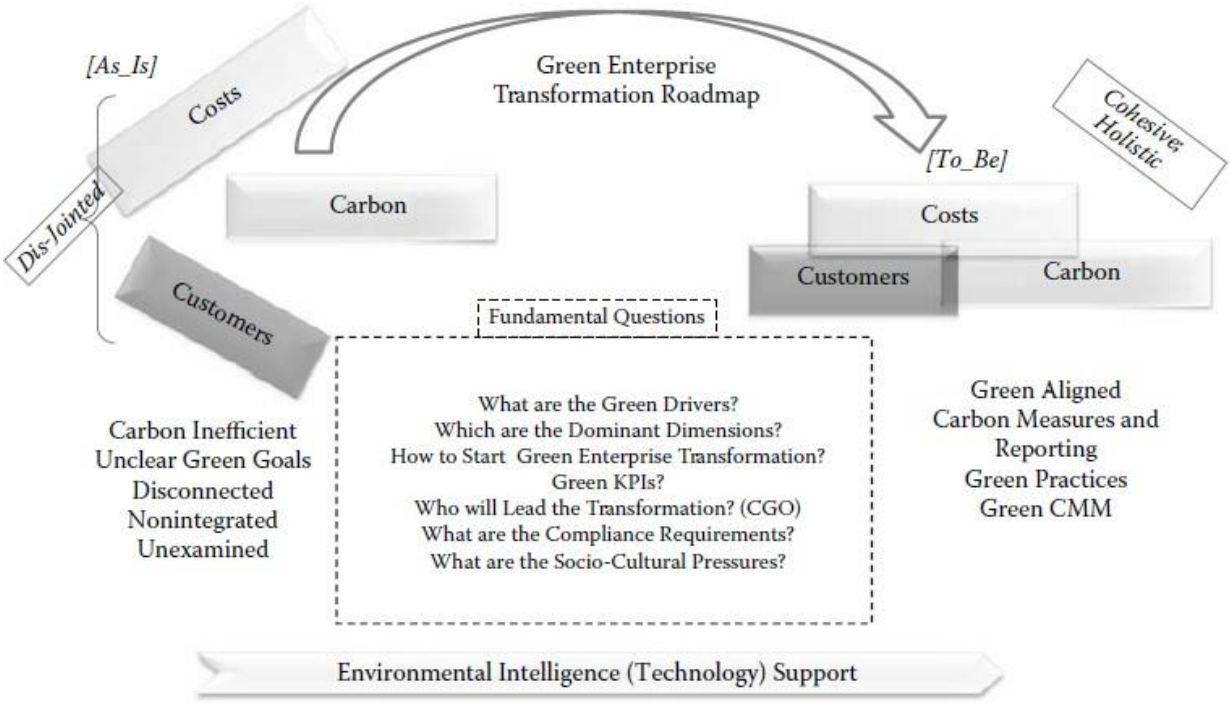
Introduction

- Green enterprise transformation (GET) is a holistic program undertaken by an organization to radically change its structure and dynamics that would change its carbon footprint for the better.
- Any transformation (also occasionally referred to as a transition) is a risky endeavour. This is so because transformation brings about the changes to the structure and dynamics of an organization that lead to disturbances in its normal operations and also its relationship with its customers and suppliers.

- These risks can be bettered by the use of a carefully throughout process for such transformation that would provide the definitions for activities and tasks, deliverables and roles that can be used to achieve the goals of that transformation.
- Such transformation is further augmented by a competent suite of metrics and measurements that justify and validate the effort to change

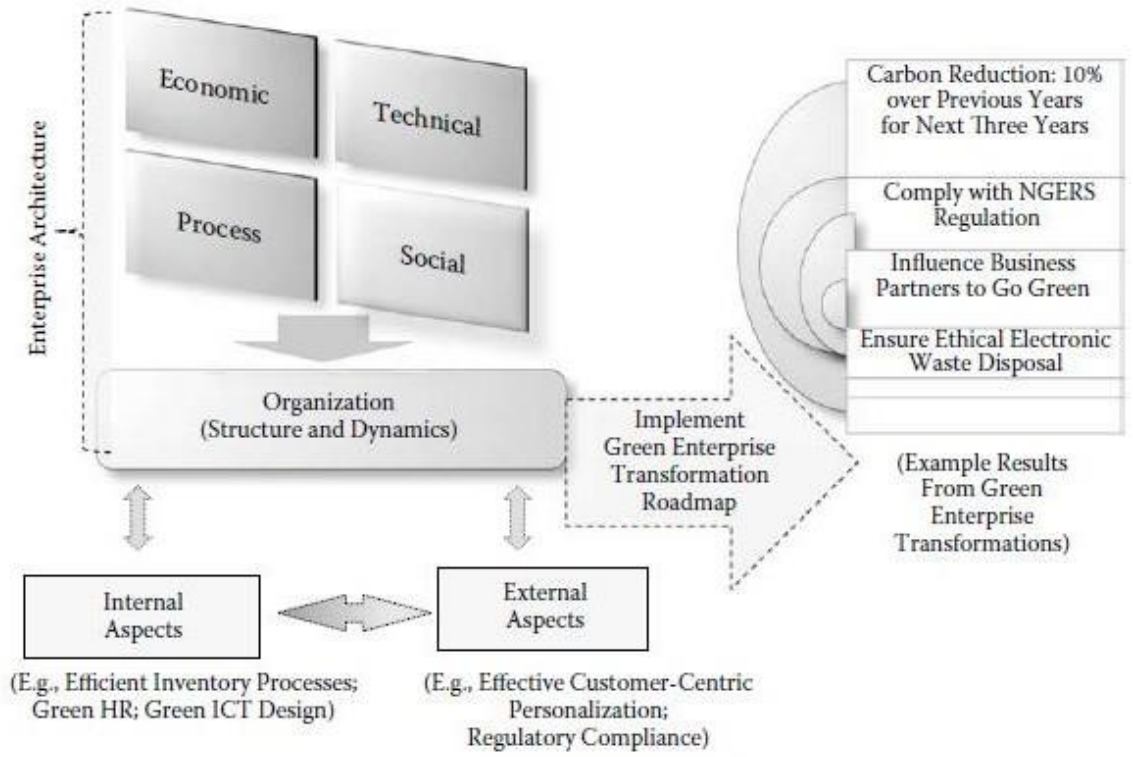
Green Enterprise Transformation

- The below figure explains the basic concept of a GET. On the left side of this figure is an organization that is represented as potentially a carbon-ineffective, disjointed organization
- This could be an organization that is pulled in separate directions in terms of its cost, carbon, and customer priorities



- On the right is shown a holistic, integrated organization with its priorities set right.
- This is an organization with its costs, carbon, and customers priorities in agreement with each other.
- This also lists, briefly, the fundamental questions that an organization (typically a person responsible for the transformation) needs to ask in undertaking GET.
- These are high-level questions of immense interest during transformation.
- However, these questions are part of the GET processes, and follow the more strategic questions asked by business decision makers in formulating Green IT strategies and polices.
- The environmental intelligence (EI) systems represented at the base of Figure provide the technical support for the transformation

- GET process needs to be a well thought out process that helps identify the business goals, the current structure and maturity of the business and steps to be undertaken to become a new, cohesive, agile, efficient, and collaborative green business
- A GET is planned and executed along the four dimensions of an organization facilitate its transformation from where it is to its future green state.
- To bring about that change, a business can be modeled and understood in various ways and through multiple dimensions as a part of its transformation.
- These factors were based along the lines of people, processes, and technologies.
- The four dimensions along which an organization transforms are shown in the below Figure.
- Thus, these dimensions provide the backdrops for creating a Green enterprise architecture that would model the two –as is‖ and –to be‖ states of an organization



- The effects of these dimensions can be broadly grouped into internal and external effects.
- The internal processes such as the inventory and HR processes are updated to green processes; and so also the external processes, such as the CRM processes to Green CRM.
- The internal and external transformation of processes an organization enable it to achieve its stated goals
- The organizational structure and dynamics also change along with these internal and external processes and corresponding technologies that eventually map to various work areas (also called focus areas) of transformation

A Green ICT Framework

- Identification of the current and future states of the organization with respect to its green capabilities is based on a Green ICT framework
- This is an enterprise architecture type framework that deals with the ‐state‖ of the organization rather than the process of ‐transformation.‖
- In this Green ICT framework, shown in below Figure , is made up of a matrix of four vertical ‐pillars‖ and five horizontal ‐rows.‖
- The vertical pillars depict the areas within an organization that will undergo change—and they are the equipment lifecycle, end-user computing, enterprise, and data center and ICT as a low carbon enabler across the organization
- The horizontal rows, in this Green ICT matrix, are made up of attitude, policy, practice, technology, and metrics. These horizontal rows form the elements of change.

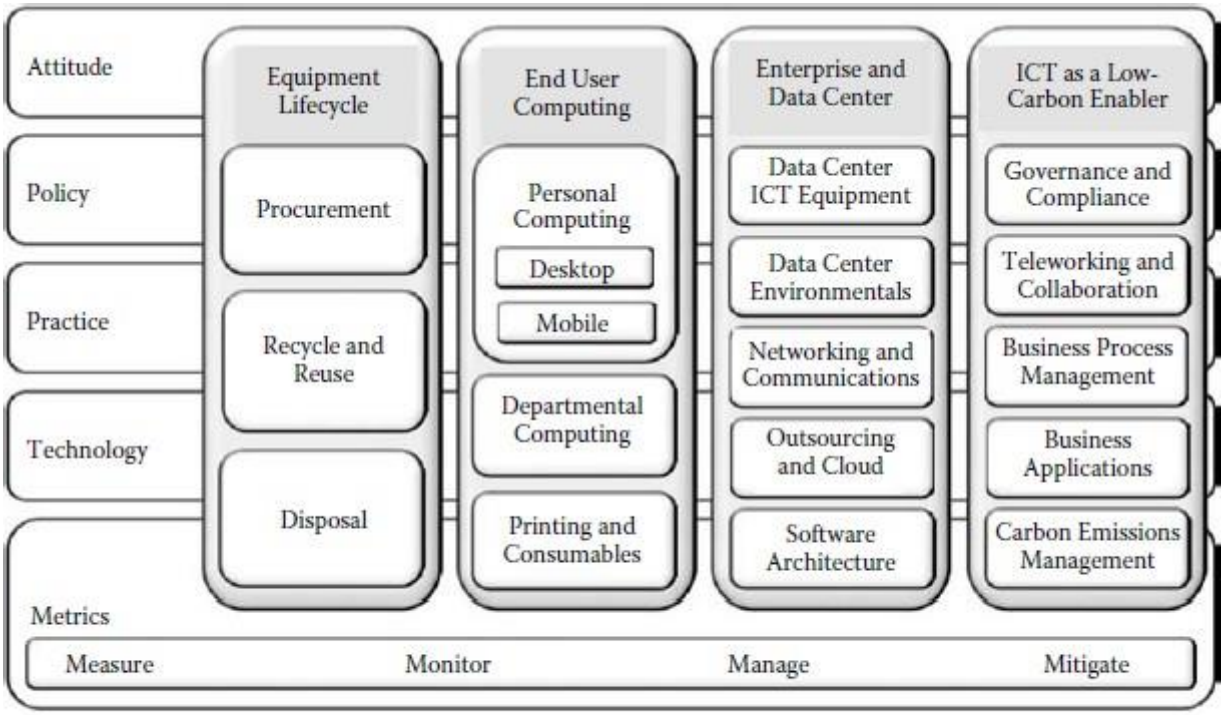


Figure 9.5 Green ICT framework. (The Envirability-RMIT Green ICT framework is reproduced with permission from Connection Research).

Equipment Lifecycle

- This pillar covers the acquisition and procurement of ICT equipment, and disposal or recycling at the end of its lifecycle in an environmentally responsible fashion.
- ICT equipment, like all other equipment, passes through a lifecycle. It is manufactured, sold (and for every sale there is a purchase), used and often reused, and then ultimately disposed of.
- That disposal may mean it is discarded or destroyed, but it may also be sold or given to another person or organisation, where it has another lifecycle contained within its larger lifecycle.

Procurement

- Procurement is arguably the most important aspect of green ICT in terms of making an overall impact on sustainability. At least as much energy is spent in manufacturing a PC as it consumes in its lifetime.

There are two aspects to green procurement

- ✓ The nature of the equipment itself,
- ✓ The nature of the suppliers of that equipment.

- The equipment an organisation purchases may comply with environmental standards such as Energy Star and the Electronic Product Environmental Assessment Tool (EPEAT)
- This includes such things as the supplier's environmental values in the design and manufacture of equipment and how it measures them, its compliance with relevant environmental laws and codes of practice, and whether the supplier reclaims and recycles old equipment from customers.

Recycle and Reuse

- All organisations replace their ICT equipment periodically. Some have regular refresh cycles, some wait till they have to, some utilise some sort of continuous update process (especially with software).
- This is a natural aspect of the ICT function. But many organisations replace equipment too early, often through a fear of not being able to run the latest versions of software.
- This can create unnecessary waste and expenditure as few organisations always need the latest versions of hardware and software to function adequately.

Disposal of ICT Systems

- No matter how far an organisation can extend the useful life of equipment, or how much retired equipment it can sell or reuse, there will always be some that it will need to be physically disposed of.
- Environmentally sound disposal practices predate the concept of Green ICT, as many organisations have been conscious for some time of the importance of reducing environmental damage from e-waste (electronic waste).

<u>End User Computing</u>

Personal Computing

Desktop Computing: Important on all sizes of organisation. In smaller organisations it is important because it represents the main areas of Green ICT, and in larger organisations the absolute numbers of end users mean that efficiencies in this area can make an enormous difference to energy consumption. Important practices include turning PCs off and various PC power management techniques, and important technologies include thin client computing.

Mobile Computing: An increasing number of end users of corporate ICT systems are no longer tethered to their desktops. They work in cafes, in client offices, on public transport and at home. Many of them use laptop computers, which have similar power management issues to desktop computers.

Departmental Computing: Departmental computing systems typically comprise of servers, storage devices and peripherals that are not housed in data centres. They are often of a significant size, and often very inefficient in both their usage of energy and their usage of resources. They are a prime target for energy reduction.

Printing and Consumables: Printing is one of the largest consumers of resources in the ICT function. There are a number of factors, of which the actual power consumption of printers is just one. Printers are very inefficient users of energy. They are usually left on, and consume significant amounts of energy even when idle. But there are many other factors which, while they do not directly affect the organisation's power consumption, have a significant effect on the environment

Enterprise Computing

Enterprise Computing is that part of the ICT function controlled directly by the ICT department – typically the data centre, networking, software development and outsourcing. In organisations large enough to have a data centre, the effective management of the equipment within it and its environment can be one of the most important aspects of Green ICT

Data Centre ICT Equipment

The two most important types of ICT equipment in the data centre include servers (including mainframes) and storage devices. Servers are usually the biggest consumers of power, and that power consumption continues to rise as more powerful processors are used inside them, and as the number of servers proliferates

The average power consumption of a rack of servers has increased fivefold over the last ten years, when cooling requirements are taken into account

Storage usage is also increasing exponentially and as prices drop storage devices are often used very inefficiently

Server and storage virtualisation has become one of the key technologies in data centres in recent years.

It is often touted as a technology for reducing power consumption, because it reduces the overall number of devices, but in practice most data centres' power consumption continues to rise because the devices are becoming more powerful and use more electricity

Data Centre Environmental

Quite apart from the ICT equipment in the data centre, there is the issue of the data centre itself. The data centre's non-ICT infrastructure can quite easily (and most often does) consume more power than the ICT equipment within it. There are three main aspects

The power supply. Data centres usually have dedicated power supplies, and very often more than one. Their efficiency varies enormously. Data centres can also generate their own power, and backup power supplies are common for business continuity.

Cooling and lighting. Modern ICT equipment typically demands significant amounts of cooling, either air cooling or water cooling. There are many design and implementation issues that affect power consumption. Lighting is also a factor

The building that houses the data centre. This may be a dedicated stand-alone facility, or it may be purpose-built within a larger facility, or it may be retrofitted into existing premises. Whatever the case, there are a number of aspects of the built environment that will have an effect on power consumption, such as insulation.

Networking and Communications

Local Area Networking – many organisations' LANs and data centre networks consist largely of an untidy collection of cables that consume large amounts of power and which add to cooling requirements. More efficient cabling design means lower power consumption

Wide Area Networking – many organisations use leased data lines or VPNs (virtual private networks) over the Internet. While they do not have direct control over these networks, their inefficient usage adds to overall power consumption and increases the overall carbon footprint

Wireless communication – wireless will never wholly replace cabling, but it is becoming more widely used and it does have a major role to play.

Outsourcing and Cloud Computing

- Outsourcing has been one of the big issues in ICT since the industry began, with computer bureaux, in the 1950s. The issues have evolved as the technology has evolved. Ultimately, all outsourcing is a make vs. buy decision. Is it more effective to make or do something yourself, or have someone else build it or do it for you? The equation keeps changing, depending on a number of factors
- In ICT, outsourcing discussions have traditionally centred around the issues of cost and capability. The cost argument usually runs along the lines of the outsourcer having economies of scale that are unavailable in-house, and the capability argument along the lines that the requisite skills are not available in-house

Software Architecture

- Computer systems consist of software running on hardware. Indeed, it is often argued that the software is the system, and that the hardware is simply an enabling technology. Most discussion about Green ICT refers to hardware, but software is also a factor
- The software architecture often determines the hardware architecture, which in turn may have a significant effect on the amount or type of hardware used – with all the consequences of the energy consumption of those systems.
- The way software is developed and used is significant – code can be efficient, or it can be ―bloatware‖. Systems can be developed from scratch, adapted or borrowed (with ―objects‖) from other software, or purchased off-the-shelf. Each approach has consequences for energy consumption

ICT as a Low-Carbon Enabler

- It is generally agreed that ICT is responsible for around 2 percent of the world's carbon emissions – mainly through the usage of electricity to run the hardware, much of which comes from carbon emitting power stations. That means that even if the carbon footprint of the entire world's ICT function was halved, overall emissions would fall by only 1 percent

Governance and Compliance

Many organisations nowadays are conscious of the desirability of being a good corporate citizen. Increasingly, that means acting in a green and sustainable manner. Publicity about climate change and related issues has greatly raised the profile of sustainability, and virtually all organisations are attempting to boost their green credentials. In some cases they do it because they are forced to, in some cases it is a case of ‒greenwash‖.But in many cases the organisation's management sincerely wants to do the right thing

‒Corporate Governance‖ is a term that has come into common use in the last decade to describe the processes by which organisations ensure that they are properly managed, not only in terms of meeting their regulatory obligations, but to ensure that they do the right things by all their ‒stakeholders‖. There is now an increased awareness that, when it comes to the environment, everybody is a stakeholder, and that good corporate governance also includes good environmental management

ICT governance refers to the practices and methodologies that ensure that ICT is managed properly, and corporate governance refers to the practices and methodologies that ensure that the corporation is managed properly

Teleworking and Collaboration

The term ‒teleworking‖ covers a range of technologies and practices that have to do with working at a distance or working remotely The carbon reduction benefits of teleworking are mostly related to removing the necessity of personal travel – if people don't have to drive a car or catch a plane to do their work, they are reducing their carbon footprint by the amount of fuel generated by that travel. Varieties of teleworking include telecommuting, teleconferencing and videoconferencing, and telepresence.

Business Process Management

Business Process Management (BPM) is the process of improving the ways an organisation or an individual does things – making them more efficient, with fewer steps or greater effect. The term is used in both a specific and a general sense. The specific sense refers to a management discipline called BPM, which typically identifies five phases: Design, Modelling, Execution, Monitoring and Optimisation.

In the general sense, BPM refers to the overall process of managing and improving business processes. ICT has a major role to play in improving most business processes. It provides both the tools for modelling the processes and many of the enabling technologies for execution

Business Applications

Most organisations run a number of ICT-based business applications. The range varies greatly depending on the industry sector, but typical applications include Financial Management Information Systems (FMIS), Enterprise Resource Planning (ERP), Supply Chain Management (SCM) and Customer

Relationship Management (CRM). Many organisations also run more specialised or even custom applications specific to their industry, or to provide them with competitive advantage.

ICT is very important in each of these applications, which are essentially specialised business process management exercises. Managers seek greater efficiencies in every phase of every process. The fewer times and the shorter distance physical items have to be moved, the better. The fewer transactions that need to be made, the better.

Carbon Emissions Management

Carbon Emissions Management is an emerging discipline which focuses on the management – and ultimately the mitigation – of an organisation's carbon emissions. This includes the use of ICT systems specifically designed to reduce the carbon footprint, rather than doing so as a by-product of greater efficiency. A key ICT application is Carbon Emissions Management Software (CEMS), which provide a compliant and consistent format for presenting greenhouse gas emission data to executive management and regulators

Green ICT Actions

Attitude

Attitude is an intangible thing. It describes how we think, rather than how we act. Most of all it is about attitude or culture. It is a necessary starting point: a desire to change is followed by a commitment to change, which is followed by actions, which is followed by measurement of the effectiveness of those actions Having a positive attitude towards Green ICT is very important – it precedes everything else. And, as is often the case in business, those attitudes are most effective if they come from the top. ‑Management buy-in‖ is an essential part of any Green ICT program.

Policy

There are many aspects to Green ICT policy. There are lots of things we can do in employing energy efficient technologies and making effective usage of existing technologies, and there are many ways we can reduce the energy consumption and/or the carbon footprint of the organisation.

Practice

Practice refers to techniques and behaviour – things we do. There are many practices that individuals and organisations can adopt that directly help in the greening of the ICT function. And the great advantage of most of them is that they cost nothing – they do not involve the purchase of any new hardware or software, but simply the alteration of habits and mind-sets. Good examples are turning off PCs when not in use, recycling printer paper and printing less, and using ICT equipment for longer rather than replacing it when it is still useful. The simplest things are often the most effective.

Technology

Some people think of Green ICT primarily in terms of technology – thin clients, virtualised servers, duplex printers. These are important, but they are ultimately just part of the picture. Too big a focus on technology means that people often concentrate on the purchase price of that technology, leading to a belief that Green ICT costs money, where the opposite is actually the case.

Metrics

The fifth action is Metrics. It is also applied across the four pillars, but it is approached differently to the other four. ―You can't manage what you can't measure‖, says the old business maxim. An effective Green ICT strategy should clearly identify reduction measures in such areas as achieving energy savings, reducing carbon emissions, improving recycling efforts and conserving water**.**

Choosing the right tools to measure, monitor, manage and mitigate power consumption and carbon emissions, both inside and outside the ICT department, is critical in ensuring that Green ICT projects are successful over time. Only with adequate metrics can progress be determined. Connection Research therefore identifies four phases (the ―Four Ms‖) of the metrics process:

Measure: The application of metrics to any aspect of the Green ICT process. A problem with this important first step is that in many cases metrics, or units of measurement, don't exist. What should be measured, and what are the units?

Monitor: Simply, continuous measurement. The ability to measure any process against itself over time to determine whether it is improving or not

Manage: Taking the results of the measurement and monitoring process and determining from that data what should be done to improve the process

Mitigate: Managing the process is such a way that a permanent improvement is made in the process, which usually means a change to the process

The Green Transformation Process

- As mentioned earlier, transforming to a Green enterprise is actually a business transformation program.
- Project from various dimensions in the business, infrastructure and systems area make up the transforming program, following figure shows the green Transformation process.

The basic Green transformation process.

The four major phases of transformation are shown here as diagnose, plan, enact, and review. The figure also shows that while these four phases appear sequential, in reality they are iterative; with the number of iterations required for a successful transformation to be decided by the chief green officer (CGO) together with the person responsible for GET.

The purpose of this basic Green transformation framework is to:

(a) Identify the current status of the organization and enlist the goals of GET—these goals will be identified, updated, and finalized through the diagnosis work.

(b) Add justification for the project using ROI calculations within a business case;

(c) Provide target metrics (i.e., values for KPIs) for the organization's ‒to-be‖ state;

(d) Organize the actual GET program; provide the basis for the pathway/road map or project plan for transformation;

(e) Undertake (or enact) the actual transformation;

(f) Review whether the KPIs have been achieved or not;

(g) Promote the success along the individual, departmental, and organizational level

Green Protocols and Standards

- Green IT, green business, and industrial verticals in which the business exists are all influenced by the government and regulatory bodies.
- Internationally, and particularly at the various levels of government, the aforementioned protocols provide a good basis for a strategic and a long-term approach to handling environmental impacts.
- Protocols themselves may not be binding, but eventually some of these protocols or some of their aspects get enshrined into law.
- For example, the U.K. government's Climate Change Act (the first national framework to address climate change) became law on November 26, 2008 that made it mandatory for organizations to legally reduce their carbon emissions by 34% by 2020 and 80% by 2050.
- Protocols relating to the environment also exist at state and even council levels. Businesses are encouraged to adopt these protocols as they formalize the business attempts at reducing carbon emissions.
- Some of the important protocols in this climate change domains are discussed next

United Nations Framework Convention on Climate Change (UNFCCC, Rio)

One of the earliest protocols that highlighted the role of climate change and brought about some action came from the Rio summit in 1992.

Dubbed the Earth Summit, this was the first protocol of its kind and became formally known as the United Nations Framework Convention on Climate Change (UNFCCC, Rio, 2010). While the protocol or ‒framework‖ arising from that convention does not contain any binding laws, the summit itself generated global awareness of the challenges of climate change and created opportunities for countries to sign and, in case of many countries, ratify the convention.

The Rio summit paved the path for ensuing global summits at Kyoto and the recent one in Copenhagen (December, 2009).

While these summits continue to substantially raise the public, political, and corporate awareness, results are not binding unless they are specifically ratified by participating countries.

Kyoto Protocol

The Kyoto Protocol (2010) is an international agreement that builds on the aforementioned UNFCCC. The objective of Kyoto Protocol was ―stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.‖ Ā e Kyoto Protocol created a set of binding targets for 37 developed countries (also known as Annex I countries) along with the European community for reducing GHG emissions.

Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHG Protocol) is a widely known protocol that has been adopted by many government and business leaders to understand, quantify, and manage GHG emissions.

Scope 1 emission - the direct emission of GHG by the organization. These are the emissions resulting from manufacturing activities (e.g., auto manufacturing), physical movements of men and material (e.g., in a foundry), or chemical emissions (such as from a paint shop).

Scope 2 emissions - These emissions form the indirect consumption of energy such as electricity. These are added on to the Scope 1 emission calculations. The emissions from a coal fired power station will be a Scope 1 for that power station, but Scope 2 for a bank that is using that electricity to power its computers.

Scope 3 emissions - The GHG emissions embedded in the supply chain of the organization primarily belonging to the business partners. Emissions in this scope are not clearly defined in the protocol and, therefore, not usually included in the emissions calculations. With the popularity of outsourced work, however, these Scope 3 emissions will become prominent in calculating the carbon footprints.

Copenhagen

- The Copenhagen summit, held in 2009, was focused on creating an agreement for a framework to address climate change beyond 2012.
- This Copenhagen summit resulted in an agreement by a large number of countries (138) to work toward keeping global temperature increases to below 2°C.
- This agreement generated substantial debate and discussion but, similar to the events in the original UNFCCC (Rio) summit, it was not passed unanimously and is not legally binding.

Green Audit

- Green Audit is a process of systematic identification, quantification, recording, reporting and analysis of components of environmental diversity of various establishments. It aims to analyse environmental practices within and outside of the concerned sites, which will have an impact on the eco-friendly environment.
- Green IT audits also provide a justified means to improvement of the carbon performance

- This is so because such Green IT audits are invaluable in providing internal reliability to the corporate board in terms of the return on investment (ROI) on Green IT investments. Externally they provide legality to the reporting and the claims to greening made by the organization
- Green audits primarily validate that whatever is being reported in terms of carbon emissions is accurate and sufficient. Green audits can also suggest areas for improvements in the organization's compliance with standards as well as legislations.
- The justification and reporting of carbon data are not only an external compliance mechanism. Internally, the chief executive officer (CEO) of an organization is easier to convince and, in turn, is able to convince the Board to undertake carbon initiatives provided the business case is supported by audited metrics
- Green audits can cover the regularity accuracy, calculations, analysis, reporting, and storage of carbon emission data.
- Such validated data analysis can ascertain the Green IT readiness and maturity of an organization, that of its corresponding industry and even at a global level
- Green metrics enable an organization to comprehend how much of carbon is being generated by the business activities and, even more importantly, the use of standardized and detailed measurements to do so.
- Green audits divide the emission measurements into appropriate sections and then validate them. In addition to validating the carbon numbers and results, green audits also point out additional areas for measuring carbon data
- There are five areas of green metrics, These are measure, monitor, manage, mitigate, and monetize. Each aspect of these measurements needs to be verified and validated in a green audit as follows:

Measure - What is being measured? Is that measurement sufficient for reporting purposes? Are there additional areas of carbon data that should be included in the measurements?

Monitor - What is the mechanism to collect the data? Where are the meters located? Sufficiency and accuracy of monitoring mechanisms.

Manage - Validate the feedback and management mechanisms of carbon data, information, and analysis.

Mitigate - Is the measurement and reporting of carbon data also being used to reduce the emissions? What are the systems in place for carbon mitigation and how well they are operating? The audit in the area of mitigation will be mainly of interest to the internal stakeholders of the organization, but will have external effect.

Monetize - Audits of the monetizing aspects of carbon data will be of immense regulatory interests as the businesses move toward carbon economy. Ability to trade carbon requires accuracy and authenticity of systems that enable that trade

- Following are the specific advantages in undertaking Green IT audits within organizations:
- Validations of entire organizations asset register from a carbon emissions perspective.

- Formalization of metrics and associated measurements related to carbon performance of an organization, particularly at the end-user and the data center level where the maximum carbon is being generated
- Validation, internally of cost-benefi t calculations that demonstrate the ROI on green initiatives to corporate governance board and the shareholders on indexing of carbon measures with financial performance of the organization
- Stocks take of the skill set, experience, and necessary expertise within the organization to put together a Green IT measurement and optimization program

Emergent Carbon Issues: Technologies and Future

- The future of Green IT is made up of multiple factors.
- These factors include scientific breakthroughs, innovative approaches to applying information technologies in business, updated and current standards and legislations that are accepted in spirit across industries and regions, and a positive, inbuilt social attitude toward carbon emissions
- e complex nature of Green IT demands flexible Green IT applications that can be used in different contexts.
- Use of knowledge management tools can foster the creation of more insights and knowledge in Green IT domain.
- The tacit and explicit aspect of Green IT knowledge is likely to take different and radical shapes. For example, the amount of savings in carbon by an organization within a permissible limit can be an explicit piece of knowledge that can be used by Green HR in its internal education program or traded by the accountants.
- Carbon trading will bring in application of mathematical formulae like Blackscholes and Binomials, graphs and tables to price and facilitate trading in the software applications.

Green ICT and Technology Trends

Cloud Computing

- Cloud computing is an important part of an organization’ s approach to Green IT.
- The underlying premise of Cloud computing has been the consolidation of hardware and software services that are made available through the uninterrupted, perpetual connectivity of the Internet.
- While this offering through the Cloud provides many business advantages to organization, the advantages in terms of carbon emission reduction through consolidation are very significant.
- The future of the Cloud, in terms of what it offers to Green IT, is based on its ability to continuously and dynamically bringing together multiple threads of computing processes multimedia data, and changing interfaces in an intelligent way.
- Following are the areas of Cloud computing that have the potential for reducing the overall carbon emissions across the industry:

Infrastructure - this is the consolidation of data servers, disk space, communications equipment, and the supporting operating system. Such infrastructure services are capable of hosting increasing array of software applications from many different client organizations.

Applications development - with the availability of a sophisticated Cloud, application development, including its modeling, testing, and deployment, can be put together in one place.

Application execution - operationally, software applications can run much better through a Cloud as they are able to make use of the run-time environment provided by the Cloud itself.

Reusable Data service – The large amount of public or partially proprietary data can be made available through Cloud-based services that can reduce the repeated storage and maintenance of such data by separate organizations

SaaS

- Software as a service (SaaS) provides an ideal way to deploy software applications. SaaS provides access to the application that is executing on a remote server, by anyone, as and when needed.
- SaaS is the execution of application from a centralized server through the connectivity accorded by the Internet.
- SaaS model offers a combination of shared services model, improved power consumption, cooling efficiency, and equipment density
- SaaS is closely associated with Cloud computing, and adheres to the principle of pay as you go, mentioned earlier
- While the Cloud offers opportunities to consolidate infrastructure and hardware, and enables expansion without the usual overheads, SaaS creates opportunities to execute applications that are not installed, and configured on the local servers of the organizations.
- The challenge with SaaS-based deployment is related to data, its integration and its security. Therefore, the application execution and reusable data service discussed in the previous section assume greater importance in SaaS-based software deployment
- SaaS applications are easier to maintain and upgrade as they are installed and configured in a centralized place. Ā is reduces the upgrade and maintenance of the applications.

Nanotechnologies

- Nanotechnology deals with computing at a microscopic level. These technologies have the potential to impact Green IT in terms of both its hardware and its software.
- Nanotechnologies provide means to create, measure, and manipulate electronic data and communications at atomic size reduction in size requires considerable research effort design, development, and production.
- The power to these minuscule devices requires innovation in battery power technologies. However, the amount of power required by these devices is also small due to their smaller size.
- Reduction is device size, potential elimination of movement (e.g., spinning of disks) within the devices and ease of handling can all reduce overall carbon emissions resulting from these devices.

Quantum/Trinary Computing

- Trinary (or ternary) computing has significant possibilities not only for computing itself but also for improving on the carbon footprint of IT.
- Trinary computing works at the very fundamental of computing by adding to the binary bit options of –0‖ and –1,‖ another option of –-1.‖

New Renewable Energies

- Wind, solar, wave, nuclear, and biomass are at the cusp of renewable energy sources. Current oil, coal, and gas are exhaustible sources of energy.
- Exploring new energy sources that would not deplete with use is an on-going scientific exercise.
- Advent of these renewable sources of energy will change the carbon emissions calculations as the emissions resulting from these energies are expected to be much less than those generated by coal and gas