## UNIT: 1

## FUNDAMENTALS

***Syllabus:***

Green IT Fundamentals: Business, IT, and the Environment – Green computing: carbon foot print, scoop on power – Green IT Strategies: Drivers, Dimensions, and Goals – Environmentally Responsible Business: Policies, Practices, and Metrics.

### INTRODUCTION

An indisputably winning argument behind the implementation of green IT initiatives is based on business efficiency. This is the same reason why businesses strive to be lean, improve their quality, and reengineer their processes. Thus, while myriad reasons abound for why an organization should become green, the one reason that is beyond reproach is that "a green business is synonymous with an efficient business." When a reduction in carbon is allied with the economic drivers of a business, the search for justifying the costs to optimize business processes and virtualized data servers become relatively straightforward.

Green IT is defined as " the study and practice of designing, manufacturing, using and disposing of computers, servers and associated subsystems (such as monitors, printers,storage devices, and networking and communication systems) efficiently and effectively with minimal or no imoact on the environment."

### THE ENVIRONMENT TODAY

As mentioned earlier, whether human activity is the cause of change in the environment or not becomes a background conversation to improving business and achieving environmental outcomes In the process. It is this business-driven collaborative path that opens opportunity for corporate action.

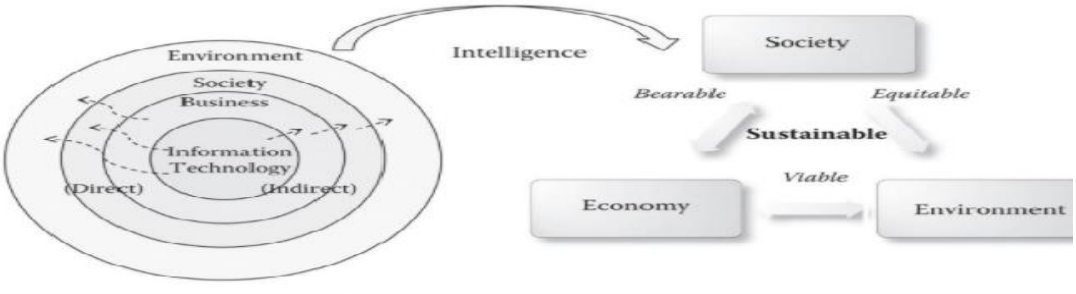


Fig.1.1 information technology influences business, society, and environment – lead up to the sustainable triangle.

Fig shows that the information technology affects business, which in turn, influences the society and the overall environment in which the business exists. It in business makes use of massive computing and networking technologies that require large and dedicated data centers. The location of these data centers and the people who work in them are all socially affected by this use of IT by business. The direct influence of IT is seen in the massive proliferation of household gadgets, use of computers in schools and hospitals, the popularity of social networking, and the high level of communications technology.

A carefully constructed strategy for Green IT is a crucial enabler for an organizations overall transition toward an environmentally sustainable 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 complementary 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 organizations carbon foot print.
- Applies the concept of carbon efficiency to business processes leading up to green business process management and green process reengineering.
- Develops the idea of the carbon footprint of collaborative business processes that cut across multiple organizations and approaches to improve that collective carbon footprint.
- Proposes a Green enterprise architecture (GEA) that builds on the technologies of web services and cloud computing.
- Discusses the importance of people, their attitude, and approaches to Green IT that would bring about a positive change without condemnation.
- Expands on the role of Green HR including the training and positioning of roles and responsibilities in the green space.

- Expands on the vital role of business leadership in bringing about positive green change across the organization.
- Presents the legal and political aspects the international protocols on greenhouse gases (GHGs).
- Argues for the use of ISO 14001 family of standard for the environment within the organization.
- Discusses the metrics and measurements related to carbon data with an aim of understanding and mitigating the sources of carbon generation within and outside the organization.
- Incorporates the use of mobile technologies and smart metering for real-time measurements and use of carbon data.
- Discusses and advises on the use of Carbon Emissions Management Software (CEMS) in the context of carbon metrics, measurements and reporting.
- Outlines the approach to Green IT audits for reporting and compliance.
- Explores the futuristic issues impacting environmental performance of an 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 is difficult to imagine any modern core business without 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. The synergy between business and IT implies that growth in business also implies corresponding growth in IT. This in turn, also implies greater IT based carbon generation.

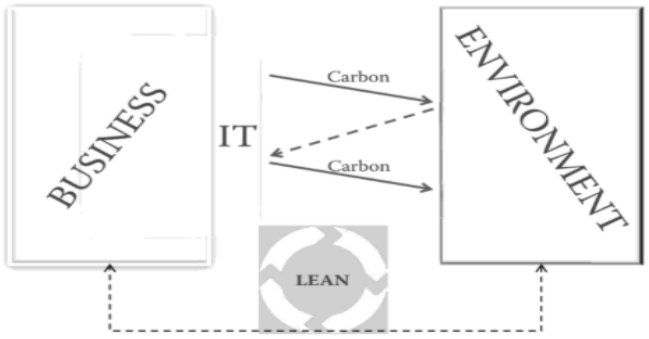



**Figure 1.2 Interplay of business and environment through information technology.**

The fig. depict this ongoing interplay between the business and the environment. The IT sheath that encompasses the business is shown on the left. Any business activity that involves IT and most does impacts the environment. The carbon impact is shown by an arrow from left to right.

This impact of business activities through IT on the environment has to be understood in three ways:
1.From the length of time

2. The depth of activity from the length of time,

3. The depth of activity, and the breadth of coverage of the carbon effect.

Following are specific areas of IT systems, processes, architecture, and people that impact the carbon footprint of an organization. These respective IT areas have a dual influence: the increase in business activities through these packages increases the carbon foot print of the organization, but the optimization of the business and backend IT servers and networks has the potential to reduce the carbon footprint of the organization. These IT areas are discussed as follows:

- ***Software applications and packages***: These are the existing ERP/CRM applications within the organization that need to undergo a major revamp to incorporate green factors. The carbon data form within the organizations are measured through various means such as smart meters, are inputted directly by users or updated through interfaces from other systems. Carbon usage data are then fed into the financial type calculators of the organization to ascertain the corresponding carbon calculations.
- ***Carbon trading applications:*** with potential carbon trading on cards, these organizational applications will also be geared toward performing analytics on the real time data that will enable the organization to figure out trends in its own carbon performance as well as that of the market. Carbon reporting tools will play equally significant role in the carbon economy.
- ***Green enterprise architectures:*** This is the ground-up building of new enterprise architectures that take a fresh look at the enterprise applications from a green perspective.
- ***Green Infrastructure:*** This is an area of IT that deals with the buildings, data centers, vehicles, and other non-movable and movable assets of the organization. The design, development, operations, and decommissioning of these IT and non-IT infrastructure assets of the organization needs to be investigated.

- ***Governance standards (ITIL and CoBIT):*** the way in which the governance standards are implemented is also reflective of the organizations carbon initiative.
- ***People:*** the attitude of the end users and the extent to which they are trained and educated in the efficient use of resources, and the feedback provided to them on their carbon usage is vital in the creation of green IT culture within and around the organization.
- ***Dynamic Social Groups:*** The creation of social groups that reflect their usage and consumption patterns can lead to not only directed marketing and sales but also help the organization in its green credentials.
- ***Wired and Wireless Communication:*** The way in which various communications technologies are exploding has connotations from green IT. Thus, the way in which these wired and wireless networks are configured and deployed will impact the carbon foot print of the organization.
- ***Emerging Cloud Technologies:*** Computing is becoming increasingly decentralized and having a dedicated data center is no longer the privilege that it used to be. A cloud essentially enables sharing of large scale storage of data, corresponding computation, and analysis and reduces overall carbon.
- ***Green Peripherals:*** This is the area of printers, copiers, shredders, and similar office equipment's that are associated with IT and that contribute to the overall carbon of the organization. These peripherals have a substantial impact on the carbon footprint of a growing organization.
- ***Renewable Energies:*** These include alternate sources of clean and green energies such as solar, wind , and nuclear. These energies will be treated separately in terms of their costs, and in terms of calculating their carbon contributions.
- ***Development of efficiency solutions based on IT Systems:*** These solutions would include measurement, monitoring, and reporting on energy performance. These solutions would further monitor and control resource usage and energy consumption.
- ***Design, Development, and use of power efficiency in IT and Non-IT Hardware***: This would include not only power efficiency in electronic chip designs, but also expansion into green power grids and management of equipment through software and operating systems.
- ***Adherence to regulations and standardization:*** Includes active participation in creation of new standards, agreements, and consortium-based protocols.

- ***Recycling and Disposal of IT Hardware:*** This will impact the procurement as well as disposal aspect of IT that is associated with efficient design of equipment, as well as ethical disposal of the same when their use is consummated.

**The Three Rs of Green IT**

Unwanted computers, monitors and other hardware should not be thrown away as rubbish, as they will then end up in landfills and cause serious environmental problems. Instead, we should refurbish and reuse them, or dispose them in environmentally sound ways. Reuse, refurbish and recycle are the three 'Rs' of greening unwanted hardware.

**Reuse.**

Many organizations and individuals buy new computers for each project or once every 2–3 years. Instead, we should make use of an older computer if it meets our requirements. Otherwise, we should give it to someone who could use it in another project or unit. By using hardware for a longer period of time, we can reduce the total environmental footprint caused by computer manufacturing and disposal.

**Refurbish**.

We can refurbish and upgrade old computers and servers to meet our new requirements. We can make an old computer and other IT hardware almost new again by reconditioning and replacing some parts. Rather than buying a new computer to our specifications, we can also buy refurbished IT hardware in the market. More enterprises are now open to purchasing refurbished IT hardware, and the market for refurbished equipment is growing. If these options are unsuitable, we can donate the equipment to charities, schools or someone in need, or we can trade in our computers.

**Recycle.**

When we cannot refurbish or otherwise reuse computers, we must dispose of them in environmentally friendly ways by depositing them with recognized electronic recyclers or electronic waste (e-waste) collectors. E-waste – discarded computers and electronic goods – is one of the fastest-growing waste types and poses serious environmental problems. The United Nations Environment Program estimates that 20–50 million tons of e-waste is generated worldwide each year, and this is increasing. IT hardware contains toxic materials like lead, chromium, cadmium and mercury. If we bury IT hardware in landfills, toxic materials can leach harmful chemicals into waterways and the environment. If burned, they release toxic gases into the air we breathe. So if e-waste is not discarded properly, it can harm the environment and us. Waste electrical and electronic equipment (WEEE) regulations aim to reduce the amount of e-waste going to landfills and increase recovery and recycling rates.

**GREEN COMPUTING:**

Green computing is the study and practice of designing, manufacturing and using computers, servers, monitors, printers, storage devices and networking and communications systems efficiently and

effectively, with zero or minimal impact on the environment. Green IT is also about using IT to support, assist and leverage other environmental initiatives and to help create green awareness.

**Benefits:**

Green IT benefits the environment by

- ✓ Improving energy efficiency.
- ✓ Lowering GHG emissions.
- ✓ Using less harmful materials.
- ✓ Encouraging reuse and recycling.

***To foster green IT – The issues to be concerned***

- What are the key environmental impacts arising from IT?
- What are the major environmental IT issues that we must address?
- How can we make our IT infrastructure, products, services, operations, applications and practices environmentally sound?
- What are the regulations or standards with which we need to comply?
- How can IT assist businesses and society at large in their efforts to improve our environmental sustainability?

**Environmental Concerns and Sustainable Development**

Numerous scientific studies and reports offer evidence of climate change and its potential harmful effects. Specifically, the growing accumulation of GHGs is changing the world's climate and weather patterns, creating droughts in some countries and floods in others and pushing global temperatures slowly higher, posing serious worldwide problems. Global data show that storms, droughts and other weather-related disasters are growing more severe and frequent.

Global warming can occur from a variety of causes, both natural and human induced. In common usage, however, global warming often refers to warming that can occur due to increased GHG emissions from human activities which trap heat that would otherwise escape from Earth. This phenomenon is called the greenhouse effect.

The most significant constituents of GHG are carbon dioxide (CO2), methane, nitrous oxide and chlorofluorocarbon (CFC) gases. Electricity is a major source of GHGs as it is generated by burning coal or oil, which releases CO2 into the atmosphere. Reducing electric power consumption is a key to reducing CO2 emissions and their impacts on our environment and global warming.

***Why Should You Go Green?***

The reasons for going green are manifold:

- Increasing energy consumption and energy prices,
- Growing consumer interest in environmentally friendly goods and services,
- Higher expectations by the public on enterprises'

- Environmental responsibilities and emerging stricter regulatory and compliance requirements.

**CARBON FOOT PRINT:**

A carbon footprint is defined as: The total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in equivalent tons of carbon dioxide (CO2). In few organizations, carbon footprint might mean that everything is tallied—sourcing materials, manufacturing, distribution, use, disposal, and so forth.

***The amount of greenhouse gases and specifically carbon dioxide emitted by something (such as a person's activities or a product's manufacture and transport) during a given period***.

For measuring carbon footprint we require to track lot of information such as:

- Facilities
- Operations
- Transportation
- Travel
- Purchases

Measuring Carbon Foot Print:

**Step 1: Define the boundary for your carbon footprint:**

We need to monitor the carbon footprint process year by year, so it is very important to have some rules to follow about scope of work to be done. Our primary objective is to reduce the emission of carbon, if we fail to define the carbon footprint boundary can inhibit comparisons against benchmarks and could also undermine meaningful monitoring of performance.

There are three types of boundaries:

- **Type 1: Operational control:** Using this approach every operation of our organization/company is captured in the carbon footprint. This also includes supply chain if an organization has sufficient operational control over suppliers.
- **Type 2: Financial control:** In this approach all financial elements are included. Often this excludes elements which our company may operate but not financially control and therefore using this approach can result in a smaller carbon footprint.

- **Type 3: Equity control:** This approach includes all elements that our company owns. If our company has part ownership then the proportion ownership is used to calculate the relevant carbon footprint attributable to that company.

**Step 2: Decide which emissions will be included under scope:**

Scope refers to the emission types captured in a carbon footprint. The scope of an organization's carbon footprint also breaks down into three components.

- **Scope 1 emissions:** These are direct emissions from assets that are either owned by our company (i.e. fleet vehicle emissions from the consumption of fuel) or emissions produced through an on-site activity (i.e., emissions from the burning of natural gas in a company's boiler).
- **Scope 2 emissions:** Scope 2 covers all indirect emissions or more specifically emissions derived from the production of purchased electricity. Here company hasn't actually produced the emissions associated with electricity generation but due to the consumption of electricity to power lights, equipment etc. we can say that our organization is indirectly responsible for these emissions.
- **Scope 3 emissions:** Scope 3 covers all other indirect emissions which are not as a result of the consumption of purchased electricity. This includes a wide array of emission sources including waste, consumables, staff commute, supply chain emissions, water use etc.

**Step 3: Define your carbon footprint period:**

A carbon footprint is typically measured across an annual period. When choosing our period for measurement it is best to think of other reporting cycles which can be used as the set time-frame

**Step 4: Use a practical approach to collect annual data:**

Once we have defined our boundary and the type of emissions we are going to capture, we'll then need to collect data on all elements that we are going to measure carbon emissions for (i.e. electricity and gas usage, vehicle mileage, waste volume etc.)

Here are some top tips that can be used:

- Annualize partial data: Data should be for an annual period.
- Use proxies where you don't have primary data.
- Use intelligent estimation.

**Step 5: Calculate footprint:**

After we have collected all our relevant annual data the task is then relatively simple. You need to use a carbon footprint calculator or carbon conversion factors to calculate our organizational carbon footprint.

**Need of Carbon Footprint:**

Measuring carbon footprint is nothing but it another way to measure overall progress toward becoming green. It can help with numerous business goals such as:

- Helping company to improve its efficiencies.
- Reducing costs.
- Getting public recognition.
- Maintain link in the supply chain.
- Good impact on customer.

**SCOOP ON POWER:**

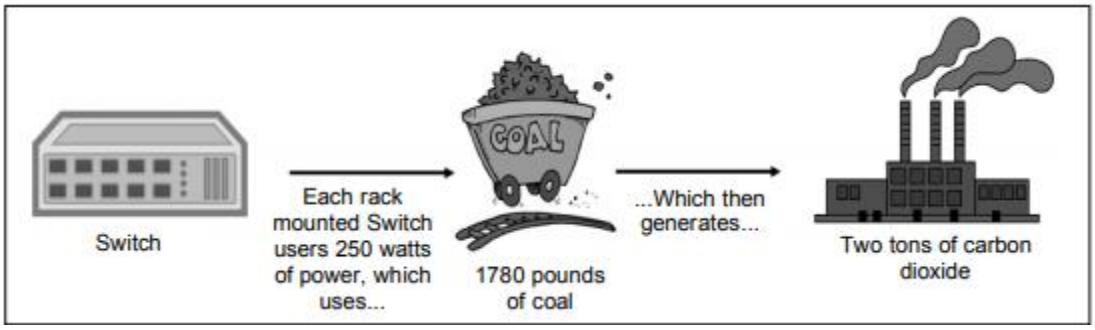
The issue of power consumption is ongoing as we continue to use new machines. The more power we use, the more money we spend as well as more fossil fuels the local electrical utility has to burn, thus causing more greenhouse gases to be generated. So saving the power is saving the money as well as saving the environment.

**Desktops:**

The power can cab be effectively used in desktop computer by enabling power management settings. Normally desktop PC requires 85 watts power, even with the monitor off. If that computer is only in use or idling for 40 hours a week instead of a full 168, much more energy costs will be saved annually from that workstation alone.

**Datacenters:**

The increase in servers and network infrastructure has caused a sharp hike in the electrical usage in the datacenter. Power consumption per rack has risen from 1 kW in 2000 to 8 kW in 2006 and is expected to top 20 kW in 2010. This increase in energy consumption is not only because of more servers but also use of additional network infrastructure. A normal 24-port Ethernet switch uses 250 watts of power on an average. If the electricity generated to power this switch comes from a coal-fired plant, 1,780 pounds of coal are needed to produce the 2,190 kW as shown in next figure.




**Consumption:**

It is estimated that datacenters consume 1.5 percent of the nation's electrical power and this number will triple again by 2020, as number users of computers are rapidly increasing. If we do not save power then we need more power plants to satisfy future needs. Which in turn will increase many million metric tons of carbon dioxide per year. The EPA (US: Environmental Protection Agency) suggested few ways for being more energy efficient, ranging from properly organizing physical space to reduce cooling loads to using energy efficient power supplies. We have to increase the use of energy efficient certified power supply. It always better if all organizations follow Green IT methodology. We can also follow the guidelines of EPA.

**Green IT Strategies:**

An important consideration in developing a green IT strategy is the timeframe of its influence. . For example, if the organization only views 'IT as Producer' of carbon footprint, then simple measures like switching off monitors and computers when not in use can be brought about immediately. A more strategic approach to carbon footprint reduction will involve other measures and take a longer timeframe to achieve.

Effective green strategies result from an approach that cuts across all the tiers and silos of an organization. Such strategies come from individual understanding, leadership, vision, knowledge about the organization's structure and dynamics, awareness of the organization's operational nuances and people's (i.e. stakeholders') attitude toward change.

**GREEN IT DRIVERS :**

Businesses need compelling reasons to undertake and implement green IT strategies. Business drivers of green IT can be grouped into six categories .

**(i)** Costs (including energy costs and operational costs),

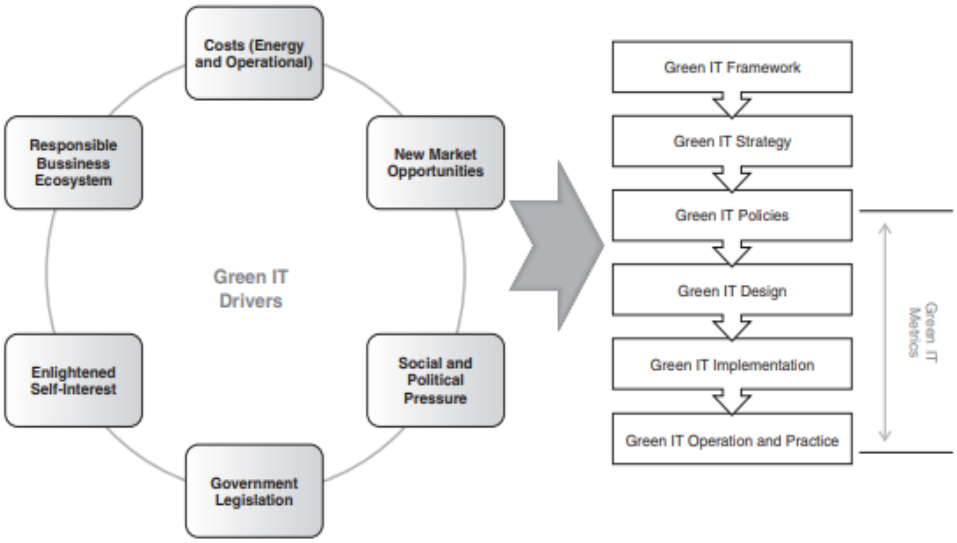
**(ii)** Regulatory and legal,

**(iii)** Sociocultural and political,

**(iv)** New market opportunities,

**(v)** Enlightened self-interest and

**(vi)** A responsible business eco-system.




***Cost Reduction:***

Cost reductions provide an excellent driver for an organization to come up with a comprehensive green IT strategy. As a result of a green initiative, cost reduction could be derived from minimizing energy consumption (improving energy efficiency), reducing the use of raw materials and equipment, recycling equipment and waste and optimizing storage and inventory.

***Demands from Legal and Regulatory Requirements:***

Government rules and regulations comprise a major driver for many green enterprise transformation programmes. The relative importance given to the regulatory factor, as compared with other factors such as organization self-initiation, customer demand and pressure from society, are the highest – 70% as reported by Regulatory acts such as National Greenhouse and Energy Reporting (NGER)) and the Carbon Pollution Reduction Scheme (CPRS) require organizations to mandatorily report their carbon emissions if they are above a certain threshold level.

***Sociocultural and Political Pressure:***

Sociocultural and political pressure becomes major driving forces when an organization's society recognizes the environment as of significant value and is interested in protecting it. Such acceptance of the environment's importance by the society brings pressure on the organization to change.

***Enlightened Self-Interest:***

Self-interest comes into play when an organization, on its own accord, realizes the need to be and the benefits of being, environmentally responsible and creates or adopts a green strategy. It may include a range of interests including the organization's desire to undertake a genuine common good, the need of business leadership to achieve personal satisfaction or maintain or raise employee morale or simply the decision makers' understanding that costs can be reduced and customers more satisfied with a self-interest approach that also helps the environment.

***Collaborative Business Ecosystem:***

If a large organization that has myriad different associations with its many collaborating smaller sized organizations changes its direction and priorities, then those collaborating organizations also have to change their priorities accordingly. When such a large organization embarks on environmentally sustainability programmes in a major way encompassing its supply chain, 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, is affected. These various stakeholders and associations are invariably pushed into implementing environmentally responsible initiatives and strategies.

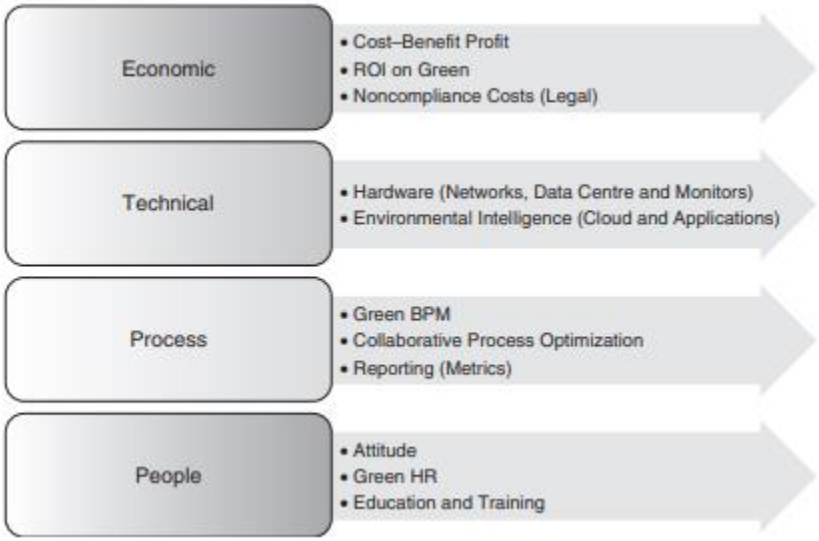
***New Market Opportunities:***

Global environmental awareness, corresponding legislations and sociocultural and political pressure on businesses have created opportunities for new markets that did exist or were not even envisaged a few years ago. For instance, these new markets can create and provide products and services that assist other organizations in achieving their green initiatives and goals. Thus, we are talking about not only 'businesses that are green' but also 'green as a business offering'.

**GREEN IT BUSINESS DIMENSIONS:**

Once the drivers that provide the impetus to the business for its green initiatives are identified and documented, they lead to discussion on the areas of business that are likely to be affected by the changes. The changes resulting from green IT initiatives transform the organization and, therefore, understanding them is an integral part of a green IT strategy. An organization changes or transforms along four different lines or dimensions.

- Economy
- Technical
- Process
- People




***Economy:***

Economic considerations are one of the key factors in an organization's decision to implement environmental policies and systems. The costs associated with green transformations and the returns on those costs are the first ones to appear in the minds of leaders and those in charge of the green transformation. Therefore, this is a primary dimension along which green transformation occurs in an organization. These include the cost–benefit analysis and a financial return on investment (ROI) analysis. Economic growth in the current economy is usually associated with increase in carbon emissions.

***Technology:***

Technology we mean an organization's hardware, network infrastructure, software and applications. This is also the more 'popular' and visible aspect of green IT. Switching off monitors, virtualizing servers and eschewing printing on physical paper are the initial, visible aspects of change that occur along this dimension. This is then followed by long-term strategic change in the way the data centre is organized and operated. Emerging information technologies, such as service orientation, software as a service (SaaS) and cloud computing, are creatively used in this dimension to reduce an entire organization's carbon emissions.

***Processes:***

The process dimension of an organization deals with 'how' things are done within an organization. Business process reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service and speed. The process dimension of an organization is perhaps the most visible one, and it is often used to judge the level of ecological responsibility for an organization's green ICT. This is because the process dimension has immediate and measurable effects on a business operation's carbon footprint. It also has effects on clients, vendors and business partners in the collaboration.

***People:***

The most difficult and perhaps most complex dimension of a green enterprise transformation is people. Whilst the people aspect of an organization's behavior has been studied to 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. An enterprise-wide green strategy is best driven from the top of the organization in order to ensure its success. Leadership within this people aspect, such as that by senior directors and chief officers, is a deciding factor in an environmental initiative. The involvement of senior management in bringing about a change in the people dimension is vital – and it has to be done at an early stage of a green initiative, though such involvement from senior leadership requires a substantial commitment in terms of time, money and other resources. Making the key stakeholders fully aware of the importance of the green initiative for the organization and, through them, promoting the initiative to bring about fundamental changes in attitudes are keys to success.

**GREEN IT METRICES AND MEASUREMENTS:**

Metrics for green IT performance of an organization can be based internal ROI goals and/or on legal reporting requirements. Whilst the ISO 14000 series of standards can provide an excellent starting point for the Key Performance Indicators (KPIs) for green IT, CEMS can be used to automate, measure and report on carbon emissions and the carbon footprint.

Following are some typical KPIs that must be embedded in an organization that is undertaking green strategies.

• **Economic outcome**.

Reduce energy consumption by 10% of its current level per year for three years; increase green services (e.g. the addition of one detailed insurance service dedicated to green).

• **Technical.**

Use virtualized data servers for all warehoused data; use smart meters to record, repost and control emissions.

• **Process.**

Optimize supply chain management to reduce or reengineer individual processes.

• **People.**

Train people for green IT at all levels. Telecommute once a week to reduce emissions.

***Carbon metrics coverage:***

A carbon intensity (or emissions intensity) is a ratio that reflects the amount of GHG emissions per unit of energy delivered. This metric reflects the operational efficiency and emissions of production processes related to the energy that will be delivered to consumers, and as such is an important tool in monitoring and assessing the environmental performance of integrated energy companies and their future strategies.

Carbon intensity metric quantifies the amount of $CO_2$ equivalent emissions per unit of energy supplied ($gCO_2e/MJ$) to the end consumer. Non energy products such as lubricants and chemicals and corresponding emissions are not included in this metric.

***Green IT Measurement Challenges:***

In the past the focus was on computing efficiency and cost associated to IT equipment's and infrastructure services were considered low cost and available. Now infrastructure is becoming the bottleneck in IT environments and the reason for this shift is due to growing computing needs, energy cost and global warming. This shift is a great challenge for IT industry. Therefore now researchers are focusing on the cooling system, power and data center space.
following are few prominent challenges that Green computing is facing today:

1. Equipment power density / Power and cooling capacities;

2. Increase in energy requirements for Data Centers and growing energy cost;

3. Control on increasing requirements of heat removing equipment, which increases because of increase in total power consumption by IT equipment's;

4. Equipment Life cycle management – Cradle to Grave; and

5. Disposal of Electronic Wastes.

***Framework for Green IT Metrics:***

Green Economy Indicators are key evidence-based instruments which facilitate the evaluation of Green Economy policies by:

(a) Identifying priority issues;

(b) Formulating and assessing Green Economy policy options; and

(c) Evaluating the performance of policy implementation.

***Measuring Carbon Footprint of your Organization:***

Carbon footprint is all about carbon (and other GHG) emissions. It isn't a measure of use of natural resources, or the waste a company produces – though those might affect the calculation's results. The real win would be achieving reductions in your absolute total footprint, which means getting total emissions down even as the business grows. The next best thing is finding ways to reduce emissions relative to output, so bringing down emissions per product, per employee, or per some unit of revenue.

***Measuring Operational Cost in your Organization:***

If properly followed Green Computing practices can save millions of rupees of an organization. Ecologically responsible practices must be adopted. For green computing, initial investment will be more, but eventually not only we will save money but also help to sustain the environment. Many organizations hesitate for going green because of initial cost. Unless equipment is planned to be replaced or there's a datacenter design in the works, most businesses aren't likely to replace their equipment just for the sake of duty to society. But when the cost of power starts taking a bigger and bigger bite out of the IT budget, organizations start really looking at green computing nowadays.

**ENVIRONMENTALLY RESPONSIBLE BUSINESS:**

One of the best ways to make your business more environmentally-friendly is to practice green procurement. This involves sourcing goods and services that are produced and supplied in a sustainable fashion. Sourcing from local suppliers rather than those located far away is a good place to start.

- Are manufactured in a sustainable fashion
- Do not contain toxic materials or ozone-depleting substances
- Can be recycled and/or are produced from recycled materials
- Are made from renewable materials
- Do not make use of excessive packaging
- Are designed to be repairable and not throwaway

**Policies in ERBs:**

A green policy usually contains the following components:

- A declaration of your company's commitment to the environment.

• A concise description of what your company is trying to achieve with your environmental goals and how you will accomplish your goals.

• A commitment to prevent pollution and to continuously improve environmental performance.

• A commitment to keeping employees and community members safe.

• A statement of the strategies and actions your business is willing to undertake to meet its commitments.

**Practices in ERBs:**

Environmental Practices are defined as those actions that seek to reduce the negative environmental impact caused by activities and processes through changes and improvements in the organisation and development of actions. The usefulness of the Good Practices is well proven and lies in its low cost and simplicity of implementation, as well as the fast results obtained.

The implementation of Good Environmental Practices is assumed by the Foundation and understood as a whole, committing itself to continuous improvement in its application. From Social Promotion, this Guide and its implementation are considered as a tool to improve the transparency, competitiveness and integral development of the beneficiaries of the activities.

This Guide has been developed in six lines of action, as follows:

- Materials.
- Energy.
- Water.
- Waste.
- Transportation.
- Communications.

**Lean Impact on Green:**

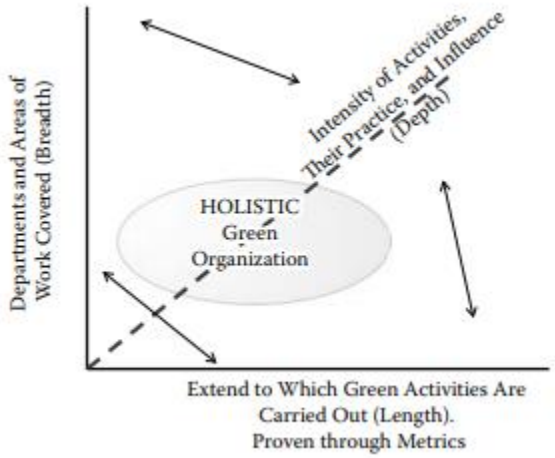
Lean Manufacturing plays an important role in supporting companies to overcome environmental, social and economic impacts attributed to the production processes, which has been a major concern for the industrial sector lately. Lean Manufacturing is focused on the reduction of waste and improvement of operational efficiency using a set of different tools to get these objectives. Many of these tools can be successfully used in isolation, which makes it much easier to get started, but on the other hand, the benefits will propagate as more tools are used, as they do support and reinforce each other. The

combination of lean and green initiatives has been contributing to seek alternatives to support companies balance efficiency gains and environmental performance in their industrial processes. The lean philosophy also intends to reduce wastes in all the organizations areas, thus the alignment with the environmental paradigm seems normal.

**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):***




What is highlighted is the need to consider the overall organization and its entire breadth in terms of Green IT policy development and implementation. Such consideration will result in appropriate creation of g green p programs, c corresponding use of a analyzing, modeling, and simulation tools for the study of environmental risk management and improved accuracy of measurements. The broader is the coverage of green policies, the better are the organization's chances at success.

***Depth of Environmental policies (Intensity of Coverage):***

A deep practice of policies in large organizations is usually well supported by tools for eco management, operating on dedicated systems platforms resulting in not only support, but also measurements and reporting of carbon performance for single and collective business processes. Depth of coverage for each process includes detailed description, mapping, responsibilities, and execution of roles,

deliverables, activities, and tasks within the organization. The depth of coverage of green policies also facilitates audits and feedback to the same process in greater detail.

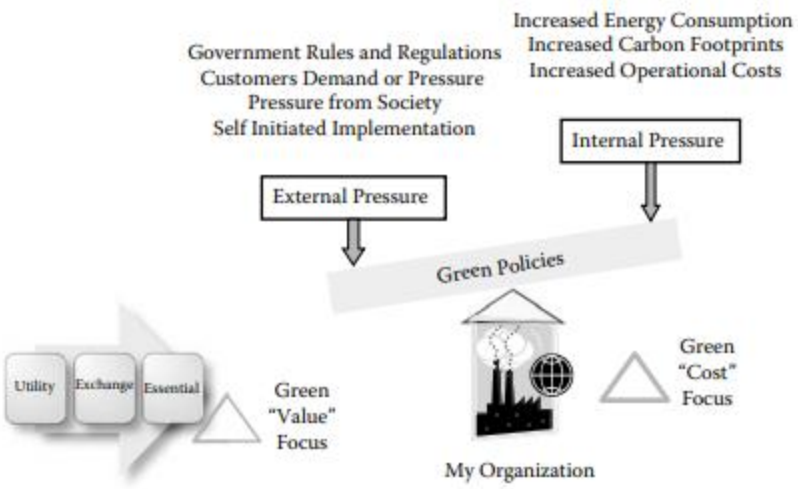
***Length of Environmental Policies (Duration of Coverage):***

Green policy formulations require the policy makers to have the ability to look at the future strategies that make predictions regarding the future of the firm. When incorporating time in policies, it becomes important to consider the longevity of the firm itself, together with the longevity of the Green IT initiative. 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.

| | *Policies* | *Practices* | *Metrics* | *Tools* |
|---|---|---|---|---|
| *Breadth* | Departments and activities covered; collaborative partners | Number of activities; people and partners practicing them | Green activities per departments | Leadership techniques; administration |
| *Depth* | Described intensity of activities | Reach—influence of each activity; honesty and seriousness | Carbon amount per activity; | Smart meters; CEMS implementations. |
| *Length* | Period of green policy implementation | Sustained period of practice by individuals and departments | Daily, yearly; other time units; staggered implementation periods | Duration on meters; time calculators; KPIs. |

**GREEN PRACTICE: A BALANCING ACT**

Balancing act, in practice, also requires consideration of the IT versus non-IT assets of the organization. In developing the green policies and eventually practicing green in a holistic way, the organization needs to consider Green IT from both IT and non-IT viewpoint. While the overall influence of IT on the greening effort will vary depending on the type and size of the organization, still understanding this mix of IT and non-IT assets is important for both policy development and eventual practice.




**Mobility and Environment:**

Mobility has a significant role to play in the reduction of carbon emissions as it has the potential to offer location independence, that is, reduce the need to t ravel, to most business processes. Some of the advantages and challenges in the use of mobile technologies in business from the point of view of environmental sustainability are noted in this discussion.

***Advantages to environment:***

Mobility offers location independence and personalization, both of which are characteristics that can be used to optimize business processes and reduce carbon. Therefore, mobile technologies—including devices, networks, and contents—have a significant role to play in the global carbon reduction effort.

***Challenges to Environment:***

There are some interesting and unique challenges of mobility when it deals with the environment. Consider, for example, how mobility enables virtual collaborations between business and individuals. These virtual collaborations, especially between businesses, can introduce management challenges in implementing environmentally responsible strategies.

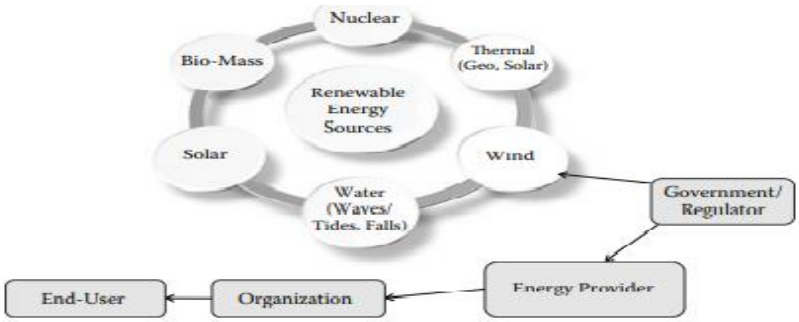
**Relating Environmental Business Policies to Goals:**

The importance of policies and their practice is that they enable an organization to achieve its environmental goals. Therefore, policies need to reflect the green strategies of the organization in this regards. Policies, in practice, also need to provide help and guidance in terms of prioritizing the actions to be undertaken by the organization. The following are some of the green policies which enable an organization to prioritize its environmental goals.

- Energy Consumption
- Energy Efficiency
- Operational Costs
- Operational Reputation
- Environmental Performance
- Green Sustainability
- Increased Revenues

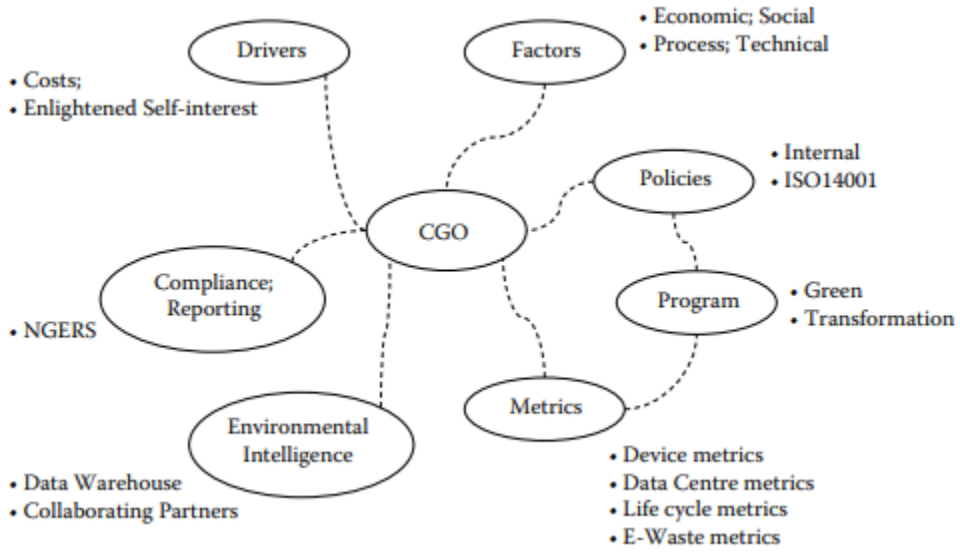
**Renewable Energy Resources:**

Apart from discussing the policies and practices associated with the organization in its current state, it is also worth considering the impact of totally different types of energy as is currently consumed within an organization. For example, if instead of oil or gas, the energy was generated from coal. Renewable energy certificates are one way for organizations to support green energy. Impact of renewable sources of energies is usually felt through Government regulatory standards. Government devises regulatory standards which controls and support the energy providers. Energy providers implement those standards and as a result, organizations have the opportunity to source from one or more energy providers.



**Mind Map for the Role of a Chief Green Officer (CGO):**

Chief Green Officer (CGO) or the Chief Sustainability Officer (CSO) is the most senior person in the organization responsible for green strategies. He/she is responsible for the development and maintenance for the green policies. The green policy should have the ability to justify the Return of Investment (ROI). An understanding of this mind map of a CGO can be helpful in setting and directing the green enterprise transformation of an organization.



## UNIT – 1

## FUNDAMENTALS

***PART – A (2 MARKS)***

**1. What is Green Computing?**

The study and practice of designing, manufacturing, using and disposing of computing devices, servers and associated subsystems (such as monitors, printers, or storage devices)efficiently and effectively with minimal or no impact on the environment.

**2. Define Green IT?**

- Green IT is the study of using computing resources effectively. It includes,
- Environmental sustainability
- Energy Efficiency
- Cost of Ownership (making, disposal)

**3. What is ERBS?**

ERBS (Environmentally Responsible Business Strategies). Focus on to achieve a green enterprise and meet the needs of various stake holders.

**4. Define Carbon Foot Print?**

A Carbon Foot Print is the amount of greenhouse gases and specifically carbon dioxide emitted by something during a given period.

**5. What is the information required for measuring the carbon foot print?**

- Facilities
- Operations
- Transportation
- Travel
- Purchases

**6. List out the need for Carbon Footprint?**

- Helping company to improve its efficiencies.
- Reducing Costs.
- Getting public Recognition.
- Maintain link in the supply chain.
- Good impact on customer.

**7. What are the categories of Green IT Drivers?**

I. Costs

II. Regulatory and legal
III. Sociocultural and Political
IV. New market Opportunities
V. Enlightened self-interest
VI. A responsible business eco-system

**8. What are the business dimensions of Green IT?**

- Economy
- Technical
- Process
- People

**9. What is the purpose of an organization to go green?**

- Increasing energy consumption
- Growing consumer interest in environmentally friendly goods and services.
- Higher expectations by the public on enterprises.
- Environmental responsibilities and emerging stricter regulatory and compliance requirements.

**10. What are the three Rs of Green IT?**

- Reuse
- Refurbish
- Recycle

**11. List out the most significant constituents of GHG's?**

Carbon dioxide (CO2), Methane, Nitrous Oxide, and Chlorofluorocarbon (CFC) gases.

**12. What are the four dimensions of green Computing Strategies?**

- Economic
- People
- Process
- Technology

**13. What is Responsible Business Ecosystem (RBE)?**

It is a large green organization which focuses on the environment; it consists of three major areas:

- Green processes
- Green data centers
- Green consortiums.

**14. List some of the objectives of green business?**

- Synergy between core business objectives and green objectives.

- Identify growth potential.
- Development of green HR

**15. Define Green Governance?**

Green governance combines EI with lean for data creation and maintenance. It measures the carbon emission of business.

**16. List the situations in which the policies can be made?**

I. External pressure (Government)
II. Internal Pressure (Inside Organization)

External

- Government policies
- Society pressure

Internal

- Internal energy consumption.
- Increased carbon footprint.

**17. List the 5M's of Carbon Metrics?**

- Measuring
- Monitoring
- Managing
- Mitigating
- Monetizing

**18. List some of the green values in practice?**

- Computing power management
- Use blank screen saver
- Limited printing
- Reuse and recycle of equipment
- Single machine to worker.

**19. What is Green Sustainable Policy?**

It is defined as a policy that incorporates a "green" factor that helps business to sustain over a longer period of time.

**20. What are the types of Emissions?**

- Scope 1 (direct emission)
- Scope 2 (indirect usage of emissions)

- Scope 3 (organization supply chain).

**21. List the steps in developing an ERBS?**

- Green business objectives
- Strategy descriptions
- Policy based pre conditions
- Resource requirements
- Transformation plans.

**22. Mention some renewable energy sources to be encorporated with green policies?**

- Nuclear
- Thermal
- Wind
- Solar
- Biomass

**23. Define Carbon Metrics?**

- Measurements eventually provide benchmark at industry levels and vital comparison statistics.
- Measure through sensors, platforms, inventory and inference methods.

**24. List the measures of balanced score card?**

- Financial measures.
- Customer measures.
- Internal business processes.
- Learning and growth.

**25. What is the role of Chief Green Officer (CGO)?**

CGO is the most senior person in the organization responsible for green strategies. He/she is responsible for the development and maintenance of green policies.

## UNIT – 1

## FUNDAMENTALS

***PART – B (16 MARKS)***

1. Discuss in detail about Green IT fundamentals?
2. Explain in detail about Green IT business and environment ?
3. Discuss in detail about Carbon Footprint?
4. Write about carbon emissions in IT?
5. Write in detail about Green IT strategies?
6. Explain about Green IT Dimensions, Drivers, and Goals?
7. Explain in detail about Environmentally Responsible Business?
8. Explain in detail about policies, practices, and metrics of ERBS?

# UNIT II

## GREEN ASSETS AND MODELING

***Syllabus***

Green Assets: Buildings, Data Centers, Networks, and Devices – Green Business Process Management: Modeling, Optimization, and Collaboration – Green Enterprise Architecture – Environmental Intelligence – Green Supply Chains – Green Information Systems: Design and Development Models.

### 2.1 GREEN ASSETS:

A green asset produces revenue with the additional aspect of an ability to be renewable. Eg) Solar Energy, The green assets and infrastructure comprise substantial part of that long-term approach to managing the carbon performance of the organization. The three major phases or activities associated with the lifecycle of these assets are depicted as follows:

- The way they are established or procured.
- The manner in which they are operated or run
- The strategies for their disposal or demolishment.

***Establish (Procure):***

Deals with the green credentials of the asset in terms of its design and development.

***Operate (Run):***

Manner of operation of the asset has a bearing on the total carbon contribution of the organization.

***Disposal (Demolishment):***

This is the eventual phase of an asset and it also impacts the overall carbon footprint of an organization. This impact is through the organization's approach to disposing or demolishing the asset.

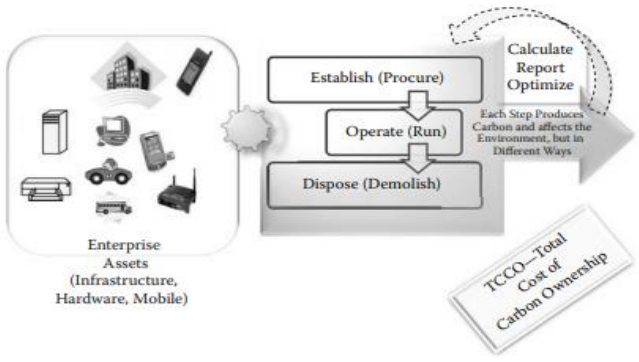



**fig. Green assets need to be organized in an efficient way throughout their lifecycle**

**Types of Assets (Categories) and Their Impact on the Environment is depicted as follows:**

| *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.<br>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. |

### 2.1.1 Building and Facility Management:

The physical buildings and facilities belonging to the organization form the core 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 need and demand to consider the carbon issues upfront, during initial procurement and/or construction of buildings. This forces the construction industry to handle issues such as the type of insulation used, facilities to recycle water, and the use of natural light in determining the TCCO (Total Cost of Carbon Ownership) for that building.

### 2.1.2 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. 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.

***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 (Procedure/Operate/Dispose) viewpoint.

***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 outdated.

***Peripherals:***

Printers, photocopiers, shredders, and so on. These 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.

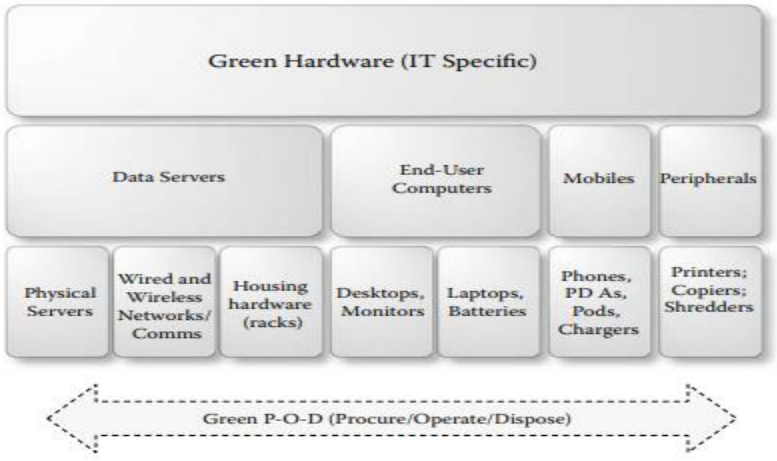



**Fig. Range of Green IT hardware generating carbon.**

**2.1.3 Green Data Centers:**

The demand for data center capacity worldwide has been on the rise. This has also lead to a steady increase in carbon emissions. Data centers form the major chunk i n the overall Green IT hardware assets of an organization. They house a suit of large computers and associated networks of the organization, forming the "heart" of most businesses. 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.

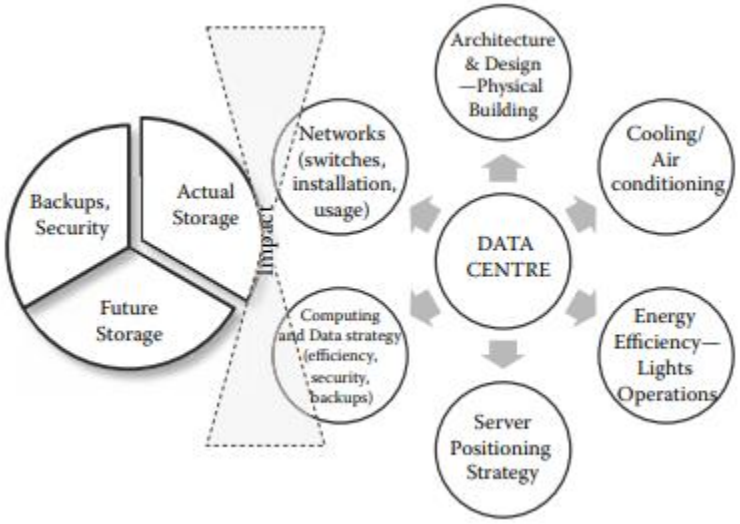



**Fig. Green data center influencing factors.**

Specific areas for Green IT with respect to data centers are discussed as follows:

***Data center design, layout, and location:***

Physical building in which the data center resides. Architecture and design of the building (physical shape, naturally cooling and ventilation, natural light, ease of access etc.), geographical region (e.g., locating a data center in Iceland), and the material used in construction of the building (Terracotta for roofing; painting the roofs white) are all valid considerations here. 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:***

This includes the cooling strategies of the servers; and the air conditioning relating to the actual building.

***Power management—lights and operational aspect:***

This would include 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, t heir positioning (hot isle/cold isle). Architecture and the physical rooms in which they are placed. Design of each server - 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. Virtualization aims to pool resources together to deliver data center services by pooling resources that may be otherwise underutilized.

***Networks and communications equipment:***

Wireless communications such as switchgears, routers, and modems. The numbers and capacities of these equipment's in the data center contribute to its carbon footprint.

**2.1.3.1 Data Center Building—Design, Layout, and Location:**

Data center buildings are specialized buildings to hold the large computing and communications equipment's of the organization. Following are the specific design, layout, and location consideration for data centers.

- Physical (geographical) location of the building.
- Building that houses the data center.
- Power supply.
- Cooling and lighting.
- Server and storage virtualization.
- Facilitation of new and emerging technologies.

**2.1.3.2 Data Center ICT Equipment—Server Strategies:**

They are housed within the green data center and require specific strategies for positioning, cooling, and usage. Following are a list of green server strategy considerations that need to be expanded in detail in practice:

- Online, real-time list of server inventory that enables location and uses of the servers.
- Power consumption bill in real time.
- Mirroring backup strategies that are balanced by the "acceptable risks" of the data center director.
- Data capacity forecasting.
- Carbon-cost visibility.
- Enhanced server distribution.
- Incorporate Cloud computing and server virtualization.

### 2.1.3.3 Data Strategy and the Carbon Emitting Bit:

Data strategy encompasses the use, storage, mirroring, security, backups, clean ups, and architectures for data. It covers both external and internal approaches to data management.

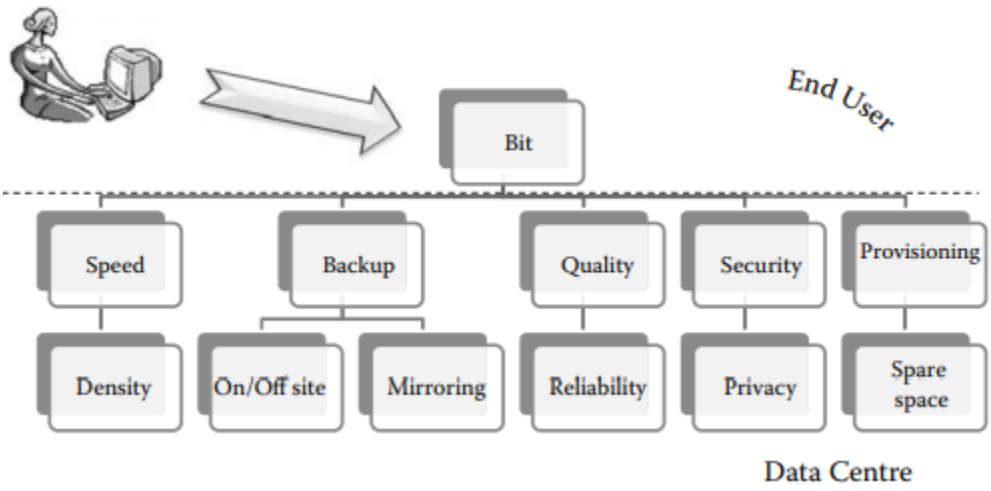



**Fig. A carbon-emitting bit—repercussions on overall carbon emissions.**

### 2.1.3.4 Data Servers Optimization:

Data server optimization can be improved through better organization of the databases including their design, provisioning for redundancy, and improved capacity forecasting, following RDBMS (Relational Database Management Systems) standards such as data normalization and usage of proper data types within database as and when required.

### 2.1.3.5 Data Servers Virtualization:

Data server virtualization, as a key strategy, includes creation of many virtual servers from one physical server. Virtualization has been popular as efficient hardware resource utilization; however, it also has significant impact on reducing carbon emissions.

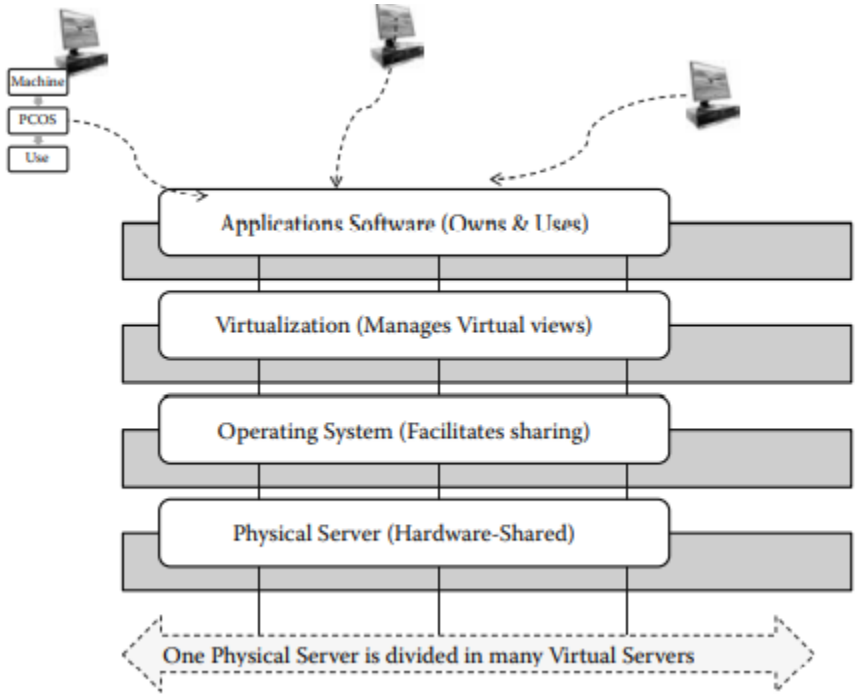



**Fig. Data server virtualization.**

### 2.1.3.6 Cloud Computing and Data Centers:

Cloud computing offers the potential for economies of scale that go beyond a single data center and a single enterprise. This is so because with Cloud computing there is opportunity to not only consolidate the costs of services but also shift the carbon generation to a relatively centralized place where it can be better controlled and optimized.

### 2.1.4 Networking and Communications Infrastructure:

Networking strategies that are part of information architecture can not only help reduce traffic but also improve carbon performance. Reduction of communication traffic eventually reduces the server load minimizing memory and processing time on the server.

Following are the categories of networks that need attention of the network manager in terms of their carbon connotation.

**Local Area Networks (LAN):**

Local networks of the organization that are made up of the physical connections amongst the machines and primarily the data center. Usually, these may be a collection of cables that may have "grown" as the organization grew; lack of planning and architecture for LANs is a major factor in consuming substantial power and thereby adding to the cooling requirements.

**Wide Area Networks (WAN):**

The wide area networks of an organization enables communication amongst its desktop and laptop machines with and beyond its data center. Typically, the WAN comprises use of communication lines that make up the virtual private network (VPN) of the organization. Such VPN is made up of leased communications lines which reduce the extent of influence an organization has over its power consumption and carbon generation.

**Mobile Networks:**

The Mobile enterprise architecture that can also provide the backdrop for carbon reduction.

**Wireless L AN/WAN:**

Wireless communication may give the impression of reduced hardware and infrastructure (due to lack of physical wiring).

**WiMax:**

WiMax is another mobile standard for point-to-point communication that is based on radiofrequency standardized technology. WiMax, made up of transceivers to base antennas, need standards to ensure these networks are switched on-and-off depending on their usage pattern.

**2.1.4.1 Devices and Organizational Boundaries for Measurements:**

Devices in the Green IT discussion play two roles:

- Those that emit carbon and
- That which is used to measure, monitors, and mitigates carbon.

The various tools and techniques in carbon measurement are as follows:

- Dashboard displays attached to the devices to display emissions.
- Mobile gadgets attached to devices for measuring emissions.
- Surveys of employees and other stakeholders.
- Inventory of the organization to identify unused goods.
- Interviews of employees and stakeholders to ascertain carbon emissions.

**2.2 GREEN BUSINESS PROCESS MANAGEMENT:**

Green B PM is an overall approach to modeling, optimizing, consolidating, and executing business processes of an organization from a carbon perspective. Application of Green B PM results in improving the ways in which an organization (users and business areas within an organization) undertake operations. BPM can be understood as a discipline of modeling, realizing, executing, monitoring, and optimizing business processes.

**2.2.1 Green Reengineering:**

Reengineering of processes to green processes will incorporate reevaluation of processes and also an understanding and modeling of their supporting hardware, software, and people in order to cut down the carbon generated through t hem.

The following figure illustrates the concept of process reengineering in a simple way from a green perspective.

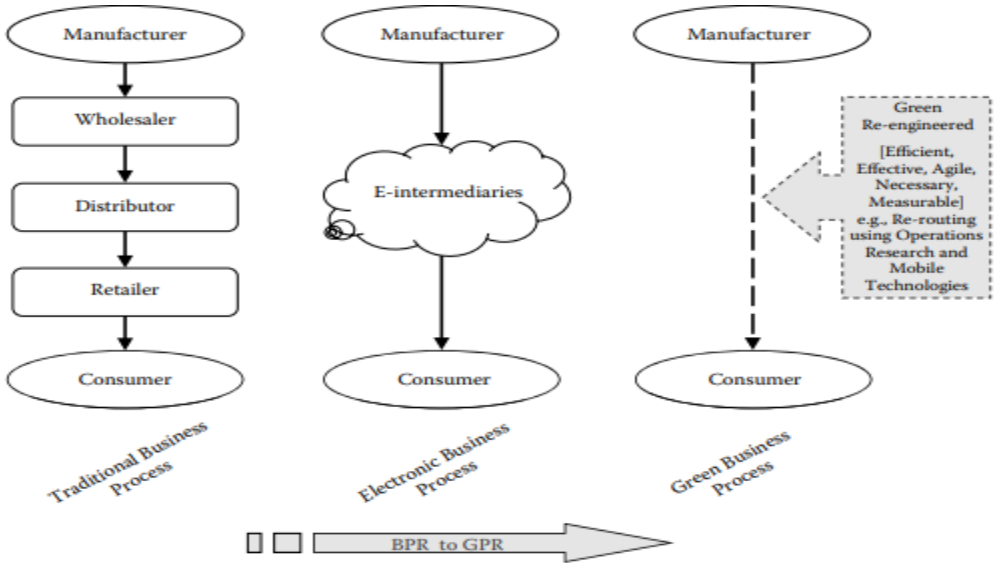



**Fig. Core concept of GPR—a distribution example.**

The following are the steps in terms of Green BPR

***Listing:***

This is an initial list, which will be refined as this green transformation exercise proceeds. This 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.

***Ranking:***

Ranking of the processes within the process list can be undertaken based on the carbon criteria. Thus, while normal BPM exercises list the processes with criteria such as their costs and effectiveness, in Green BPM, these processes are also ranked based on the amount of estimated carbon they produce.

***Modeling:***

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 available. If not, the green transformation project can start by modeling the processes that are ranked high in the previous step.

***Optimizing:***

This step i s the study of the processes that are modeled from t heir carbon impact.

***Retaining:***

Processes that are modeled and optimized will reduce their carbon contribution.

***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.

**2.2.2 Green BPM and Standards:**

Green BPM can be carried out in a number of ways, and using different tools and techniques.

Following are the important aspects of the use of standards in Green BPM:

- TQM, Kaizen, and Six Sigma provide standards and techniques to optimize and improve business processes.
- Efficient business processes may also create opportunity to produce greater quantity of goods resulting from improved production capacity.
- Customization and personalization of products to suit the de ands of customers is the result of process reengineering.
- Reengineering of processes also results in optimizing the internal organizational structure.
- Knowledge management enables keeping track of customer p references.

**2.2.3 Green Business Analysis:**

Role of a Green BA can provide analytical help and support for green business process modeling. BA is the role that owns and models the requirements of the project. BA is also responsible for working with the key business executives and users to determine the goal and expectation of the business process.

**2.2.4 Green IT Governance:**

Indicates how a governance standard is translated into policies and practices through business rules. The most commonly used governance standard is the Information Technology Infrastructure Library (ITIL).

The context of Green IT process and management is discussed briefly as follows:

- ✓ ***Service Strategy***—provides guidance on explanation and prioritization of service provider and their customers' investments in services.
- ✓ ***Service Design***—provides guidance on design of new or modified IT services through a catalogue.
- ✓ ***Service Transition***—facilitates transition of a service to the operational area of the business with environmental considerations inbuilt into them.
- ✓ ***Service Operation***—is when the service has become operational and can be called "Green Service" when the environmental considerations are taken into effect.
- ✓ **Continual Service Improvement**—provides guidance on the things that need to be controlled and measured for improving service quality, particularly from a green business perspective.

**2.2.5 Green Business Processes—Incremental Complexity:**

The increasing complexity of these green processes.

***Broadcast processes***—these are easiest processes to understand, model, and optimize when they are the one-way broadcast processes typically used by the organization to promote and advertise their products.

***Informative processes***—the green aspect of this informative category comes from the fact that the receiver of the output of this informative process is known to the organization.

***Transactive processes***—typically called the electronic commerce processes requiring a 3-way interaction between the vendor, the customer, and the payment facility.

***Operative processes***—these processes are of more complexity and deal with the internal, operational aspect of the organization.

***Collaborative processes***—When multiple organizations interact with each other through collaborative web -based processes, the carbon generation i s not only significant, but also increasingly challenging to trace because the organizational boundaries of these processes is extremely fuzzy.

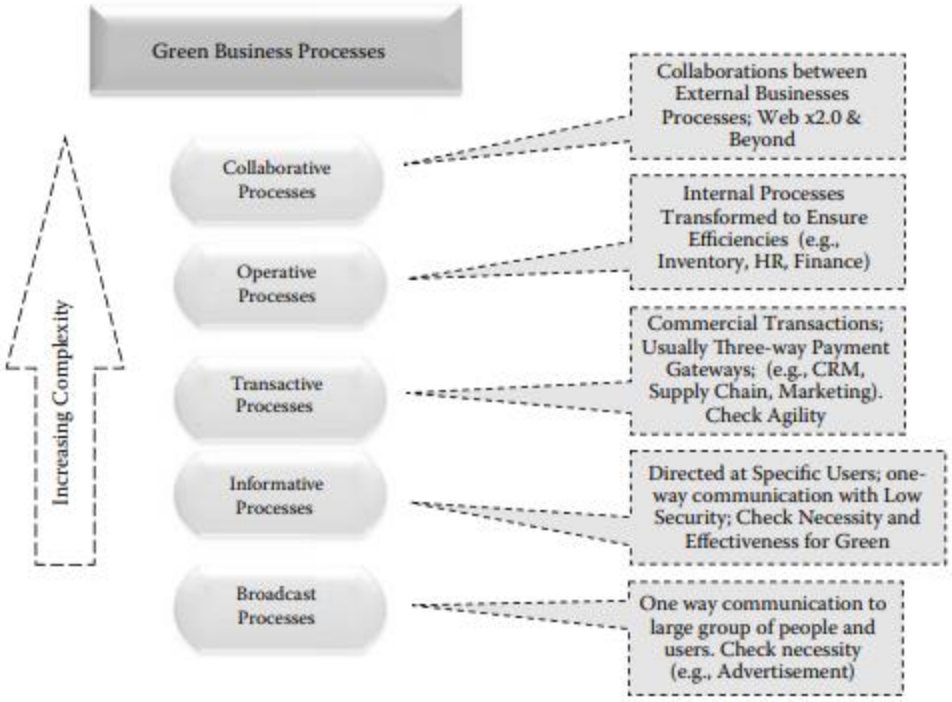



**Fig. Increasing complexity of green processes.**

### 2.2.6 Green Mobile Business Processes:

The way in which mobile green processes are enacted by incorporation of mobility in to the business processes is also based on the increasing complexities of the processes as was discussed earlier. An understanding of this increasing complexity also provides opportunity, through the use of mobile technologies, to reduce corresponding carbon contents of these processes. Increasing complexity of transactions also implies an opportunity to reducing that complexity and, thereby, reducing carbon emissions in those processes.

***Mobile-Broadcast***—use of mobile technologies enables sending of one-way information to a large group of people who may or may not be registered as users.

***Mobile-Informative***—use of mobility provides the organization with the ability to provide environment-related information to the various stakeholders within the business.

***Mobile-Transactive***—usage includes collection, collation, and reporting of environmental data with the use of handheld mobile as well as stationary but wireless devices.

***Mobile-Operative***—usage provides opportunities for the organization to model and optimize its internal processes that will produce environmentally friendly results.

***Mobile-Collaborative***— where organizations are influenced by their business partner's policies and strategies toward green environment.

**2.2.6.1 Environmental–Economic Mobile Use:**

The economic influence of mobility needs to be considered here in terms of its relevance to the environment. For example, the economic reasons for transitioning to mobile business can be extended and discussed in terms of the economic reasons for transitioning to and managing a sustainable mobile business. The important economic factors of costs and competition for mobile transitions have a correlation with the environmental issues as well.

**2.2.6.2 Environmental–Technical Mobile Use:**

Environmentally responsible mobile businesses apply the concept of reuse to the design and distribution of mobile gadgets as well. Technical designers seek to create mobile gadgets which will have minimum impact on the environment. This environmentally responsible design of mobile phone can reduce the amount of the materials used, reducing the impact of those materials and thereby increasing the efficiency of the use of the mobile phones with the customers.

**2.2.6.3 Environmental–Process Mobile Use:**

The way in which businesses operate can have a tremendous impact on the environment. The modeling, study, and optimization of business processes need to be undertaken from a mobile perspective. Ā e potential of mobile devices to reduce people movement is obvious; this potential needs to be woven in the green business processes of an organization.

**2.2.6.4 Environmental–Social Mobile Use:**

The social dimension of mobile technologies—particularly the devices and the social networks—relate to the environment in many ways. For example, the ability of personalized transmission of messages can be utilized in raising environmental awareness amongst specific users. Mobile businesses can also take additional social responsibilities by investing in communities that can be helped to learn, work, and thrive in a "green" environment.

### 2.3 Green Enterprise Architecture:

The aim of a GE A is to develop an understanding of different viewpoints of business, technology, and the environment in which the business exists. Ā is 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.

#### 2.3.1 Views of Green Enterprise Architecture:

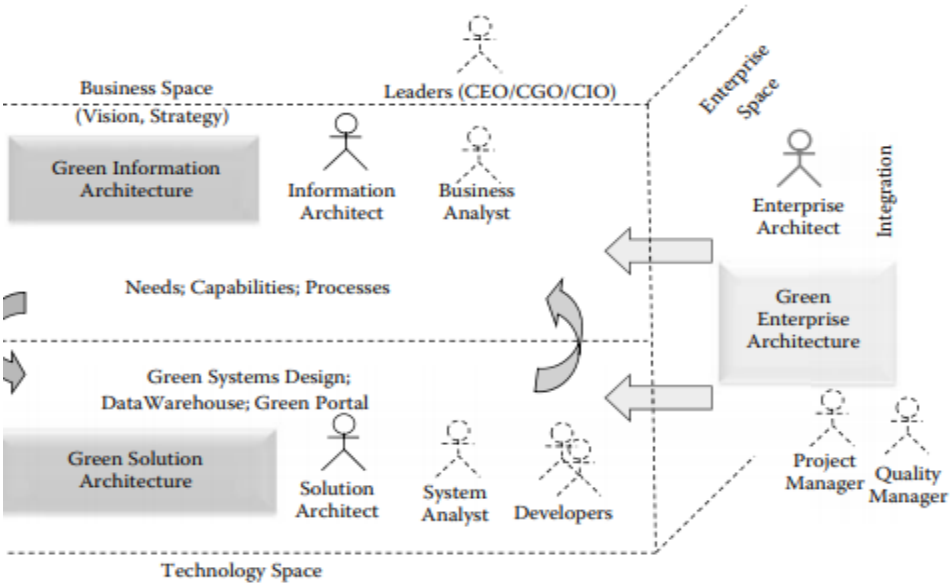



**Fig. Various views of comprehensive Green enterprise architecture: Business, technology, and enterprise spaces.**

A comprehensive GEA encompasses an understanding of the various views of the organization and its interrelationships. Green information architecture (GIA), shown in upper half of Figure 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. This architecture is developed based on the business requirements in the "problem space" and takes into account the strategies and policies of the organization. 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.

#### 2.3.2 Green Enterprise Architecture—Categories of Requirements:

The GEA is not an independent entity per se. While a GEA deals with constraints, compliance, integration performance, and security issues, it also influences both—the GIA in the business space and the GSA in the technology space. Thus, the activities with GEA span the problem, solution, and

background space. The following figure expands and groups the various activities that form part of the overall green architecture of the enterprise.

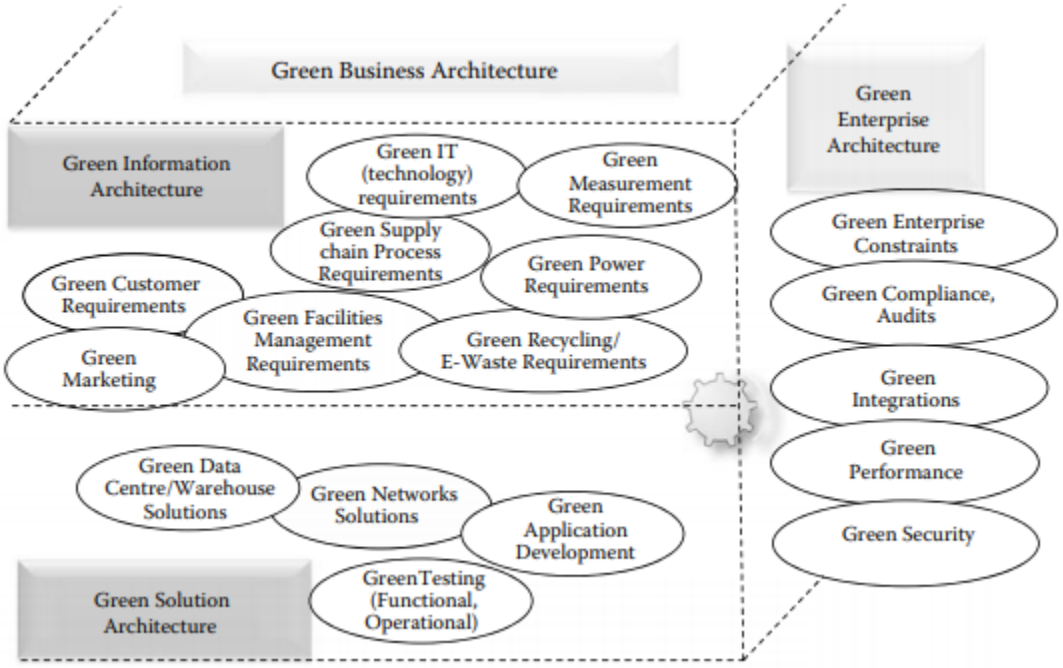



**Fig. Categories of requirements in the various green architectural spaces.**

The GEA in the background is influencing and influenced by the GIA as well as the GSA from the problem and the solution space respectively. The GIA provides the basics 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.

### 2.3.3 Aspects of Green Solutions Architecture:

GSA brings about a synergy of technologies that can enable efficient use of IT resources. Thus, the resources are themselves used efficiently and, in turn, these IT resources provide the basis to enhance the efficiency of the rest of the equipment's and processes in the organization.

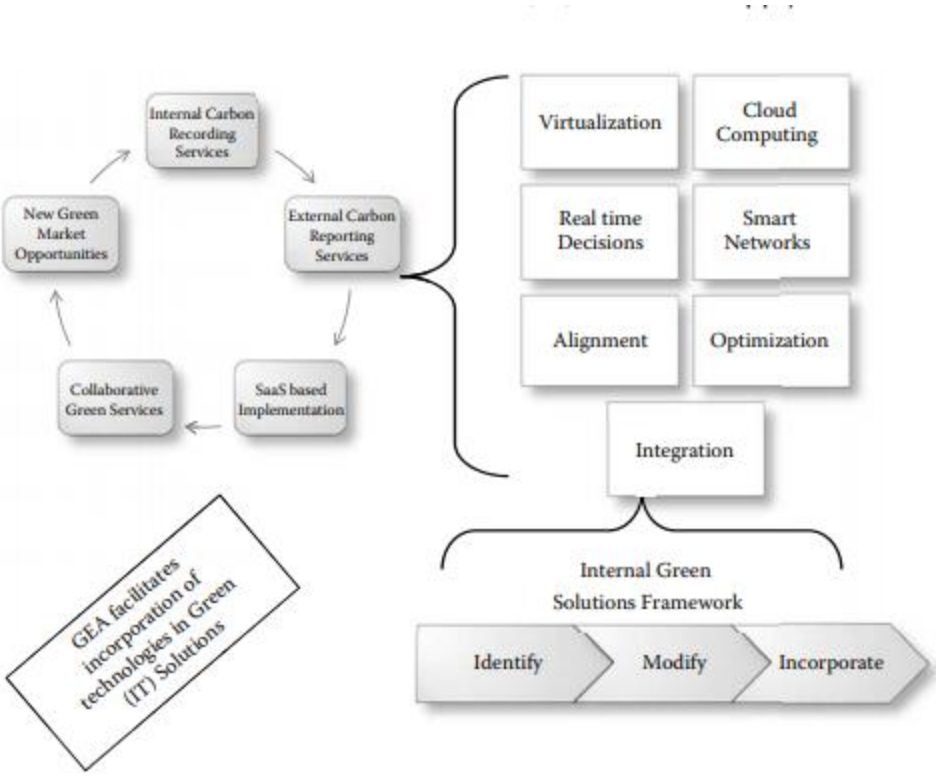



**Fig. Various aspects of a Green solutions architecture.**

***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.

***Virtualization:***

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. Carbon performance requirements from virtualization should be identified, documented, and measured in accordance with the overall green strategies and objectives of the organization.

***Smart Networks:***

Smart networks and their management make use of automated devices, sophisticated switch management, optimized network operations and re al time reporting of the network performance. Efficient network operations assure delivery at lower cost and improved environmental footprint.

***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.

***Alignment:***

Alignment of data, processes, and interfaces is an architectural issue in the solution space that focuses on reducing the friction within and amongst the systems. Ideal Green IT solutions, therefore, can be understood as absence of contradictions amongst data, processes, and interfaces.

***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.

**2.3.4 The Environmental Intelligence Domain:**

EI can be considered as an umbrella term that encompasses integrated suite of tools, architecture, databases, data warehouses, performance management, and methodologies. The EI can also refer to processes, techniques, or tools to support faster and better decision making for environmentally responsible strategies. EI systems consist of the tools, technologies, and processes that turn environmental data into information and knowledge that optimizes decision making.

**2.3.4.1 Environmental Intelligence Systems' Evolving Complexity:**

The evolving EI complexity is understood as follows:

***Data:***

Identification of carbon data related to equipment's (gadgets) across the company that generates greenhouse gases; Provisioning the step-by-step collection and collation of the carbon-related data within the organization.

***Information:***

Analysis and processing of the data in order to provide information to all parties concerned regarding the carbon-position of the organization. Environmental transactions are recorded and processed here in order to produce valuable information.

***Process:***

Optimizing procedures and controls within the organization using the concepts of business process modeling (BPM) to ensure efficiency; developing an understanding of process maturity in the context of green processes.

***Knowledge:***

Incorporation of external climate change data such as those provided by governmental bodies or other third-parties, into the internal systems of the company by using Cloud computing fundamentals.

***Intelligence:***

This is the semantic green enterprise. This is where the systems embrace people machine continuum. EI system requires two major activities from an organization: upgrading existing BI systems to incorporate environmental data, information, processes, and knowledge; and, analyzing, designing, developing, and deploying systems that are specific to the environmental needs of the organization.

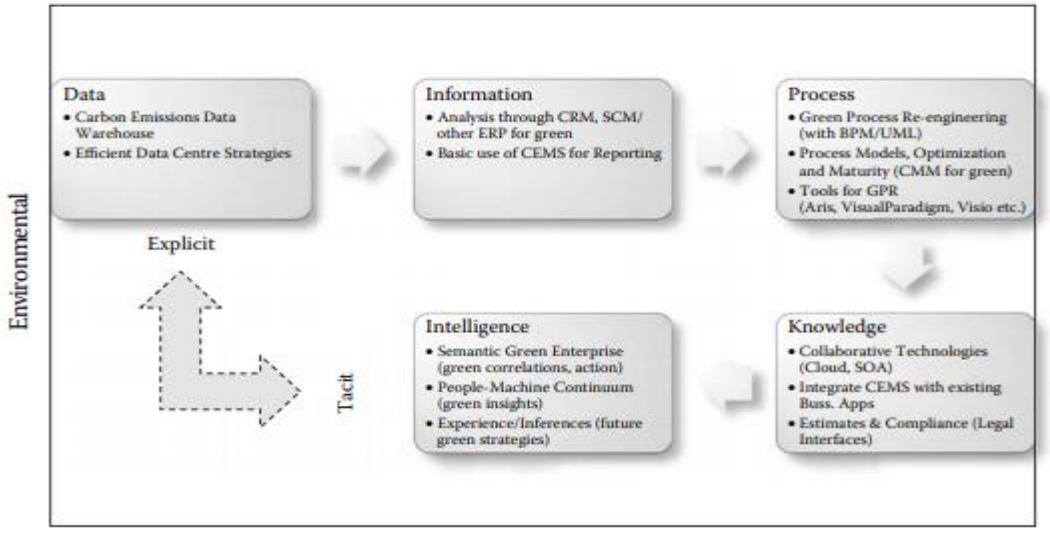
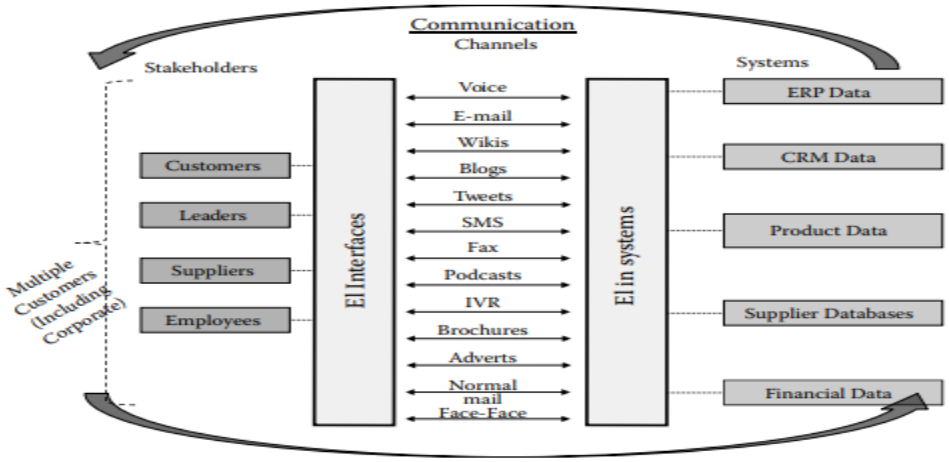



**Fig.Evolving complexities in environmental intelligence systems.**

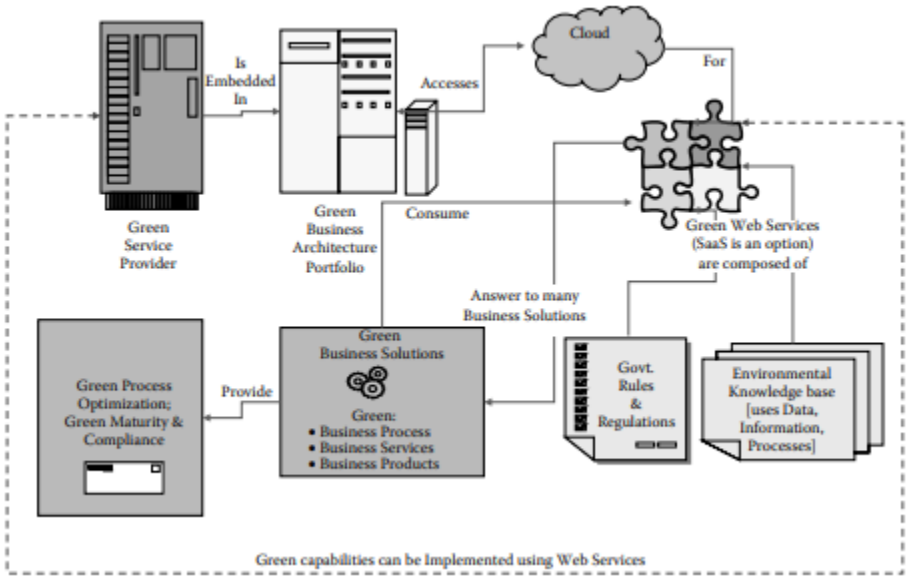
### 2.3.4.2 Communication Channels in Environmental Intelligence:

Environmental intelligence, combines not only myriad systems through correlations, but also synergistically brings in people. This is important in a GEA that has to incorporate systems intelligence with the human intelligence (shown on the left). The iterative influence of systems on stakeholders, and vice versa, is through the various communication channels shown in the center of the figure.




### 2.3.4.3 Environmental Intelligence Implementation with Web Services:

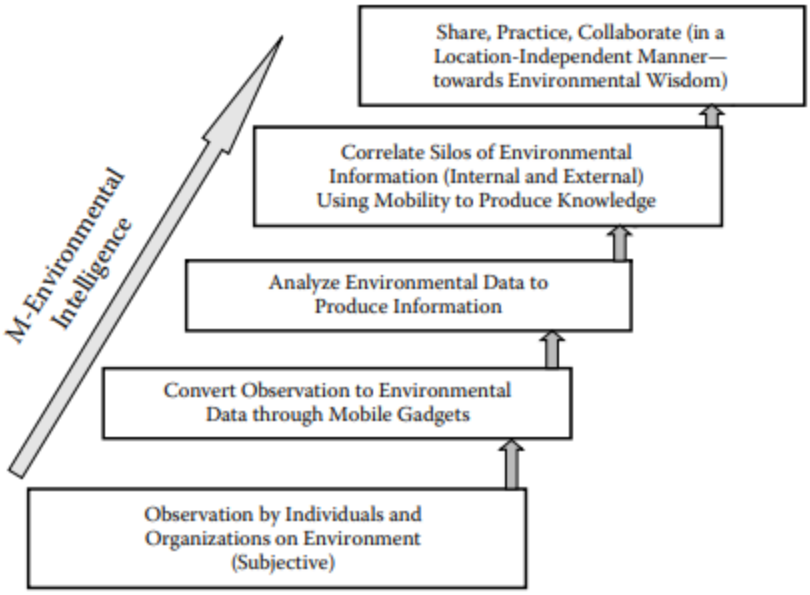
WS can be used to create and modify environmental services that would integrate carbon information silos by connecting them, and providing real-time reporting features to decision makers. WS can be used in the business environment to measure, monitor, and finally help for the process optimization with respect to the environmental factors. With the help of the tools such as Green web services (GWS), business can begin to develop EI systems, implement them in the business, monitor, measure, and mitigate the emissions and monetize the process.




**2.3.4.4 Environmental Intelligence with Mobility:**

Mobility has a role to play in the environmentally responsible business strategies that make an organization sustainable which, in turn, makes it a long-lasting and profitable organization. Mobility can be said to help the business be EI. Mobility enables virtual collaboration between business and individuals. Reengineering the business processes with mobility provides enormous opportunities for virtualization. The more virtual a business is the less physical resources it will consume—therefore, well-modeled mobile processes greatly assist in creation of environment friendly businesses.

EI systems involve and employ mobility solutions to coordinate office, field, and home decision making. Figure extends the EI concept with mobility.




## 2.4 GREEN SUPPLY CHAIN MANAGEMENT:

SCM have evolved rapidly to automate and optimize the lifecycle of material procurement. Similarly, SCM are also integral to procurement and use of equipment's and corresponding infrastructure. Supply chain management (SCM) systems are an integral part of organization's systems. SCM of an organization needs to be analyzed, planned, and optimized for sourcing and deliveries in an environmentally conscious manner.

## 2.5 GREEN INFORMATION SYSTEM (GIS):

A GIS is a software system that provides support to the business to implement its environment responsible business strategies (ERBS). Thus, this system has to cover the length, breadth, and depth of various structural and dynamic aspects of the business.

***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.

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

***Use***—Use of GIS will lead to ongoing recording of carbon data creation of reports as well as comparisons.

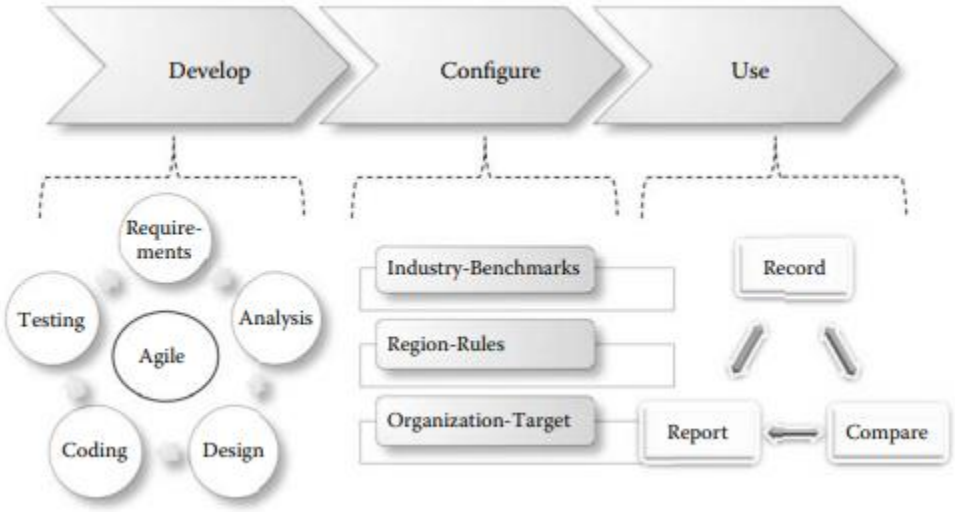



**Fig. Major phases in GIS: development, configuration, and use.**

***Features of GIS:***

The features of a GIS that play a significant role in enhancing this ability of business to coordinate its environmentally responsible approaches can be listed as follows:

- Collecting environment-related data in real time.
- Providing querying tools, key performance indicators (KPIs), and business analytics to field workers and decision makers in the area of EI.
- Enhancing the decision-making capabilities of senior management by collating and computing up-to-date information from varied external sources.
- 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.
- GIS also provides feedback to customers and other external users of the business on its environmental performance.
- GIS provides the business with the ability to sustain itself for a long time.

- GIS enables collaboration amongst businesses for the purpose of achieving environmental responsibilities.

**2.5.1 Modeling and Architecting GIS—Requirements, Design, Implementation, and Testing:**

The UML has been used in presenting the models of the GIS

***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. This is the expected behavior of the system documented as interactions.

***Use case diagrams***—provides a model describing all the related business processes/functionalities of a particular package.

***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.

***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.

**2.5.2 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. Green ICT system analysis and design is performed using the UML. These diagrams help in modeling the operations and interactions at the business level and also in system design thorough classes, packages, components, and deployment diagrams.

A typical GIS would involve two subsystems:

1. Green organizational portal (GOP)
2. Regulatory standards portal (RSP)

**2.5.2.1** ***Green Organizational Portal:***

The GOP is made up of organizational data on its "green" performance. These data are updated by the organizational representatives on an ongoing basis. These data record the organization's pollutant performance such as

(a) Heat generated by the desktop machines, data centers and network equipment's within the organization.

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

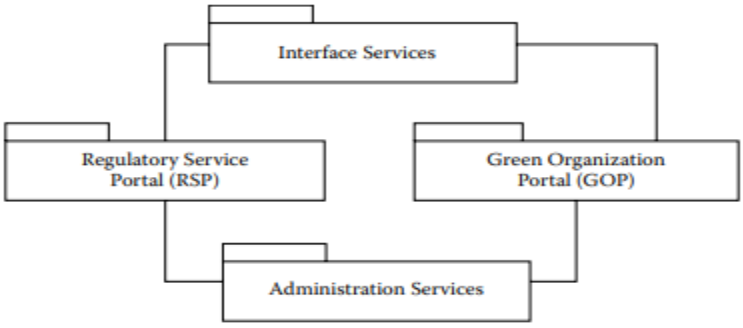
(c) Hazardous materials produced by the organization's activities such as lead in batteries and mobile phones.

***2.5.2.2 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. The RSP will have to have detailed and continuously updated information on the pollutant categories that are producing the carbon emissions.

***2.5.2.3 Package Diagrams and System Scope:***

The system should cover all the functionalities required to record, calculate, analyze, and report on carbon emissions. GOP and RSP functions like emission details management and comparing them with standards are done based on the company size and location.



GOP and RSP are shown as two packages that also interface with the interface and administration services. While the GOP will have multiple instances across various organizations, the RSP will have a single instance.

***Use Case Diagram for GOP:***

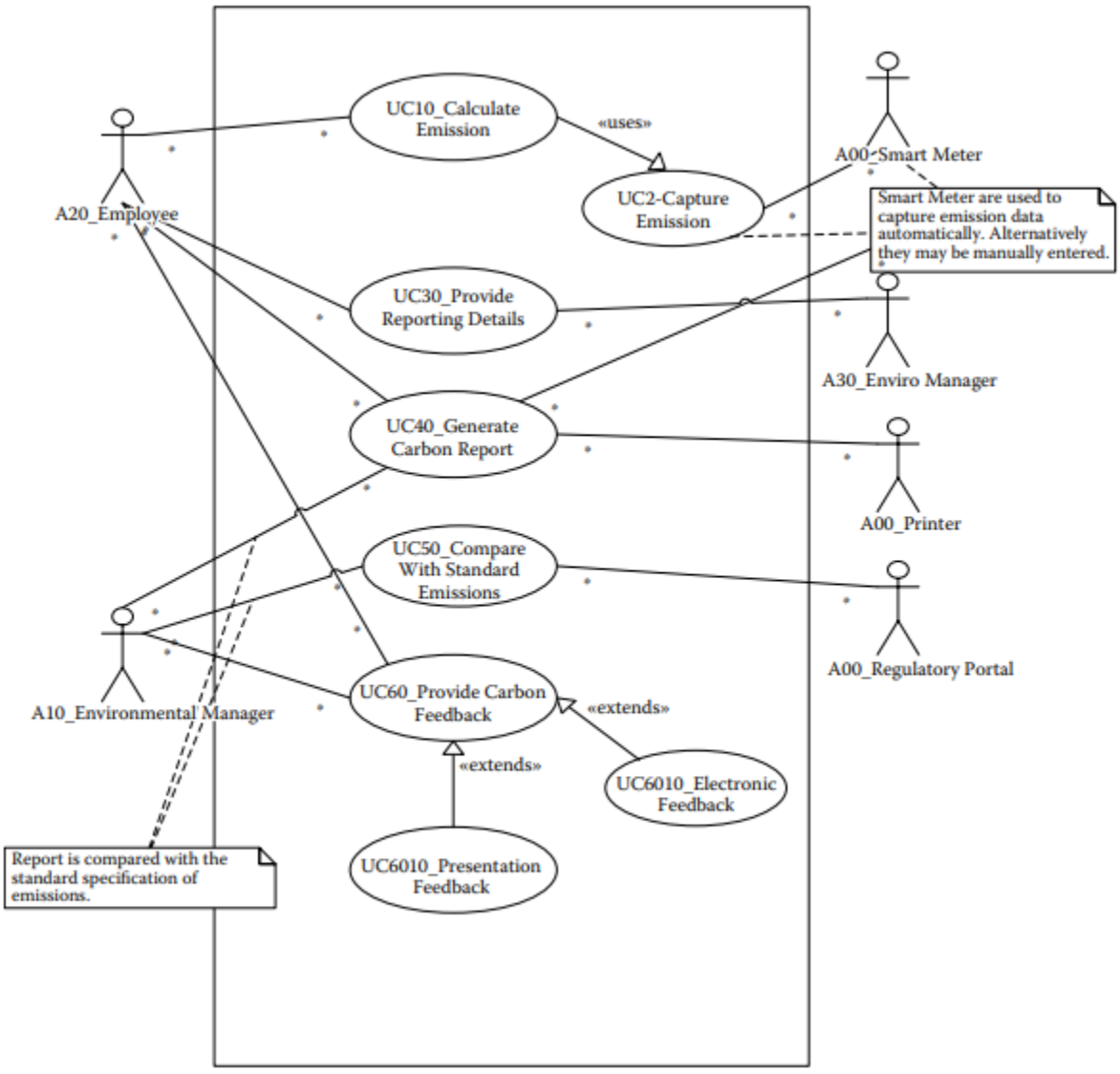



**Fig. Use case diagram for "green organizational portal."**

***Use case diagram for ROP:***

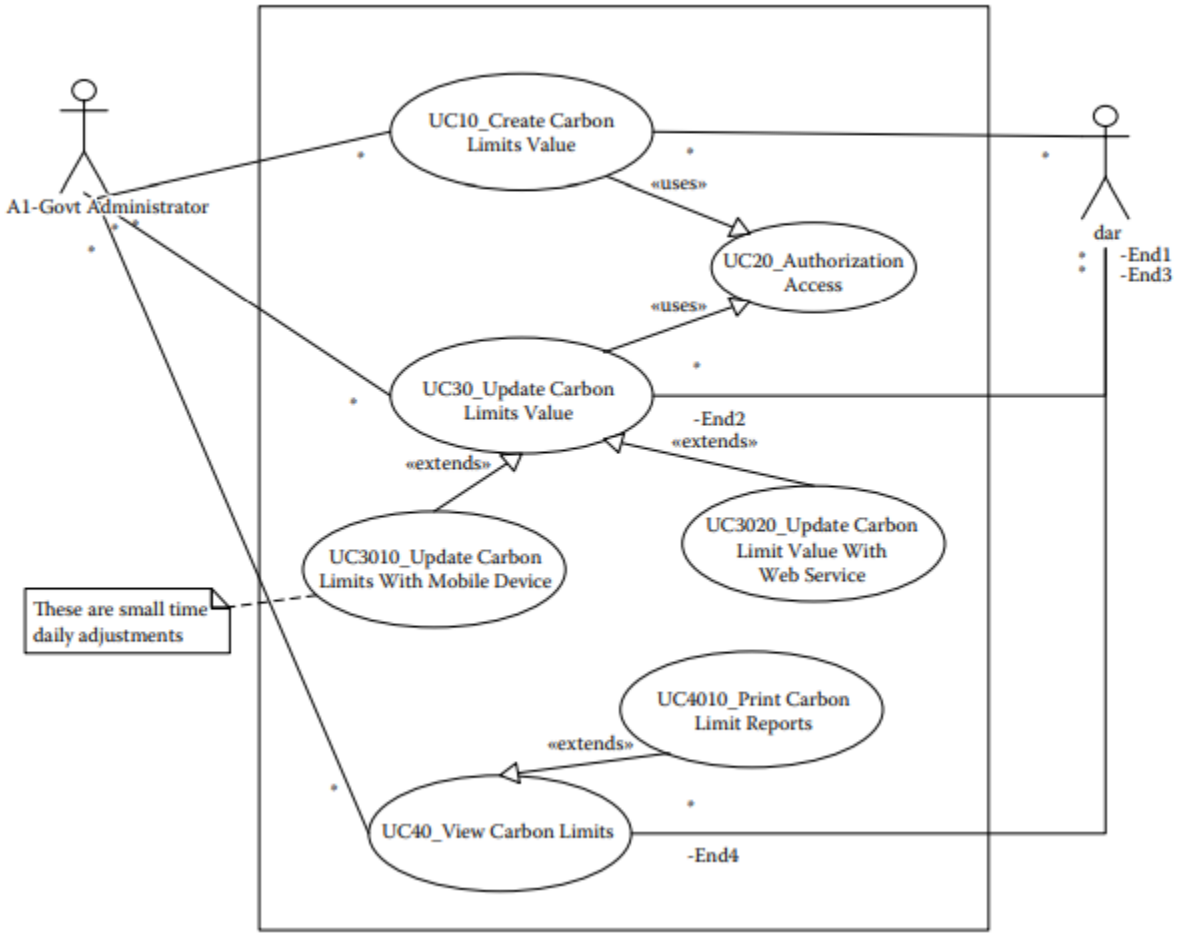
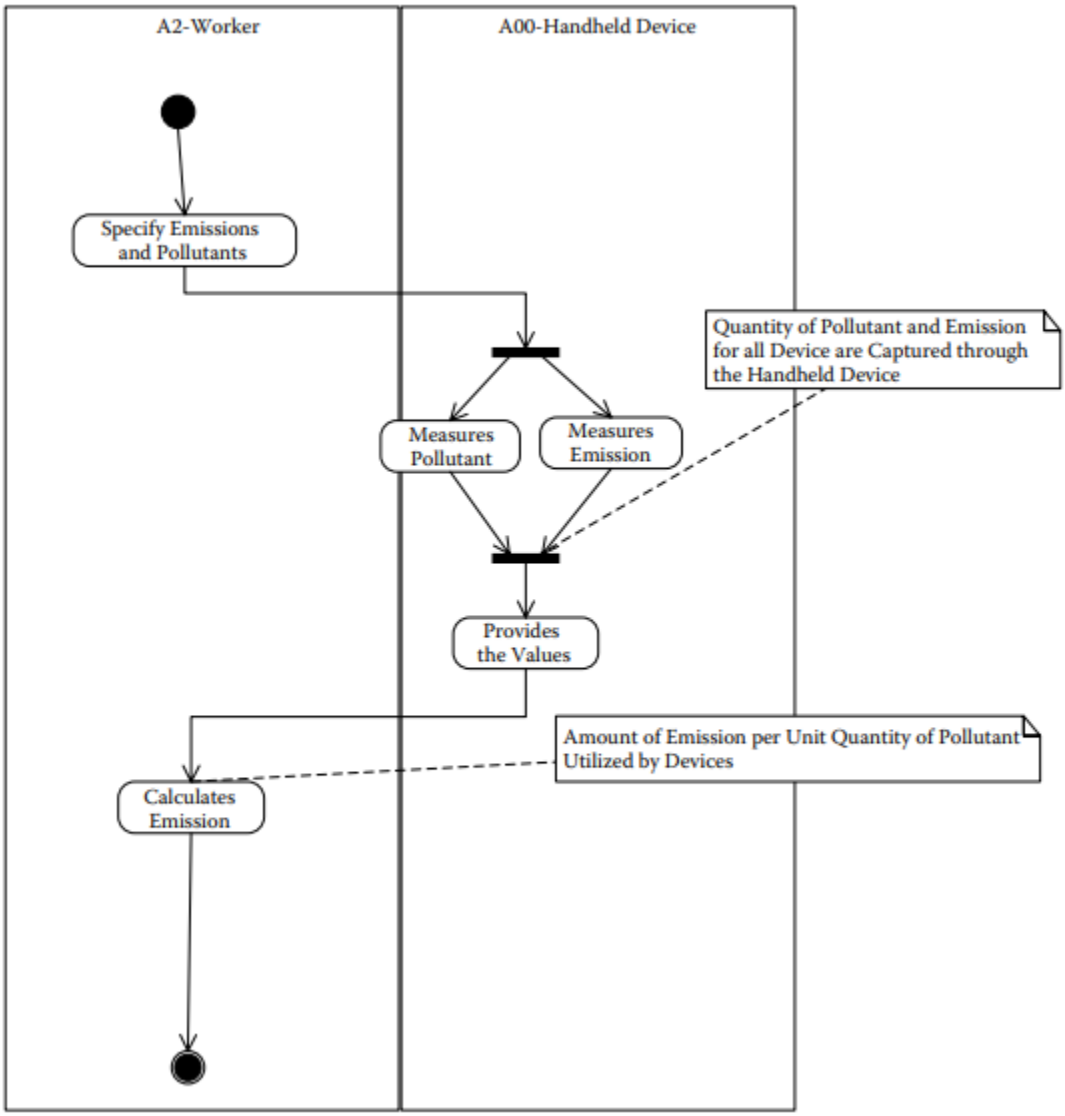
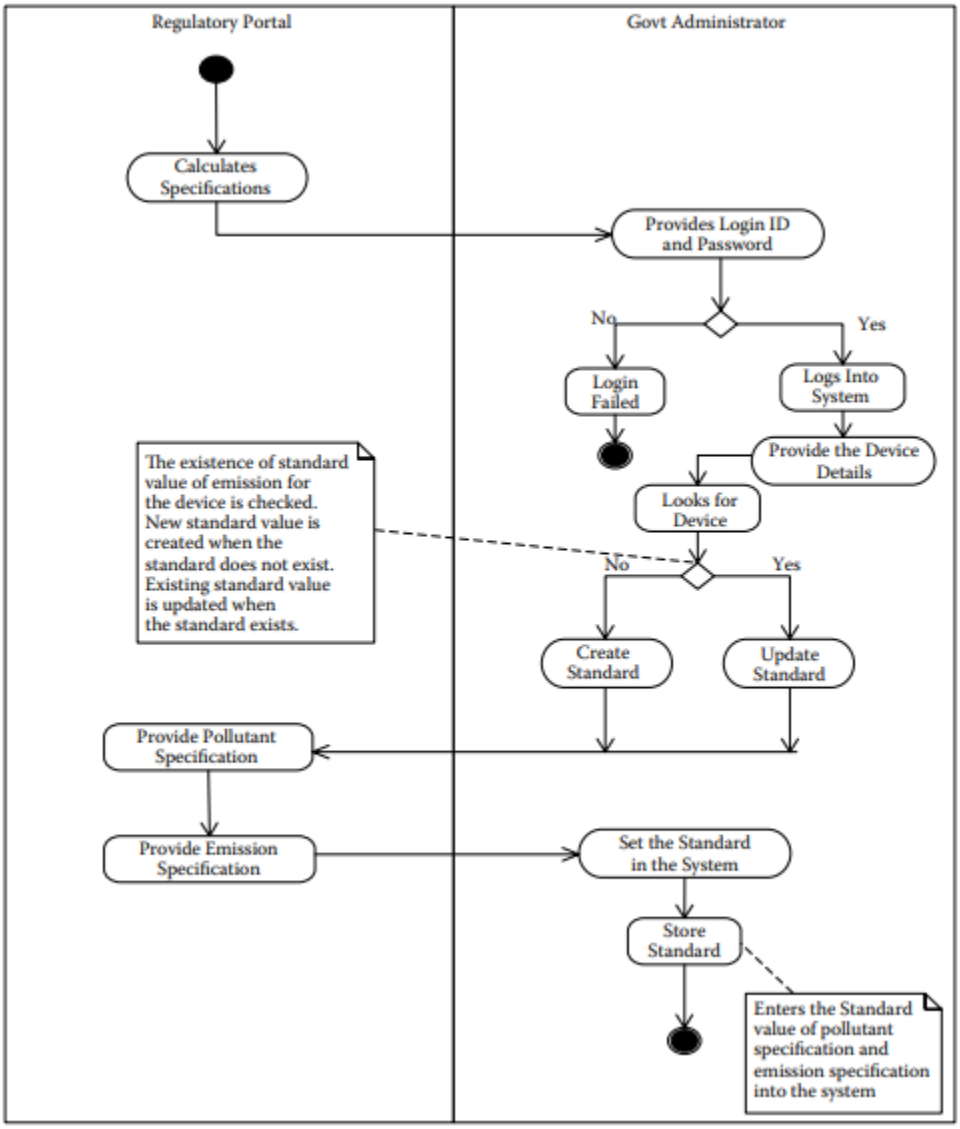



***Fig.*** **Use case diagram for "emissions benchmark maintenance (ROP)."**

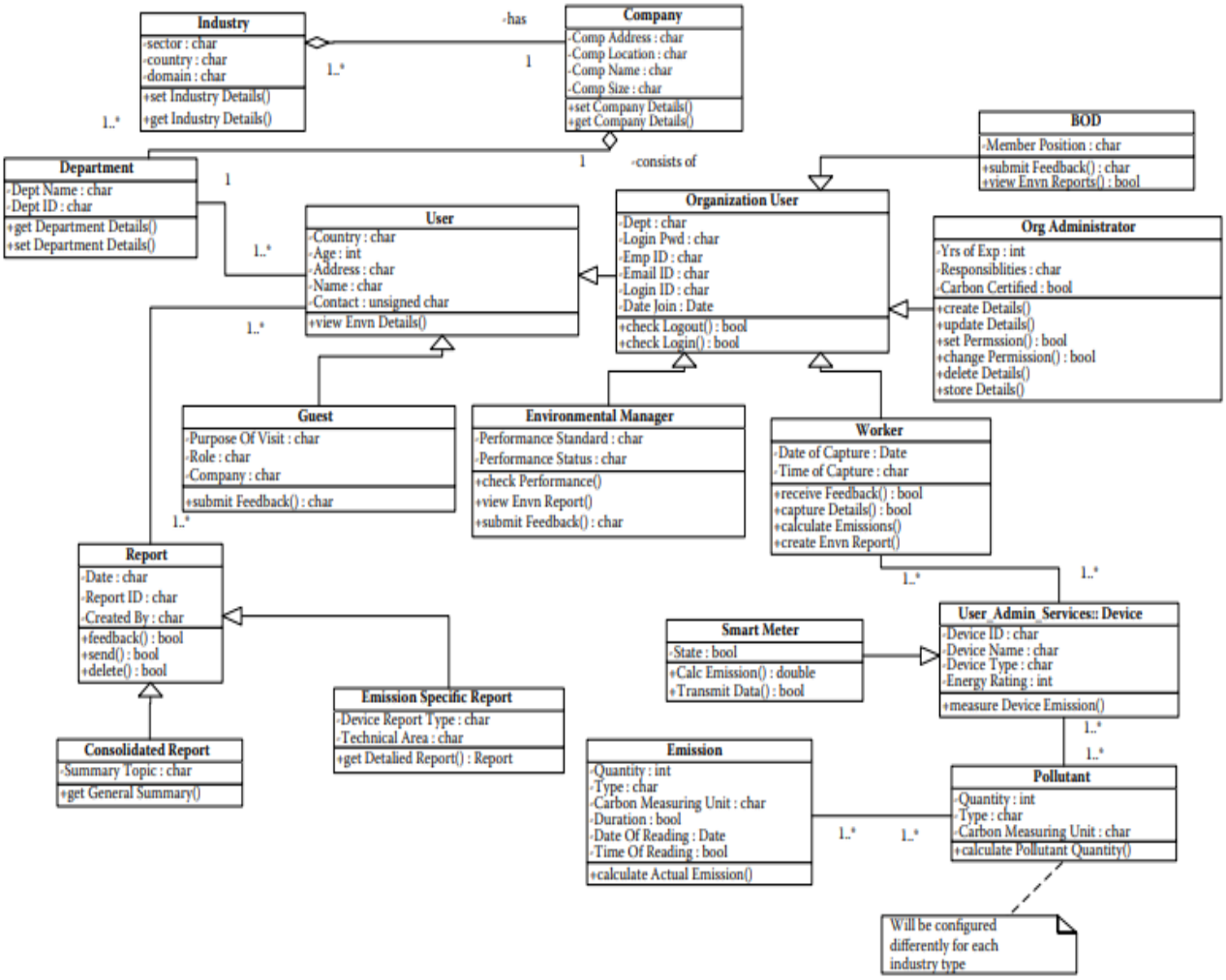
***The activity diagram for the use case "Calculate Emissions.":***



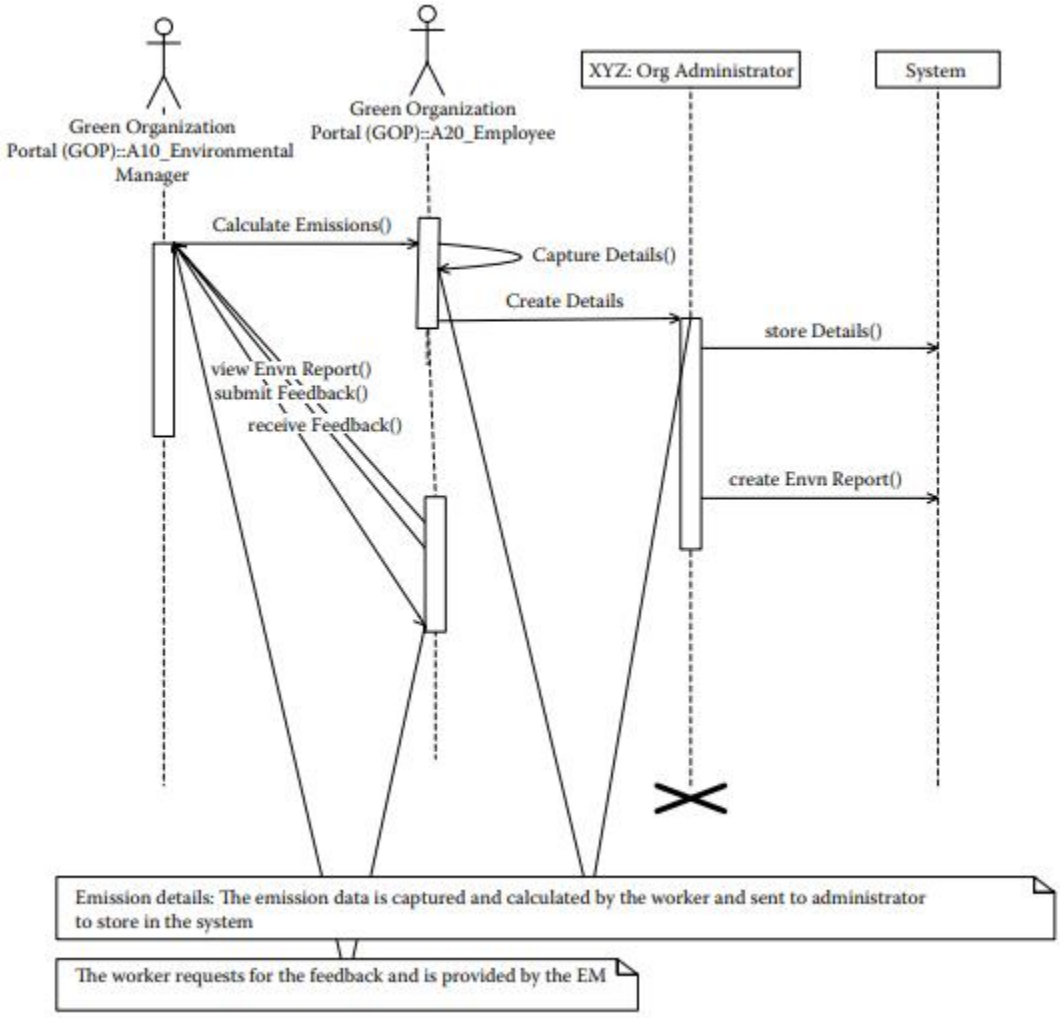
***Activity diagram for maintaining emission standards:***



***Class Diagram for GOP:***



***Sequence Diagram for "Emissions Check"***



## UNIT II

## GREEN ASSETS AND MODELING

***PART – A (2 MARKS)***

1. **Define Green assets?**

Anything that has social, environmental and or economic value that is owned by an individual, business, family or community. It includes intangible, non-physical assets, resources and rights.

2. **What are the three activities of Green assets?**
   - Establish (Procure)
   - Operate (Run)
   - Dispose (Demolish)
3. **Define Green Data Centers?**

A Green Data center or sustainable data center is a service facility which utilizes energy efficient technologies. They do not contain obsolete systems, and take advantage of newer more efficient technologies.

4. **Which are the key elements of Green Data Center?**
   - Minimizing the footprints of the buildings.
   - Sustainable landscaping.
   - Waste recycling.
   - The use of low-emission building materials carpets and paints.
   - The use of hybrid or electric company vehicles.
5. **Define Green Communication?**

Green Communication is the practice of selecting energy efficient communications and networking technologies and products, minimizing resource used whenever possible in all branches of communication.

6. **What is a mobile network in communication?**

Mobile communication networks are a type of telecommunications networks with a collection of terminals, entities and nodes connected to each other through links that enable telecommunication between the users of the terminals.

7. **Define Local Area Networks (LAN)?**

The local networks of the organization that are made uo of the physical connections among the machines and primarily the data center.

**8. Define WAN?**

The Wide Area Networks of an organization enables communication amongst its desktop and laptop machines with and beyond its data center.

**9. What is Green Business Process Management (GBPM)?**

Towards the sustainable enterprise consolidates the global state of the art knowledge about how business processes can be managed and improved in the light of sustainability objectives.

**10. Define green reengineering?**

A green reengineering framework is proposed that establishes a research agenda in the green. It improves business domain from the information systems, management perspective.

**11. Write some of the uses of reengineering?**

- Business process reengineering improves quality by reducing the fragmentation of work and establishing clear ownership of processes.
- The workers gain responsibility to their output and can measure their performance based on prompt feedback.

**12. What are the categories of green processes?**

- Individual
- Organizational
- Collaborative

**13. Define functional requirements?**

Functional requirements define the basic system behavior, essentially, they are what the system does or must not do, and can be thought of in terms of how the system responds to inputs.

**14. Define enterprise?**

An enterprise is a high-level, strategic view of the organization and “architecture” implies a structural frame for the analysis, planning and development of resources.

**15. List the categories of requirements?**

i. Green Business Architecture
ii. Green Information Architecture

iii. Green solution Architecture

iv. Green Enterprise Architecture

**16. Define environmental intelligence?**

Environmental intelligence is a system through which information about a particular region or process is collected for the benefit of decision makers through the use of more than one inter-related source.

**17. Define mobility?**

Mobility can play a vital role for the sustainability of a business and sustainable business provides impetus for economic growth as well.

**18. What are the technical areas for EI?**

i. Data warehouse.

ii. Business Analytics.

iii. Business performance management.

iv. User interface.

**19. Define Generic green information system (GIS)?**

GIS is a system that is dedicated to management of carbon data. Therefore a GIS forms the basics for measuring. Monitoring and reporting on the carbon data of the organization.

**20. What are the major phases of GIS?**

- Develop.
- Configure.
- Use.

**21. What are the types of GIS subsystems?**

i. Green Organizational Portal (GOP).

ii. Regulatory Standards Portal (RSP).

**22. Define GOP and RSP?**

Regulatory portal provides the standard emission value determined by the regulatory body for each emission type based on the industry and company.

Organizational portal focuses on the capture of emission data and its comparison with the emission standards.

## UNIT II

## GREEN ASSETS AND MODELING

***PART – B (16 MARKS)***

1. Explain in detail about Green Assets, Buildings and Facility management?
2. Discuss in detail about Green assets?
3. Write in detail about green data centers?
4. Explain about Green Enterprise Architecture (GEA) and Green Solution Architecture (GSA)?
5. Briefly explain about Environmental Intelligence Domain (EI Domain)?
6. Explain in detail about
    i. EI Domain.
    ii. Complexities.
    iii. Web services.
    iv. EI Mobility.
7. Describe the Green Supply Chain Management (SCM)?
8. Explain in detail about Green Information System (GIS)?
9. Briefly explain about GIS phases, Requirements design, Implementation and Testing?
10. Discuss the Green information System Requirements?
11. Explain in detail about GIS package Diagrams and system scope?
12. Discuss in detail about Green Organization Portal (GOP) and Regulatory Standard Portal (RSP)?

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# UNIT III

# GRID FRAMEWORK

***Syllabus***

Virtualization of IT systems – Role of electric utilities, Telecommuting, teleconferencing and teleporting – Materials recycling – Best ways for Green PC – Green Data center – Green Grid framework.

## 3.1 VIRTUALIZATION OF IT SYSTEMS:

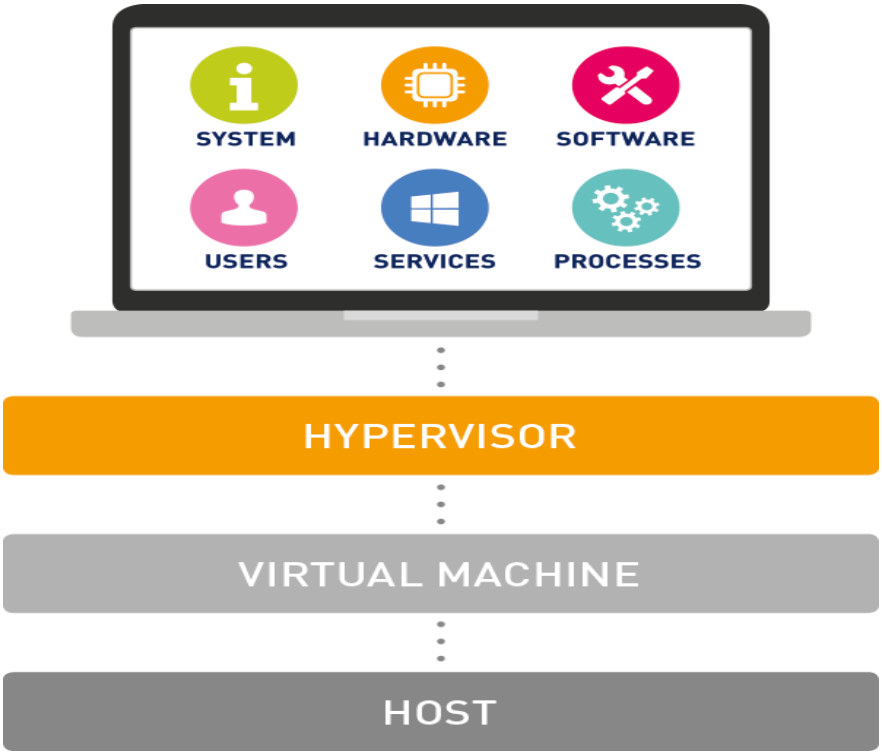
The term Virtualization is described as the decoupling of a service request or system resource from the underlying physical infrastructure that powers the service. It is the science of emulating a hardware functionality within a software system – creating a virtual version of a physical systems such as hardware platforms, storage and network resources. The hardware resources are logically distributed between software applications that can consume the computing power in virtual infrastructure environments without having to depend on the physical hardware components. As a result, virtualization lets organizations operate hundreds of servers in the same way they operate a few server machines.

**Virtualization architecture:**

A virtualization architecture is a conceptual model specifying the arrangement and interrelationships of the particular components involved in delivering a virtual -- rather than physical -- version of something, such as an operating system (OS), a server, a storage device or network resources.

Virtualization is commonly hypervisor-based. The hypervisor isolates operating systems and applications from the underlying computer hardware so the host machine can run multiple virtual machines (VM) as guests that share the system's physical compute resources, such as processor cycles, memory space, network bandwidth and so on. A type 2 hypervisor, also known as a hosted hypervisor, is installed on top of the host operating system, rather than sitting directly on top of the hardware as the type 1 hypervisor does. Each guest OS or VM runs

above the hypervisor. The convenience of a known host OS can ease system configuration and management tasks.




**Benefits of Virtualization:**

- Server Consolidation
- Energy consumption
- Better availability
- Disaster recovery

**Important Goals to Follow:**

- Optimize the power consumption of physical servers, while maintaining the Qos.
- To treat power as a constraint via server power budgets.

**The concepts of Consolidation and Virtualization:**

- Leveraging existing IT Assets like Servers, Storage and Network resources.
- Increasing the efficiency of IT Professionals through centralized simplified management.

- Improving Availability and Ensuring Business Continuity.
- Defeat Data Center sprawl and Infrastructure underutilization.

**Server Consolidation**:

Server Consolidation is an approach to the efficient usage of computer server resources in order to reduce the total number of servers or server locations that an organization requires. Server consolidation is exactly what it sounds like; it's essentially consolidating hardware for more effective usage.

Consolidating resources offers several benefits, such as:

- Decrease in cooling and electrical costs
- Reduction in server load growth and data center expansion
- Reduction in warranty and licensing costs
- Purchasing power of commodity hardware as opposed to specialized hardware
- Business agility with the ability to leverage cloud and shared infrastructure

**Storage Consolidation:**

Storage Consolidation**,** also called storage convergence is a method of centralizing data storage among multiple servers. The objective is to facilitate data backup and archiving for all subscribers in an enterprise, while minimizing the time required to access and store data. Other desirable features include simplification of the storage infrastructure, centralized and efficient management, optimized resource utilization, and low operating cost.

**Server Virtualization:**

Server Virtualization is the portioning of a physical server into smaller virtual servers. In server virtualization the resources of the server itself are hidden, or masked, from users, and software is used to divide the physical server into multiple virtual environments, called virtual or private servers. One common usage of this technology is in webservers. Virtual Web Servers are a popular way of providing low-cost web hosting services. Instead of requiring a separate computer for each server, dozens of virtual servers can co-reside on the same computer.

**Storage Virtualization:**

Storage Virtualization is the amalgamation of multiple network storage devices into what appears to be a single storage unit. Storage virtualization is often used in Storage Area Network (SAN), a high speed sub network of shared storage devices. The management of storage devices can be tedious and time-consuming. Storage Virtualization helps the storage administrator perform the tasks of backup, archiving, and recovery more easily, and in less time, by disguising the actual complexity of the SAN. Users can implement virtualization with software applications or by using hardware and software hybrid appliances. The technology can be placed on different levels of a storage area network.

**Virtualization to Promote Green Computing:**

A data center consumes the power that can otherwise be used to power thousands of homes, that huge level of power consumption is what makes data center and environmentalists look for ways to reduce power usage and make data centers for more energy-efficient than they currently are. Virtualization is the answer to resolving the power consumption of data centers. 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. 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%.

**3.2 ROLE OF ELECTRIC UTILITIES:**

Energy corporations, especially electric utilities, have an interesting role in the establishment of green data centers. On one hand electric utilities are for profit, corporations

that make money by selling electricity, so the more electricity they sell, the more the profit they make. On the other hand, electric utilities have a significant interest in avoiding having to build new electric power plants to meet peak demand. New power plants are extremely expensive and the strict emission controls for coal fired plants greatly add to the expense. New nuclear power plants face even more hurdles, as global economy evolves from heavy dependence on oil to a mixture of energy alternatives, the marketplace will push for new alternatives in the supply and demand of energy. Electric utilities are in position to have a significant role in motivating companies to move to green IT.

**The significant Role of Electric Utilities and IT Energy Ratings in Green IT:**

Electric utilities and governments now often offer financial incentives to encourage investments in energy-efficiency measures. As the largest portion of the cost of generating electricity is in plant expenditures, it is actually good business if utilities use existing facilities more efficiently while reducing wasteful demand. Providing electricity for energy efficient equipment as opposed to planning capacity for inefficient equipment can be a win-win situation for both electric utilities and their customers. Such financial incentives for commercial and individual energy consumers help buy down the additional cost of more-efficient products.

Tips on qualifying for incentives and maximizing the advantage you get from them follow:

1. ***Find available programs***: The first step is to contact your electrical utility or state energy efficiency program to determine what energy efficiency incentives might be available for IT consolidation or data center energy efficiency improvement projects. You can also check the Database of State Incentives for Renewables & Efficiency (DSIRE). This comprehensive source includes information on state, local, utility, and federal incentives that promote renewable energy and energy efficiency.
2. ***Assess Energy Usage:*** Many organizations see only a monthly power bill of their total consumption. Consequently, those in charge rarely see the impact of their equipment decisions and cannot prove their changes saved energy. In order you need to determine the power usage for the total data center or the systems or hardware you target to improve. The best measurements include both peak and seasonal events to better comprehend the energy provisioning required.

3. ***Take advantage of project design and energy-efficiency teams:*** Many energy-efficiency groups can provide project support to help maximize energy efficiency gains, cost savings and incentives. Partnering with your utility can help ensure you meet all the program requirements.
4. ***Calculate energy savings:*** You probably need to provide a direct measurement of your power usage before and after your project is implemented or perform other required calculations of the energy saving benefits. Your utility or efficiency program can help you with this requirement.
5. ***Submit incentive or rebate payment application:*** Programs generally require proof that changes have been done and energy is being saved. You can reap additional goodwill benefits from your project by publicizing your energy efficiency efforts.

**Power Company Incentives for Companies to Go Green:**

Companies in every industry from non-profits to consumer goods are paying much closer attention to their power bills, as the amount spent on data center power has doubled in the past six years. Data centers can use up to 100 times more energy per square foot than office buildings. A group of government and industry leaders is trying to set a clear standard for what constitutes a green computer. IT vendors are responding to the call for energy conservation, making energy efficiency central to their sales pitches and routing ecofriendly policies such as carbon-neutral computing.

**Energy-Efficiency Ratings for IT:**

Energy utilities need to base their rebates on proven, measurable ways to save energy in the data center. Tools such as IBM's Active Energy Manager can monitor and manage the use of energy in the data center. Guidelines such as EPEAT tool are starting to provide those energy ratings for the data center.

**3.3 TELECOMMUTING, TELECONFERENCING AND TELEPORTING:**

**3.3.1 Telecommuting:**

Among the many, many benefits of working at home, helping the environment is at the top of the list. Here are some of the ways in which telecommuting is eco-friendly.

i. **It reduces carbon emissions:** Whether it's by planes, trains or automobiles, traveling in to work has a negative impact on the environment. By cutting the commute, you'll

prevent an excessive amount of carbon emissions to go into the air. To see how much telecommuting helps the environment, you can use this calculator.

ii. **It reduces electricity**: When you work in an office, almost everything is powered by electricity. From lights to computers and printers—even the coffee machine—everything consumes large quantities of electricity. Working at home allows you reduce your electricity consumption to what it really takes to make your home office run.

iii. **It reduces paper printing:** At the office, you wouldn't think twice about printing that 60-page report—single-sided, too. At home, you know better. When you work at home, you only print what you truly need, saving trees—and unnecessary waste—in the process.

iv. **It makes you take better care of your equipment:** Think about how often you actually shut down your computer at work. When you work at home, you shut it down after the end of each work day. Not only does this save energy, but it also increases its lifespan. Taking better care of your computer and other office items allows them to last longer—and prevents them from potentially ending up in a landfill.

**3.3.2 Teleconferencing:**

Teleconferencing and telepresence technologies are often implemented in green computing initiatives.

The advantages are many:

- It increases worker satisfaction.
- Reduction of Green House Gas Emissions.
- Increased Profits Margins.

The average annual energy consumption for U.S office buildings is over 23 kilowatt hours per square foot, with heat, air conditioning and lighting accounting for 70% of all energy consumed. Other related initiatives, such as hoteling, reduce the square footage per employee as workers reserve space only when they need it. Many types of jobs, such as sales, consulting, and field service, integrate well with this technique.

Traveling to meetings and conferences takes its toll on the environment in many ways.

- Flying or driving and staying in hotels uses lots of energy, which inevitably generates carbon dioxide that contributes to climate change plus air pollutants that lead to smog.
- In-person meetings are often littered with excessive paper documents, plastic bottles of water, and refreshments served on paper and plastic that can't be recycled.

- Food waste is another big issue; most conference organizers order much more food than can be consumed by the attendees. When the meeting is over, those extra food usually end up in the trash.


**5 Ways Video Conferencing Protects the Environment:**

- **Save Energy** – According to a report commissioned by the Carbon Disclosure Project (CDP) and sponsored by AT&T, video conferencing can avoid millions of metric tons of carbon dioxide emissions.
- **Reduce Paper, Printer Ink and Toner** — Reducing paper consumption is another significant bonus. Rather than print out paper documents for each in-person attendee, agendas, memos, reports, edits and recommendations can be shared digitally, eliminating the need for any paper at all. Every piece of paper you don't use is not only money saved, notes the Natural Resources Defense Council, but also energy and effort saved.
- **Skip Plastic –** Most conferences make sure all attendees have an unlimited supply of bottled water. But what happens to all those throwaway bottles when the conference is over? When you're sitting in on a teleconference, you're more likely to use a water glass or reusable mug.
- **Limit Food Waste –** Most conferences end up providing two or three meals per day, plus snacks and a cocktail hour of some sort. Ideally, the leftovers would be

picked up by a soup kitchen or food bank. More often, they're just thrown away. If you're sitting in on a teleconference at your desk at home or in the office, you're probably eating what you'd normally have, and wrapping up the leftovers for the next day.

- **Save Time and Increase Flexibility –** One big benefit of video conferencing that has less to do with the environment than with overall quality of life is that it saves so much time.

**3.3.3 Teleporting:**

Virtual reality systems typically allow users to physically walk and turn, but virtual environments (VEs) often exceed the available walking space. Teleporting has become a common user interface, whereby the user aims a laser pointer to indicate the desired location, and sometimes orientation, in the VE before being transported without self-motion cues.

**3.4 MATERIALS RECYCLING:**

Recycling is one of the most significant green practices that contribute to green computing. Recycling falls in the green disposal category of green computing. The end-of-life products constitute various types of raw materials including metals and other elements that can be recycled and put to reuse again. This is one of the most efficient ways to combat e-waste problem. Also, recycling helps in bringing down the greenhouse gas emissions caused by the manufacturing of new products.

**Categories of e-waste:**

- Large Household Appliances *(Washing machines, Dryers, Refrigerators, Airconditioners, etc.)*
- Small Household *Appliances (Vacuum cleaners, Coffee Machines, Irons, Toasters, etc Office, Information & Communication Equipment PCs, Latops, Mobiles, Telephones, Fax Machines, Copiers, Printers etc.)*
- Entertainment & Consumer Electronics *(Televisions, VCR/DVD/CD players, Hi-Fi sets, Radios, etc)*
- Lighting Equipment Fluorescent tubes, sodium lamps etc. (Except: Bulbs, Halogen Bulbs)

- Electric and Electronic Tools Drills, Electric saws, Sewing Machines, Lawn Mowers etc. (Except: large stationary tools/machines)
- Medical Instruments and Equipment
- Surveillance and Control Equipment
- Automatic Issuing Machines

**State-of-the-art Recycling Technologies:**

The state-of-the-art recycling of e-waste comprises three steps

**Detoxication:**

The first step in the recycling process is the removal of critical components from the e-waste in order to avoid dilution of and / or contamination with toxic substances during the downstream processes. Critical components include, e.g., lead glass from CRT screens, CFC gases from refrigerators, light bulbs and batteries.

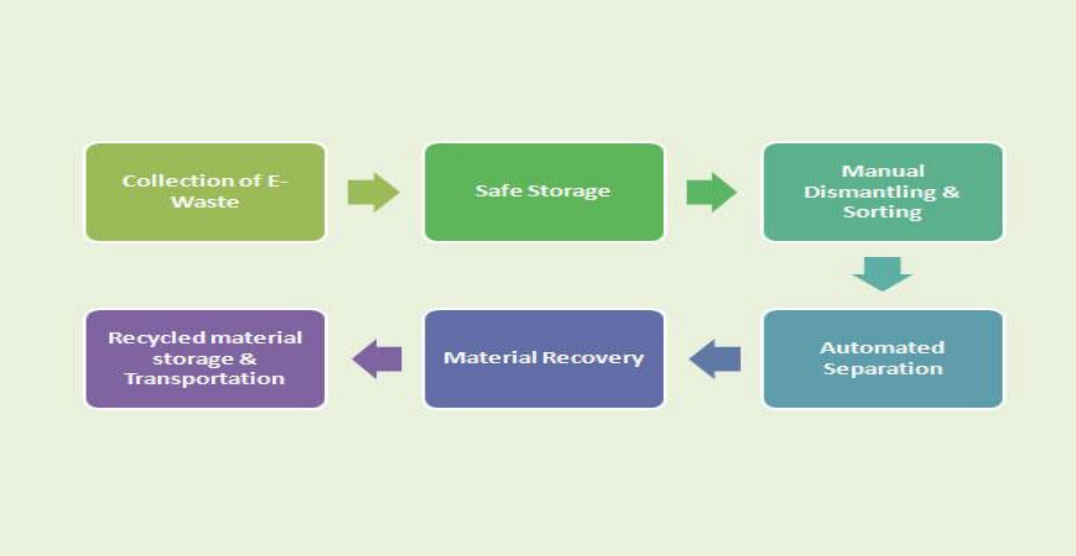
**Shredding:**

Mechanical processing is the next step in e-waste treatment, normally an industrial large scale operation to obtain concentrates of recyclable materials in a dedicated fraction and also to further separate hazardous materials**.**

**Refining:**

The third step of e-waste recycling is refining. Refining of resources in e-waste is possible and the technical solutions exist to get back raw with minimal environmental impact. Most of the fractions need to be refined or conditioned in order to be sold as secondary raw materials or to be disposed of in a final disposal site, respectively. During the refining process, to three flows of materials is paid attention: Metals, plastics and glass.

**E-waste Management – Six Steps**




**Benefits of recycling:**

Recycling raw materials from end-of-life electronics is the most effective solution to the growing e-waste problem. Most electronic devices contain a variety of materials, including metals that can be recovered for future uses. By dismantling and providing reuse possibilities, intact natural resources are conserved and air and water pollution caused by hazardous disposal is avoided. Additionally, recycling reduces the amount of greenhouse gas emissions caused by the manufacturing of new products.

**3.5 BEST WAYS FOR GREEN PC:**

With today's powerful systems, not to mention the myriads of peripheral devices, the home office is an area of the house where energy is wasted and lost. If you're interested in ways to reduce your power consumption, here are ways you can go "green" at home:

- **Look for the ENERGY STAR**
  Consider energy efficiency when shopping for new equipment by looking for products with an ENERGY STAR.
- **Turn Off Your Monitor**
  Your monitor uses a lot of power, so put it in standby or turn it off when not in use.
- **Adjust the Brightness**
  the brightest setting on a monitor consumes twice the power used by the dimmest setting.
- **Don't Use a Screen Saver**
  Screen savers consume power and are unnecessary. Instead set your monitor to go blank or dim when not in use.

- **Turn Off Peripherals**

  when you don't need your speakers, scanner, and other add-ons, turn them off.

- **Leave Your Printer Off**

  A printer draws a lot of power, so leave it off until you need it. Also make sure its power settings include a standby mode that consumes less energy when on.

- **Preview Before You Print**

  Select and print only the content you need. Omit unneeded pages from the printing job.

- **Print on Both Sides**

  Another way to reduce the amount of paper you use is to print multiple pages on a single sheet.

- **Don't Print**

  Ask yourself if printing is necessary. Do you really need a hard copy or can you just read the e-mail, document, or Web page on screen?

- Buy the new "Smart Strip" power strip. The Smart Strip actually senses how much power your computer peripherals use. And when the Smart Strip senses that you've turned your computer off, it automatically shuts off your peripherals, too, preventing them from drawing an idle current, which is the current drawn even after equipment is shut off.

## 3.6 GREEN DATA CENTER:

The ever increasing digitization of modern life has resulted in the increased deployment of data centre facilities. Data centres are complex ecosystems that interconnect elements of the information and communication technology (ICT), electrical and mechanical fields of engineering, and, as identified within the much cited Global e-Sustainability Initiative, they represent the fastest growing contributor to the ICT sector's overall carbon footprint.

### 3.6.1 Data Centre IT Infrastructure:

In an efficient modern green data centre there are two layers of infrastructure:

- The IT infrastructure and
- Facilities infrastructure.

By IT infrastructure, we mean the server technology, networking systems and storage provided within a typical data centre.

The key elements of IT infrastructure of a data centre,

• Server design and server systems development in support of efficient data centre service provision and the range of service function.

- The role of networking within a data centre
- The role of storage and the types of storage provision.
- The changing shapes of data centre IT platforms through system innovation.

**3.6.1.1. Servers:**

IT servers take many forms and provide many different services and functions, but the fundamental goal is the same: They provide a service as part of a bipartite communication between a client and a server. A server may be a software program connected locally on the same hardware machine, or remotely via networking infrastructure.

**3.6.1.1a Rack-Mounted Servers:**

Rack-mounted servers come in two sizes, 19 or 23 in., though the smaller of the two is the standard. Fitting a racked server into a standard-width cabinet is a fairly straightforward procedure, with the machine housing providing predrilled ears that align precisely with the vertical posts of the rack cabinet. Racked servers are self-contained individual machines with power and network cabling for each unit.

**3.6.1.1b Blade Servers:**

Racked servers are self-contained individual machines with power and network cabling for each unit. Blades are housed within a blade system container, which is mounted in a standard cabinet. The blade system provides the power and networking for all the blades housed within the system. Onboard cooling and uninterruptible power supply (UPS) requirements may also be provided by the blade cabinet system.

**3.6.1.1c Containers:**

The next logical step in server configuration design for data centres was the self-contained data centre module. Shipped inside a standard-sized transport container, of the type used for shipping goods overseas or via heavy-goods vehicles, container-based data centres provide an off-the-shelf solution to data centre needs. Designed to be self-contained, their energy and connectivity requirements are known upfront. The data centre customer need only hook up the required power and network cabling capacity to have a fully functioning data centre.

**3.6.1.2 Networking:**

The gateway machine of a data centre will sit at the entrance to the data centre. Its primary function is protocol translation in and out of the data centre, acting as the connection point between the data centre's internal local area network (LAN) and the wide area network (WAN) outside of the data centre – in most cases, the Internet Service Provider's network.

**3.6.1.3 Storage:**

Data storage is a critical element of data centre design. A number of options exist, each of which caters to the requirements of other elements in the overall IT infrastructure choices made. The key differentiator in storage type lies in the way the client machinee – in our case, the data centre server – logically sees the storage medium. This will play a part in how the server manages the space and the access protocols available for accessing the data stored.

**3.6.1.4 IT Platform Innovation:**

Physical hardware computing is only half the story of data centre design. As with physical servers, networking and storage design, innovations in software platforms and OS virtualization have resulted in the ability to modularize systems into separate servers (as services) at the software level. This advance enables efficiencies in infrastructure provision due to the separation of concerns between hardware resources and virtualized software provision.

a) **Server Farm (Cluster):** Cluster computing is characterized by multiple, physically discrete machines, closely linked to provide the logical interface of a single machine. Often associated with the parallelization of processing algorithms, cluster computing requires dedicated and highly specialized middleware to form the complex message-passing infrastructure required to manage the cluster's physical resources.

b) **Grid Computing:** The core aim of grid computing was to integrate disparate resources across organizational domains into what became termed virtual organizations. For example, a database server in one domain may be integrated with a networked cluster in another domain, to form a powerful data analytics platform.

c) **Service Orientation:** Service-oriented architecture (SOA), of which Web service is one instantiation, promotes a separation of concerns between service implementation (software) and service hosting (server hardware). It is a means of providing both data and processing resources over a network that decouples the service instantiation from a machine-readable service interface.

d) **Virtualization:** virtualized system enables a single hardware machine running a single OS to host multiple virtual machines, which may or may not be running the same OS. This leads to a single host machine running multiple virtual machines. Virtualization presents the opportunity to scale the service provision within a data centre, make far more efficient use of hardware resources, reduce running costs and reduce energy consumption.

e) **Cloud Computing:** Cloud computing makes a separation of concerns between service, platform and infrastructure, with each of these layers being virtualized and provided as a service in itself. Networking is used to communicate between different service layers and the application services supported.

**IT Infrastructure Management:**

**Server Power:**

The traditional approach for data centre operators to meet SLAs has been through provisioning for peak demand, for not just daily peaks but also seasonal ones, and to top it off with a generous safety margin to allow for demand growth through the expected planning horizon of the deployed equipment.

**Server Power Management in the Data Centre:**

Power management represents a collection of IT processes and supporting technologies geared towards optimizing data centre performance against cost and structural constraints, for instance increasing the deployable number of servers per rack when racks are subject to power or thermal limits makes power consumption more predictable and easier to plan for. Server equipment represents the most energy-intensive portion in a data centre, and the server infrastructure constitutes a logical starting point for any comprehensive data centre power monitoring and control strategy.

The integration of server power monitoring and control technology with sophisticated IT processes allows reduction goal setting in data centre energy consumption, not just instantaneous power reduction. Of course, it is important that this integration be interoperable across equipment providers to accommodate the diversity of equipment in the data centre.

**3.7 GREEN GRID FRAMEWORK:**

The Green Grid Association is a non-profit, open industry consortium of information and communications technology (ICT) industry end users, policy makers, technology providers, facility architects, and utility companies that works to improve IT and data center resource efficiency around the world. The Green Grid offers the data center expertise that governments turn to for industry insight and counsel, bringing to bear the combined influence of a diverse body of ICT industry leaders. The consortium's vendor-neutral dynamic creates a rich, collaborative environment of peers, competitors and industry experts that work closely together to advance the organization's mission.

The Green Grid's mission is to drive accountable, effective, resource-efficient, end-to-end ICT ecosystems, by:

- Establishing metrics
- Driving an understanding of risk
- Proactively engaging governments to influence effective policy
- Providing frameworks for organizations to realize operational efficiency and maturity across the ICT infrastructure.

**What needs to change for Green Grid to happen?**

The grid will need to get a lot "smarter" and more flexible, say researchers in America. A carbon-free power network will have to handle instantaneous shifts in both electricity supply and demand. That will require major upgrades (read investments) in grid communications and computer-based control systems to make sure everything works together.

**What stands in the way of a green grid?**

The main obstacles will be cost and feasibility. Wind and solar only work when the sun shines or winds blow. So they need help from big batteries or power plants that stand by to run when needed. While batteries have fallen in price, they remain an expensive way to back up clean power. In addition, batteries have yet to be tested on a large scale on the grid. Still, a recent study by the University of California at Berkeley's Goldman School of Public Policy found that reaching 90% zero-carbon electricity by 2035 could be feasible and economic by using mostly solar, wind and batteries.

**What about the last 10%?**

Eliminating the last of the carbon from the grid will likely prove difficult and very expensive unless there is a technological breakthrough. Those could include advances in carbon capture and storage, small nuclear reactors and hydrogen.

**Other drawbacks and benefits, besides less carbon:**

Adding a lot of new communication technology to the grid could make it more vulnerable to cyber-attacks. Grid managers and utilities will need to take extra precautions to prevent bad actors from infiltrating critical infrastructure. Building a clean grid, however, could create a lot of new jobs. Workers would be needed to build and install solar and wind farms, string up power lines and design new control systems.

Metrics created and endorsed by The Green Grid include:

- Electronic Disposal Efficiency (EDE) - the percentage of decommissioned information technology electronics and electrical equipment that is disposed of through known responsible entities.
- Power Usage Effectiveness (PUE) - the ratio of total facilities energy to IT equipment energy.
- Data Center Infrastructure Efficiency (DCIE) - the ratio of IT equipment power to total facility power.
- Carbon Usage Effectiveness (CUE) - the product of the amount of carbon dioxide emitted per kilowatt hour (CEF) and the data center's annual PUE.
- Water Usage Effectiveness (WUE) - the ratio of the annual site water usage in liters to the IT equipment energy usage in kilowatt hours (Kwh).
- Data Center Productivity (DCP) - the quantity of useful information processing completed relative to the amount of some resource consumed in producing the work.

## UNIT: III

## GRID FRAMEWORK

**PART:A(*2 Marks*)**

1. **Define Virtualization?**

It is the science of emulating a hardware functionality within a software system – creating a virtual version of a physical systems such as hardware platforms, storage and network resources.

2. **What is the role of hypervisor?**

The hypervisor isolates operating systems and applications from the underlying computer hardware so the host machine can run multiple virtual machines (VM) as guests that share the system's physical compute resources, such as processor cycles, memory space, network bandwidth and so on.

3. **List out the benefits of Virtualization?**

- Server Consolidation
- Energy consumption
- Better availability
- Disaster recovery

4. **What are the basic concepts of consolidation and virtualization?**

- Leveraging existing IT Assets like Servers, Storage and Network resources.
- Increasing the efficiency of IT Professionals through centralized simplified management.
- Improving Availability and Ensuring Business Continuity.
- Defeat Data Center sprawl and Infrastructure underutilization.

5. **What are the benefits in consolidating servers?**

- Decrease in cooling and electrical costs
- Reduction in server load growth and data center expansion
- Reduction in warranty and licensing costs
- Purchasing power of commodity hardware as opposed to specialized hardware
- Business agility with the ability to leverage cloud and shared infrastructure

6. **List out the desirable features of storage consolidation?**

Simplification of the storage infrastructure, centralized and efficient management, optimized resource utilization, and low operating cost.

7. **What are the advantages of teleconferencing in promoting green environment?**
    - It increases worker satisfaction.
    - Reduction of Green House Gas Emissions.
    - Increased Profits Margins.
8. **Define the term recycling?**

Recycling is one of the most efficient ways to combat e-waste problem. Also, recycling helps in bringing down the greenhouse gas emissions caused by the manufacturing of new products.

9. **Define Green Data Center?**

Data centres are complex ecosystems that interconnect elements of the information and communication technology (ICT), electrical and mechanical fields of engineering, and, as identified within the much cited Global e-Sustainability Initiative, they represent the fastest growing contributor to the ICT sector's overall carbon footprint.

10. **List out the key elements of data center IT elements infrastructure?**

• Server design and server systems development in support of efficient data centre service provision and the range of service function.

• The role of networking within a data centre

• The role of storage and the types of storage provision.

• The changing shapes of data centre IT platforms through system innovation.

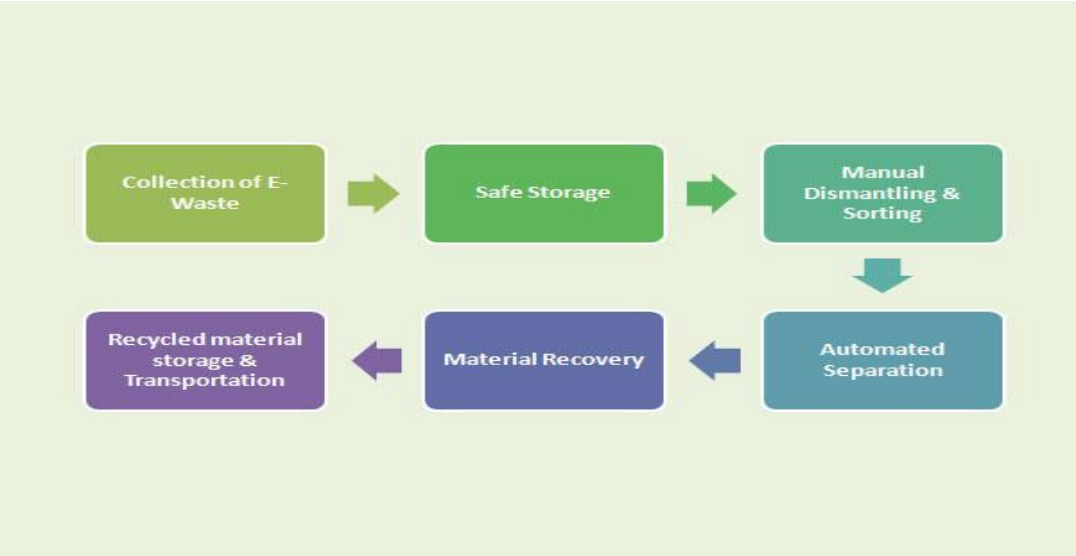
11. **What needs to change for Green Grid to happen?**

The grid will need to get a lot "smarter" and more flexible, say researchers in America. A carbon-free power network will have to handle instantaneous shifts in both electricity supply and demand. That will require major upgrades (read investments) in grid communications and computer-based control systems to make sure everything works together.

**12. Define the role of Grid Computing?**

The core aim of grid computing was to integrate disparate resources across organizational domains into what became termed virtual organizations. For example, a database server in one domain may be integrated with a networked cluster in another domain, to form a powerful data analytics platform.

**13. What are the six steps in recycling?**




- Automatic Issuing Machines

**14. State-of-the-art Recycling Technologies?**

The state-of-the-art recycling of e-waste comprises three steps

- Detoxication
- Shredding
- Refining

**15. What is the purpose of Smart Strip?**

The Smart Strip actually senses how much power your computer peripherals use. And when the Smart Strip senses that you've turned your computer off, it automatically shuts off your peripherals, too, preventing them from drawing an idle current, which is the current drawn even after equipment is shut off.

## UNIT: III

## GRID FRAMEWORK

**PART-B(*16 Marks*):**

1. Explain in detail about virtualizing of IT Systems?
2. Briefly explain the contribution of telecommuting, teleconferencing, and teleporting in conversion of Green IT?
3. Explain in Detail about material recycling?
4. Discuss the best ways to make your PC Greener?
5. Explain in detail about Green Grid framework?
6. Write in detail about the Green Data Centers?

******

# UNIT: 4

# GREEN COMPLIANCE

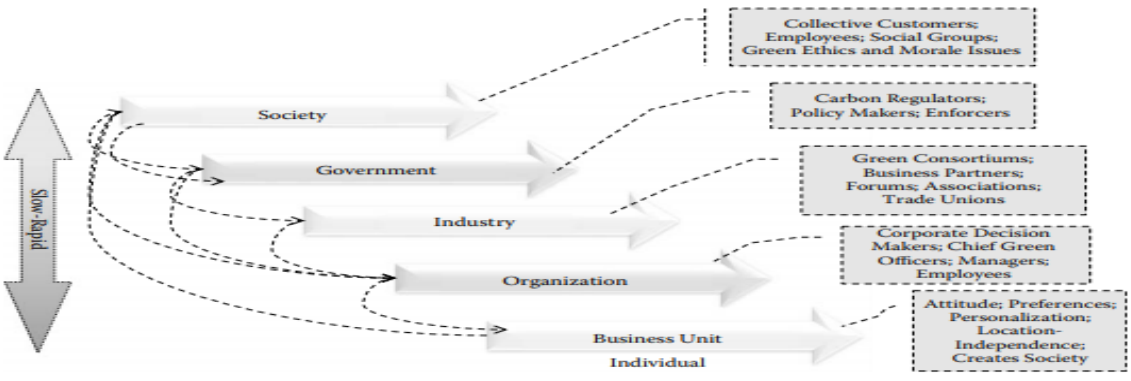
***Syllabus***

Socio-cultural aspects of Green IT – Green Enterprise Transformation Roadmap – Green Compliance: Protocols, Standards, and Audits – Emergent Carbon Issues: Technologies and Future.

## 4.1 INTRODUCTION:

Green IT comprises the important and subjective element of the green enterprise transformation. This discussion is vital in undertaking a holistic approach to transformation and therefore, is not limited to technologies and processes of an organization. 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 green attitude.

Green transformation of an entire society involves green ethics, morals, value systems, and attitude across multiple layers of people. This makes environmental changes for the society even more complicated than organizational and governmental changes. Thus, while a government can bring about changes through ratification of agreements and converting them into law, the changes in the society are based on protocols and understanding that is "in grown." Training and awareness associated with the Green IT issues can play a key role in handling the subjective nature of green transformation.



### 4.1.1 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, this interest leads a business to have what is popularly known as corporate social responsibility (CSR).

### 4.1.2 Learning Organization:

One of the ways an organization can successfully discharge its CSR is by incorporating Green IT in both the tacit (subjective) and explicit domains of the organization. Thus, to be environmentally and socially responsible, an organization requires regular and unified systems for knowledge management that lead it to be a learning organization. A knowledge management system will enable the department head to update the information in both formal, explicit form and also in a descriptive form.

### 4.1.3 Green Social Stake Holders:

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. Information flow between various groups of employees in different regions supported by the organizational change management is required for successful transition to a green organization.

The issues relating to 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. The greening of an enterprise thus continues to demonstrate substantial subjective element to it.

The following table highlights the differing viewpoints and impacts of some of the roles in the society. These same roles with their potentially different viewpoint also influence the roles within the organization.

| *Categories* | *Activities (Typical)* | *Green Viewpoint (Typical Examples)* |
|---|---|---|
| Children | Playing games<br>Being entertained<br>Being monitored | Carbon emission due to use of electronic gadgets, TV, and computers<br>Usage not controlled and financed by actual users |
| Adolescents | Games<br>Entertainment message Exchange (IM, Email) | Carbon emissions resulting from gaming gadgets<br>Increased electronic storage and use of Internet-based communications for group games |
| | Study activities (education) | Reduced outdoor activities<br>Reduced activities with paper and pen<br>Reduced readings from books and journals (and therefore, less visits to the library, for example)<br>Desirous of faster results |
| Adults | Social networks<br>Email/communications<br>Learning<br>Banking/finance<br>Work related<br>Search engines | Concerns about the environment from futuristic viewpoint (what will happen to my children and their children?)<br>Reduction in travel through—telecommuting<br>Capable of influencing policies and regulations |
| Elders | Increase in social networks<br>Health | Skepticism and inhibition in using IT |
| People with special needs | Online facilities<br>Communication<br>Search engines | Ease of movements<br>Hiring of experience |

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

### 4.1.4 Role Based View of Green IT:

The subjectivity of Green IT is seen in the various roles within an organization. For example, the decision maker is primarily interested in the ROI on the green initiatives, where an engineer is interested in improvement of design and production process. Green IT initiatives and their subjective interpretations are based on various roles. 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.

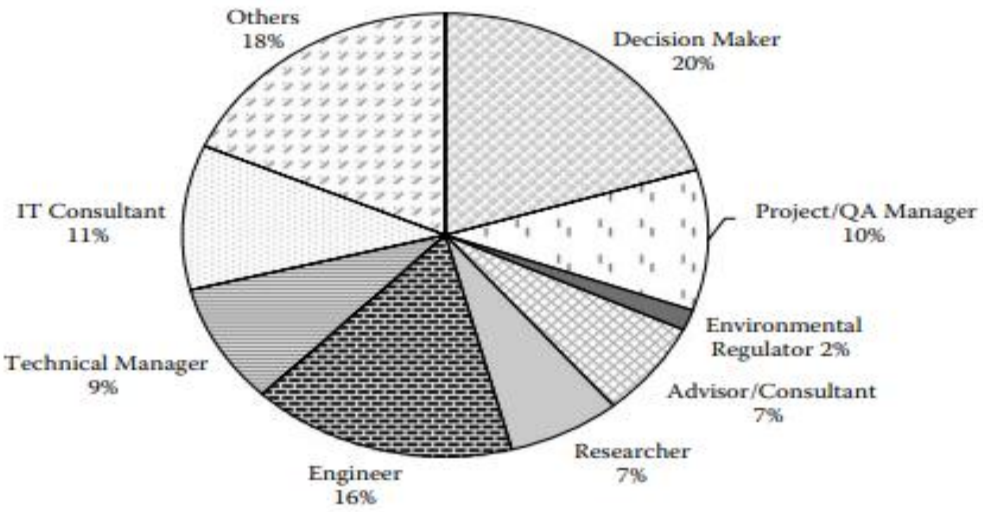



**Fig. Role-based view of Green IT.**

**Table : 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. |

### 4.1.5 Green Users Practices:

There are three major areas of changes to working lifestyles that are involved in a green enterprise transformation. These practices included videoconferencing, telecommuting/teleworking, fleet and field force management, web, and use of collaboration tools such as emails and mobile phones/PDAs, these practices in terms of their importance to carbon reduction. The percentage respondents who "agreed" and "strongly agreed" to the use of the approaches in reducing the carbon footprint of the organizations itself proves their tremendous importance in the green initiative. Another important user practice with respect to Green IT is the reengineering of business processes of an organization based on virtual team. The changes resulting from formation and operation of virtual teams require corresponding changes to the processes that describe the way in which business is carried out.

### 4.1.6 Green IT Ethics and Code of Conduct:

In discussing the social aspect of Green IT, it is worth delving into these ethical codes of conduct as they apply to Green IT. A Green IT code of conduct can augment and support the expectations and behaviors of individuals operating as employees and consulting professionals as well as the organizations that subscribe to that code of conduct.

***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 re duce 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.
- Ensure ongoing effort at all levels of IT—architecture, design, development, testing, deployment, and maintenance—of hardware, software, and networks—to re duce their carbon emission.
- Ensure ongoing 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.
- Maintain the security and privacy of carbon data.
- Promote public understanding of the issues related to carbon emissions particularly in the context of the industry sector in which the individual/organization operates.
- Honestly represent "skills, knowledge, service and product" relating to carbon.

### 4.1.7 Green Washing:

Green washing is where a firm spends time and money advertising and marketing that their goods or services are environmentally friendly when, in fact, they are not. In other words, green washing is the act of making false or misleading claims about the environmental benefits of a product, service, technology, etc.

### 4.1.8 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. Good communication will socialize and support employees and customers in understanding the reality of Green IT within the organization.

There are two major important areas of communication:

- Within the organization—between managers and employees.
- Outside of the organization—with the customers, partners, and regulators.

***Within the organization:***

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.

***Outside of the organization:***

Communicating outside of the organization has to be more formal. Regulations also dictate the format, frequency, and style of communication. Based on the easier discussion of web services, many of these external compliance and regulatory communications will be standardized and formatted electronically.

**4.1.9 Green IT Project—Channels of Communication**:

Communication can be through various channels in a Green IT transformation program. To start with, involvement of all stakeholders, the "buy-in" is crucial. 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 important parts of a transformation project need to be explained in the most clear and understandable way.

***Following are the categories of communication channels 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.
- **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).

### 4.1.10 Green HR and Changing Organizational Structures:

Organization's social changes resulting from Green IT initiative include changes to the skill set of individuals supporting the organizational systems and processes. This requires support from the green HR function of the organization in terms of understanding, positions, training, and rewarding the staff for their Green IT effort.

***The following shows the evolving role of the HR function with a green enterprise:***

A green HR has to engender change from the social perspectives (as against the technical or economic perspectives). This change is initially focused at an individual level with the organization. The departmental change deals with procedures and practices. The organizational change involves restructuring the hierarchy, creation of new green-specific role, and spelling out the reward structure for meeting green goals.


**Fig. Evolving Green HR**

In addition to working with organization in its green endeavor, the HR function itself needs to be organized from ground up. Figure shows the basis of such functional organization. The CGO (also referred to as CSO) remains at the helm, responsible for managing the transformation to a green enterprise. This is the strategic role that covers the length, breadth, and depth of Green IT strategies. The environmental manager forms the next tier in a green HR setup. They have a department level focus, and are dealing with metrics and measurement (compliance) issues. The environmental offices have a very practical, operational focus.

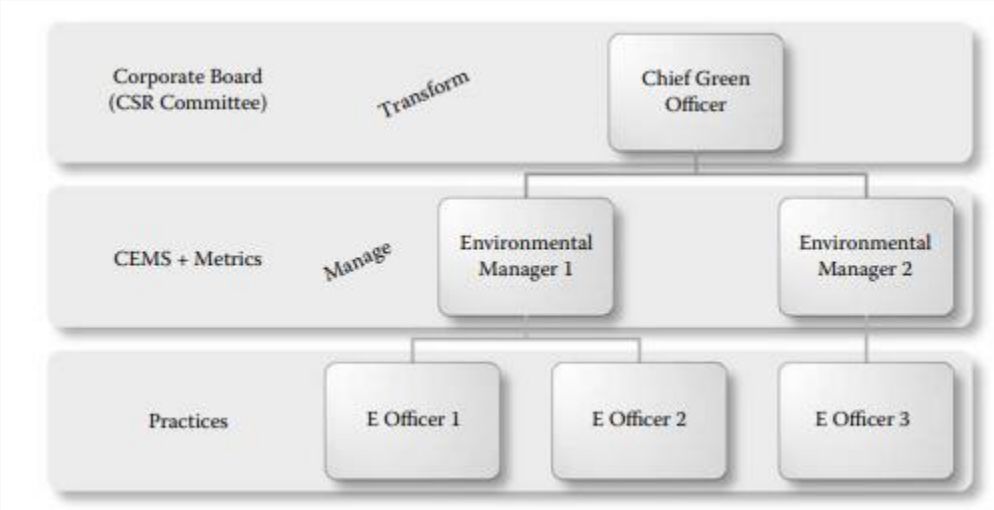



**Fig: Organizing the green HR function**

### 4.1.12 Green-Collar Workers: Roles and Skill Sets:

Green-collar workers are the ones that are associated directly or indirectly with an organization's endeavor to become a green organization. Green HR has to define and position green-collar workers correctly. Properly defined green-collar roles reduce friction amongst staff and support Green IT initiatives. A Green IT project will create new roles, as well as transform the known roles in IT and in the business.

***The roles played by these green-collar workers can be divided into the following three main categories:***

- ✓ The roles that are newly created within the organization and that are specific to the green initiatives of the organization (such as a green transformation champion).

- ✓ The roles that exist within the organization but are modified to befit the green organizational initiatives (such as a green business analyst).
- ✓ The external roles that deal with the specification of carbon levels, and audits of its compliance (e.g., an external carbon regulator).

### 4.1.13 Skills Framework for Information Age (SFIA) and Green HR:

For a smooth transformation of an organization, it is essential that these new Green IT specific roles are understood and well defined. The skills framework for information age (SFIA) provides an excellent framework for positioning Green IT roles within the organization. SFIA can be used in helping in the maturing of Green IT as a profession.

***SFIA levels are also briefly described below in the context of Green IT:***

- **Level 7: Strategy and Inspiration**—Individuals performing at this level focus on the strategic aspect of the organization. Therefore, this role will be focused on the creation of Green IT strategies and high-level visions for the organization
- **Level 6: Initiate and Influence**—mainly undertaken by executive and senior leaders of an organization. Green roles within this level are responsible for initiating and understanding green enterprise transformation, manage the ROI, and take a unified approach across the organization. Strong leadership, management, and communication skills are required to succeed in the roles at this level.
- **Level 5: Ensure, Advise, and Consult**—Individuals working at this level of SFIA are able to ensure transformation of an organization to a green organization. They have specific Green IT skills that enable them to provide advice and consult the line managers responsible for green transformation within their departments. Green HR has to specifically define the skills at this level based on the experience and responsibilities held by the individual in the IT industry together with the ability of understand and advise on the new green concepts, standards, and regulations.
- **Level 4: Enable**—Individuals operating at this level on the SFIA skills map are enablers; they work primarily at departmental level, leading and motivating their staff as the organization undergoes green enterprise transformation.

- **Level 3: Apply**—Individuals at this level are focused on accurate application of the rules and regulations, policies and practices, standards and procedures associated with Green IT.
- **Level 2: Model Assist**—Individuals at this level are primarily involved in modeling processes, systems, data, and operational requirements.
- **Level 4: Follow**—this starting level in the IT skill set is primarily involved in documentation in various areas of the green transformation initiative. Thus, individuals operating at this level would be educated and/or trained in the concepts of Green IT including green data, metrics, and processes.

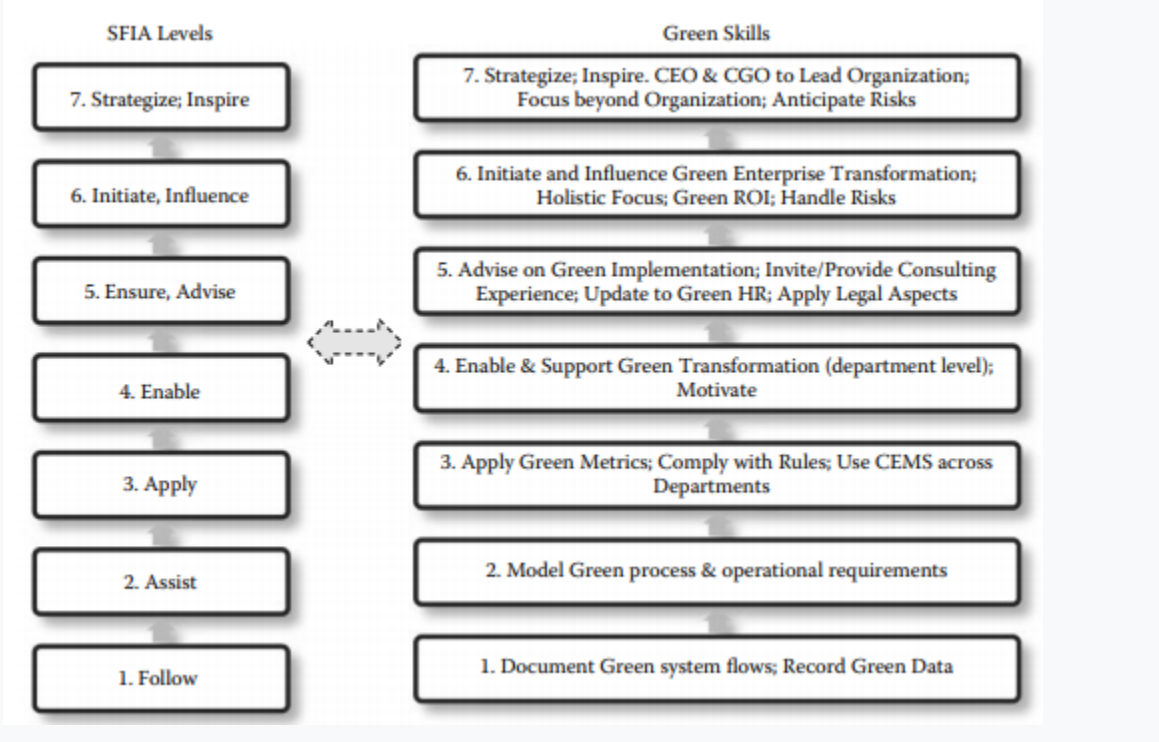



**Fig. Potential mapping of green skills to SFIA levels.**

### 4.1.13.1 SFIA Skill Set and Green Roles:

The usefulness of the SFIA levels and competencies can be used to understand the way in which people can be organized within and across organizations. SFIA enables definition and creation of roles that span both business and IT—therefore, it is the right framework to create levels of responsibilities for individuals working in and around Green IT.

The focus of those strategies is briefly described below:

| SFIA Skill Level | Roles | Business Activity | Green Inclusion for Transformation |
|---|---|---|---|
| 1 to 4 | Managers and Team Leads | Operational reporting | Training on reporting of green metrics within business operations |
| 4 to 6 | Senior Management | Operational risk management | Training on environmental risk and carbon risk within risk management |
| 6 to 7 | Strategists, Leaders | Risk Anticipation | Plan for carbon risks, legislative changes, global carbon trading |

***Operational/tactical implementation of Green IT:***

The Green IT work here deals with its immediate implementation in practice, as well as work at documentation of processes. This work primarily corresponds to the SFIA levels from 4 to 4.

***4–3-year Green IT strategies:***

These are the strategies at departmental level, and have much more depth than the immediate tactical approaches to Green IT. Therefore, SFIA levels 4–6 are poised to provide immense value in the development of these Green IT strategies.

***3–5-year Green IT strategies:***

These are the medium to long-term strategies that are based on the visions of the organizational leadership. These strategies go beyond an organization and move into industry or consortium-based strategic approaches that influence the organization and the society.

**4.1.14 Green Virtual Communities:**

A virtual community is formed through social networks that allow people to interact irrespective of geographical and political boundaries. Green virtual communities can be social groups that transcend the organizational boundaries to discuss and form opinions on green issues. These virtual communities can start as a page on Facebook and may not be mediated.

## 4.2 GREEN ENTERPRISE TRANSFORMATION ROADMAP:

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. 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. The Green IT metrics and measurements used in GET are context sensitive in nature and a good transformation program will deploy them with care across the organization. These metrics start applying from the diagnoses phase and right through to the review phase.

Two types of frameworks in GET Process are as follows,

- The Green ICT framework and its various elements that help understand and model the enterprise.
- The GET process—this is also a Framework, but a process framework that is used for undertaking the transformation process.

### 4.2.1 Green Enterprise Transformation:

A GET is made up of processes and frameworks. The green enterprise framework provides the “as is” and “to be” states, whereas the transformation process provides the activities, roles, and deliverables that are employed in reaching that new state. The fundamental questions in a GET are as follows: What are the green drivers? Which are the dominant dimensions? How to start GET? Green KPIs? Who will lead the transformation CGO? What are the compliance requirements? What are the sociocultural pressures?

The following 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. The figure 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. The environmental intelligence (EI) systems represented at the base of provide the technical support for the transformation.

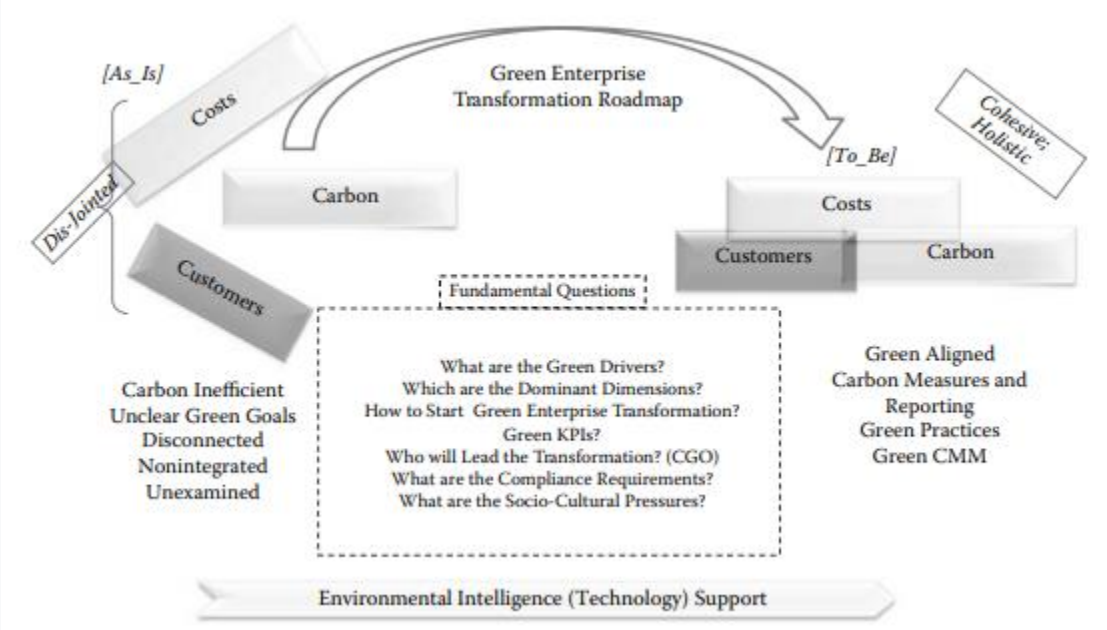
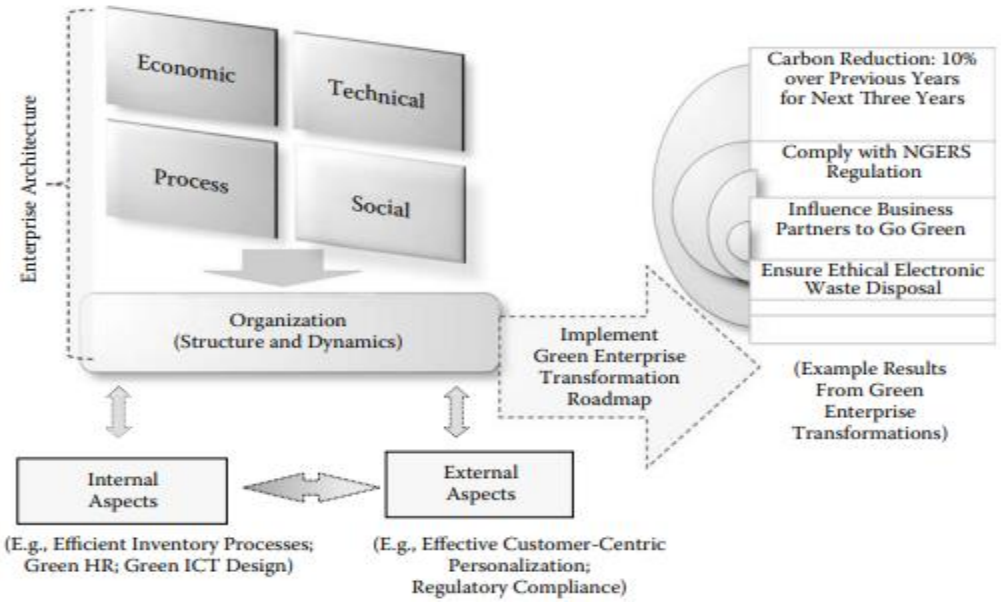



**Fig. Green Enterprise Transformation**

The four dimensions along which an organization transforms are described as follows:



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 effect 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. Transformation of the internal and external processes of the organization is coupled with the development of the Green IT portals. The organizational structure and dynamics also change along with these internal and external processes and corresponding technologies that eventually map to various work areas of transformation.

The influence of each of these dimensions on the GET is discussed in detail next.

#### *4.2.1.1 Influence of Economic Dimension on GET:*

The changes along the economic dimension of business, as it transforms to green organization has to do with its financial position, the changes to its budgets, product portfolio, and return on investment (ROI) calculation. This is the change that is based on the answer to the question of why to transform? The changes in this dimension also include changes to the business model, its investment strategies, its customer relationships and its partner management.

#### *4.2.1.2 Influence of Technical Dimension on GET:*

The technical dimension is "technologically lead" conduit for the business to transform. In case of GET, numerous technologies including hardware, software, databases, and networks undergo changes. Thus, in this dimension, the organization strives to reduce carbon emissions related to desktop machines and personal devices, data servers, ICT-based systems and their usage, underlying network infrastructure, and security protocols. These technologies are eventually also used to reduce the emissions of the rest of the organization. For example virtualization, can be used to reduce the overall power and resource consumption of the organization's systems.

### *4.2.1.3 Influence of Process Dimension on GET:*

This process dimension of a business is the dimension dealing with "how" the business conducts its transactions. These are both internal and external processes of the organization. GET along this dimension of the business entails changes to the way the business interacts with the customers, the way in which it manages its employees and the way it sets up and conducts collaborations with other business partners.

### *4.2.1.4 Influence of Social Dimension on GET:*

The social dimension of GET deals with the sociocultural changes that occur in the business as a result of the transformation. This dimension encourages the transformation champion to focus greater interest in the people aspect of transformation. These people include the clients, employees, and other "users" of the business. Changes to work formats, for example, including telecommuting, telemarketing, and their resultant impact on the organizational and social structures are all part of this social dimension.

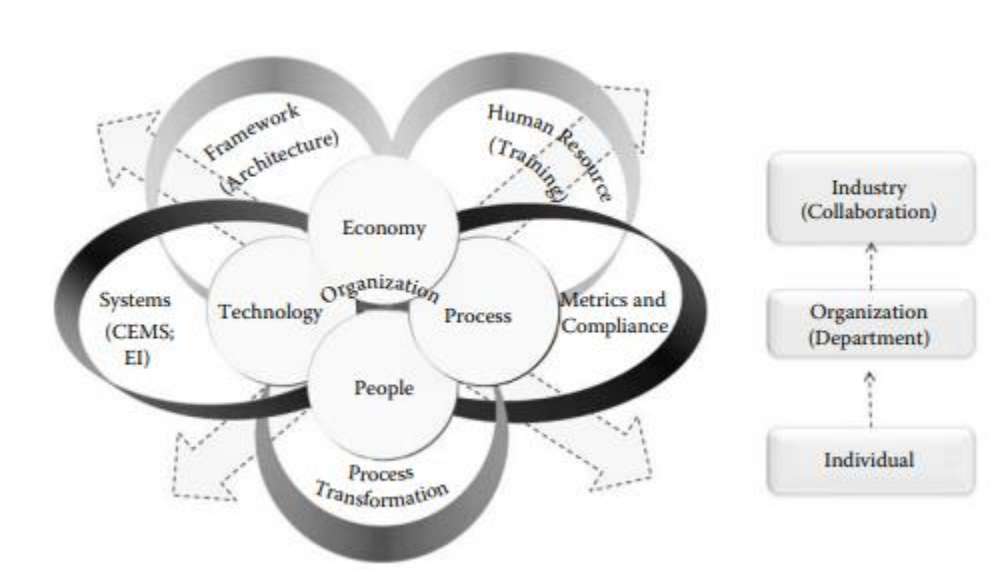



**Fig. GET is a mix of the four dimensions.**

**Difference between Transforming the Individual, Organizational, and Collaborative Processes:**

| *Green Enterprise Transformations* | *Individual (User, Customer, Employee)* | *Organization (Small—Large—Multinational)* | *Collaboration (Vertical—Horizontal; Static—Dynamic)* |
|---|---|---|---|
| Economic | A unit cost of product or service; carbon offsets in daily purchases | Profit verses carbon; costs associated with changes to infrastructures and operations | Green consortiums and alliances; changes to SLAs; legal compliances across regions |
| Technology | Mobile/personal devices; usability; storage space | Applications, networking, data servers, Intranet; environmental intelligence | SOA web services and Cloud computing; security (EI) |
| Process | Customer experience; individual sales | Business process management; modeling and optimization | Collaborative industrial processes across multiple, global businesses (CBPE) |
| Sociology | Privacy; telecommuting and telework; work-life balance | Green HR; training; rewarding structure | Social networking; green consortiums |

### 4.3 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". This Green ICT framework 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. These pillars evolve into work areas, or focus areas for transformation. 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.

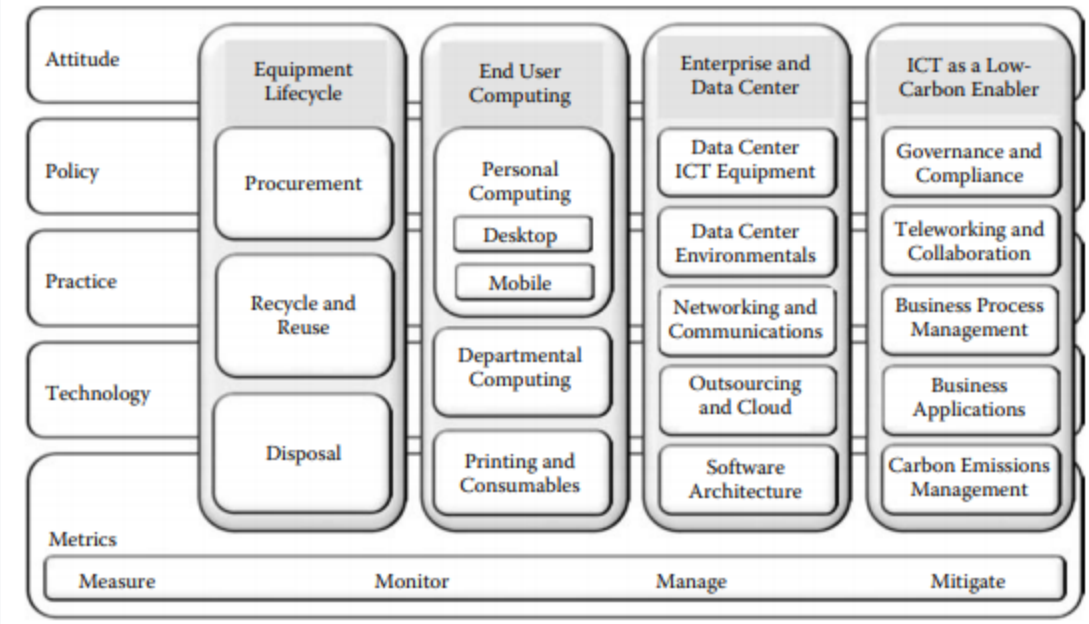



**Fig. green ICT framework**

### 4.3.1 Equipment Lifecycle:

The equipment lifecycle deals with the procurement, recycling and reuse, and eventual disposal of all equipment within the organization. The primary interest, in this lifecycle, is of electronic equipment's (such as desktops and servers) that produce emissions. However, the equipment lifecycle is interested in all equipment's. All equipment in the organization undergo this cycle wherein they are procured (or manufactured), sold, used (and reused), and ultimately disposed. The entire equipment lifecycle is of immense interest in Green ICT as the process of carbon reduction can be initiated right from the procurement phase and continue through its operation and eventual disposal.

#### *4.3.1.1 Procurement:*

Procurement is arguably the most important aspect of Green ICT in terms of making an overall impact on sustainability. Therefore, focusing the design and procurement of ICT equipment makes a substantial impact on its total carbon cost of ownership (TCCO).

There are two aspects to green procurement

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

***4.3.1.2 Recycle and Reuse:***

All organizations replace their ICT equipment periodically. Some have regular refresh cycles, some wait till they have to, and some utilize some sort of continuous update process (especially with software). Further, even when it is time for a hardware upgrade, the organization that needs newer hardware may be able to share their old equipment to other parts of the organization with less critical processes. Any equipment that complies with the base hardware standards, and that can support the software, is potentially re deployable.

***4.3.1.3 Disposal of ICT Systems:***

After extending the useful life of equipment and eventually selling or reusing it, there will always be a situation where it will need to be physically disposed. The importance of electronic waste disposal has led to the growth of an entire industry around the disposal of ICT and other electronic equipment, often based on the extraction of precious metals from printed circuit boards and other components. This industry too has to be regulated, and there have been legislations, making the environmentally friendly disposal of e-waste mandatory.

***4.3.1.4 End User Computing:***

End-user computing deals with IT Efficiencies that the end-user has most control over. These end-user gadgets are divided into three main areas—personal (desktop computing, mobile computing), departmental computing, and printing. For each of these there are a range of different technologies and techniques that can reduce the organization's power consumption and carbon footprint.

- Desktop computing - Important practices include turning PCs off and various PC power management techniques, and important technologies include thin client computing.
- Mobile computing (Laptops, PDAs)— An array of mobile devices, such as notebook computers, smart phones, and PDAs (personal digital assistants), may not in themselves

use a large amount of power, but there are still a number of Green ICT considerations that need to be taken into account with their usage.

- Departmental computing—this is the computing that is localized to a department and not under direct control of the IT department of the organization.
- Printing and consumables—Consume significant energy particularly due to their large numbers and inbuilt inefficiencies.

**4.3.1.5 Enterprise and Data Center:**

Enterprise and data center represent those aspects of an organization that are controlled directly by the IT department. This is true even with the small IT departments that exist within user's departments of organizations that have their own servers occasionally lying under the desk of the manager. In organizations large enough to have a data center, the effective management of the equipment within it and its environmental can be one of the most important aspects of Green IT.

***Data Center ICT Equipment:***

The two most important types of ICT equipment in the data center 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 five-fold over the last 10 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 virtualization has become one of the key technologies in data centers in recent years. But in practice most data centers' power consumption continues to rise because the devices are becoming more powerful and use more electricity.

***Data Center Environmentals:***

The data center's supporting infrastructure can easily consume more power than the ICT equipment within it. This supporting infrastructure is made up of the following three main aspects:

- ***The power supply***—Data centers usually has dedicated power supplies, and very often more than one. Their efficiency varies enormously. Data centers 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.
- ***The building that houses the data center***— 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.

#### *4.3.1.6 Networking and Communications:*

- **Local area networking**—many organizations' LANs and data center 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 organizations 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. But wireless communications can be very inefficient, especially when transmitters and receivers are left on when they are not being used.

#### *4.3.1.7 Outsourcing and Cloud Computing:*

Outsourcing has been one of the big issues in ICT since the industry began. The rise of sustainability as an issue has added a new dimension to the ICT outsourcing debate. Many facilities management companies are now highlighting their green credentials and building

energy-efficient data centers that they say will enable users to lower their overall carbon footprint.

#### *4.3.1.8 Software Architecture:*

Computer systems consist of software running on hardware. 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.

#### *4.3.1.9 IT for Enterprise:*

A vital aspect of Green IT is its use in reducing the carbon footprint beyond IT itself to the whole organization. It is generally agreed that IT emissions are mainly through the usage of electricity. The real potential benefits of Green IT are in using IT as an enabling technology to help the organization, and the wider community, reduce its carbon emissions.

#### *4.3.1.10 Governance and Compliance:*

Many organizations nowadays are conscious of the desirability of being a good corporate citizen. Increasingly, that means acting in a green and sustainable manner. “Corporate governance” is a term that has come into common use in the last decade to describe the processes by which organizations 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.”

#### *4.3.1.11. 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 associated with reduction in personal travel obviating the need to drive a car or catch a plane reduces the carbon footprint of that activity by the amount of fuel generated by that travel. Teleworking also opens up opportunity to collaborate more than in the physical world.

#### *4.3.1.12 Business Process Management:*

Business process management is the process of improving the ways an organization or an individual does things, making them more efficient, with fewer steps or greater effect. Environmental intelligence has a major role to play in Green BPM. EI provides both the tools for modeling the processes and many of the enabling technologies for their execution. This can be done both with business processes in the broadest sense, and through and with the use of specific business applications.

#### *4.3.1.13 Business Applications:*

ICT-based business applications include financial management systems (FMS), enterprise resource planning (ERP), supply chain management (SCM), and customer relationship management (CRM). Many organizations also run customized applications that are specific to their industry that would provide them with competitive advantage. ICT is very important in each of these applications, which essentially support BPM.

#### *4.3.1.14 Carbon Emissions Management:*

As the carbon emissions regulatory framework continues to evolve, CEMS is becoming an increasingly popular tool to manage the carbon emissions lifecycle. The market will continue to mature and will most likely consolidate around major technology vendors and a smaller group of niche or vertical industry players, and CEMS products will become a functional component within many organizations' application portfolio. The horizontal layers of the Green ICT framework deals with attitude, policy, practice, technology, and metrics.

- ***Attitude:*** Attitude can be understood as a desire and a commitment to change by the individual that is based on honest belief in the ensuing results. Having a positive attitude toward Green IT is at the heart of the transformation as it is depend on individuals.
- ***Policy:*** Policies help set the direction for the organization and provided basis for action.

- ***Practice:*** An interesting aside to practice is that they, like processes, involve alteration of habits and change of mindsets (attitude) rather than procurement of new equipment. This involves training.
- ***Technology:*** The Green IT techniques—of using thin clients, virtualizing data servers, and using duplex printers are all examples of technology-based changes in the organization that lead it toward Green IT. Thus, the ideal way to approach equipment replacement is to balance out the change and incorporate the practice of Green IT as part of the normal equipment replacement cycle.
- ***Metrics:*** Choosing the right tools to measure, monitor, and potentially mitigate power consumption and carbon emissions, both inside and outside the IT department, is critical in the GET. Good set of green measures ensure that Green IT projects receive maximum business commitment and are proven to be successful over time. Only with adequate measurement can progress be proved. Hence, metrics need to be supported by CEMS and "smart metering."

**4.4. Green Transformation Process:**

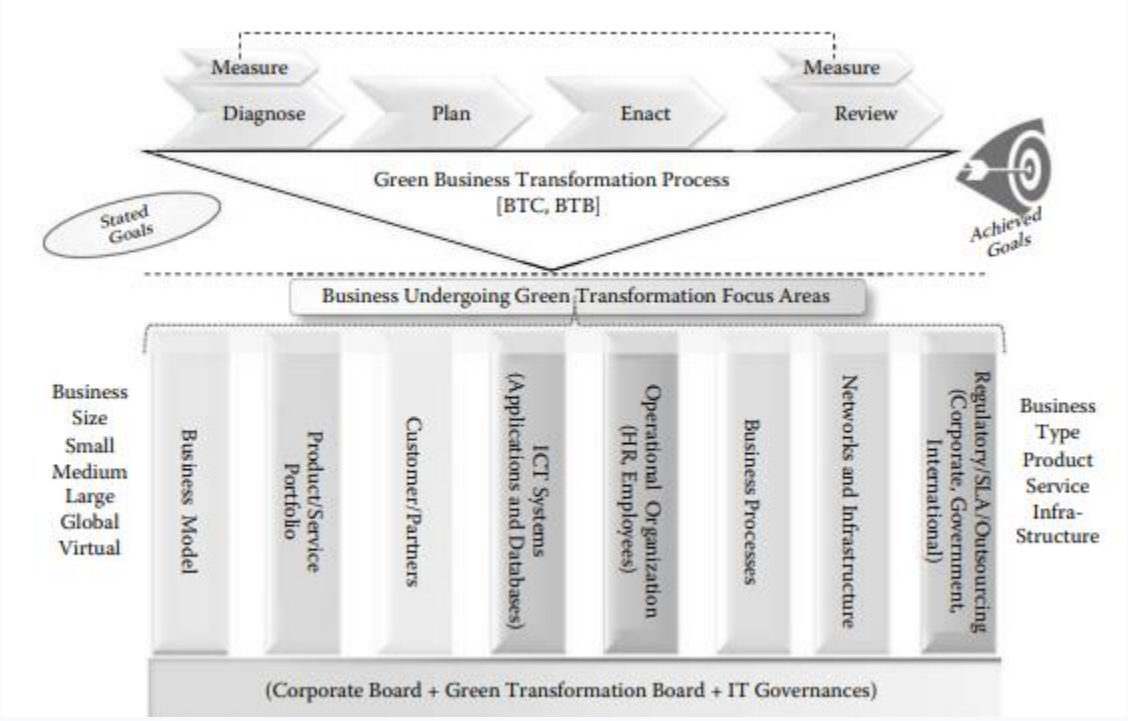
Transforming to a Green enterprise is actually a business transformation program. Project from various dimensions in the business, infrastructure and systems area make up the transforming program. The four major phases of transformation are diagnose, plan, enact, and review. The purpose of this basic Green transformation framework is as follows:

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.
e) Provide the basis for the pathway/road map or project plan for transformation.
f) Review whether the KPIs have been achieved or not.
g) Promote the success along the individual, departmental, and organizational level.

Eventually, such Green transformation will open up opportunities for the organization to also help and support its collaborating partners.


**Fig. The Basic Green Transformation Process**

### 4.4.1 Organizational Focus Areas for GET:



- ***Business Model:*** which deals with the way a business is organized. GET influences and, usually, changes the business model to reflect the green priorities of the organization. Smaller organizations have a simple, subjective business model that can change easily.
- ***Product and Service Portfolio:*** provides an overall summary of the offerings of the business. GET results in the organization having new green products and, also, dropping of carbon-intensive products and corresponding services. Infrastructure-intensive organization may have buildings and facilities instead of products or services.
- ***Customers and Partners***—describe the external parties interacting with the business.
- ***ICT Systems, Applications, and Databases***—include the technological changes in the software systems and technologies of the business.
- ***Operational, Organizational***—handles the internal parties such as employees and management, and their reporting hierarchies, within the business.
- ***Business Processes***—model and describe the way in which all activities of the business are sequenced and carried out.
- ***Networks and Infrastructure***—focus on the underlying communications technologies used by the business.
- ***Regulatory***—deals with legal, accounting, and financial aspects of the business.

### 4.4.2 Configuring a GET Road Map:

A GET roadmap is a high-level program plan that outlines the major steps in an organization's transformation. Following are the major considerations in the configuration of such a road map:

- Type and size of organization
- Nomination of roles and responsibilities
- Formation of the Green enterprise transformation board (GETB)
- Diagnose

- Plan—Formation of work areas; Outlining the GE T deliverables, their format and their timings
- Enact—Format, timing and frequency of reporting
- Review
- Measure

### 4.4.3 GET Program: Roles and Deliverables:

GETB is an early indication that the business is ready to move forward with its change. The GTB is entrusted with the task of successfully steering the organization to a Green organization as it undergoes changes. The chief executive officer (CEO) nominates this board, which is made up of experts, leaders, and personnel from marketing, technology/infrastructure, finance/legal, CRM, communications, and HR/union. The CEO, together with the members of the GTB, selects the Green enterprise transformation champion (GTC).

### 4.5 Green IT Project Roles:

These include the business partners, business architect, technical architect, Green IT champion, end-user representative, IT managers, IT governance, business manager, data center director, Green IT auditors, and corporate governance.

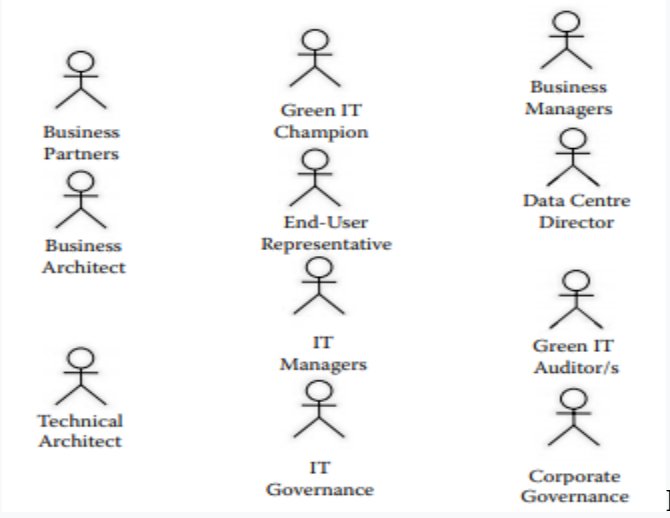



**Fig. Roles in a Green IT Project**

***Green Enterprise Transformation Champion (GTC):***

The responsibility of GTC will include the following:

- Formalizing the leadership and constitution of the GETB.
- Identifying the current Green maturity state of the organization based on Green metrics.
- Benchmarking best practice goals for the organization that describe it's "to be" state.
- Manage budgets.
- Organizing the creation of a project management plan for GET.
- Stakeholder management including expectation management of the board, related external parties, and the society.
- Report progress on the GET to the corporate board.
- Monitor KPIs.
- Balance the "driving dimension" of GET with other dimensions.
- Track progress and of the GET project.

***Business Architect and Variations:***

The GTC will appoint a business architect to investigate and handle the business model work area of the GET. Such business architect should have a clear vision of the business "as is" and its goals and aspirations. A business architect takes a long-term view of the organization (3–5 years and above) when she participates in the GET project. A business architect would create business architectural map that will provide the overall view of the business model and associated work areas.

***Technical Architect and Variations:***

The technical architect is responsible for the following:

- Creation of a technical architecture map to understand where the organization currently is—including networks, databases, security, and contents.
- Collection and use of a toolbox of various tools that are used in technical implementations during GET.

- Creation of a comprehensive repository of software applications currently used by the organization.
- Dividing and categorizing these repositories of applications into different business/application domains that will enable ease of modification with carbon data.
- Ensuring that the applications that support specific decision making are part of the overall EI suite, and are available to decision makers.
- Creation of a new technical architecture that would reflect the goals of the business transformation itself.
- Ongoing alignment of technologies with business plans during and after GET.
- Coordinating the development of a Green IT portal.
- Managing quality initiatives during GET.
- Develop an understanding of the future trends in technology that the organization will have to deal with after the GET.
- Produce a suitable technical strategy including a technical roadmap for transformation.

***Business Partners:***

Business partners play a crucial role in GETs. As the business interests of collaborating partners coincide, there is added impetus to provide wide array of support to the partners. This support can take shape in the form of knowledge and experience sharing, providing relevant tool support and help with understanding dynamic customer preferences as the business transforms.

***Green IT Auditors:***

Auditors carry out checks and balances throughout and after the transformation. Auditors measure and audit to ensure that the transformation has created value for the business as stated by its goals.

***End-Users:***

End-users are the employees, managers, and customers of the organization who are affected by the GET. They are represented in the GET.

- Represents user groups
- May be more than one
- Highlights device usage
- Highlights attitude for roles
- Helps in Green HR
- Understands CEMS and smart meters

***IT Managers:***

IT management—deals with the operational and management aspect of IT within the organization. They are responsible for the IT systems, their operations on the corresponding hardware and approaches to using IT for overall carbon reduction.

***Business Managers:***

Business managers assume the responsibility at department level to measure, report, and reduce emissions. They are more interested in the economic and process dimension of the GET than in technology and social dimensions.

***IT Governance:***

This is an activity for which more than one role within the organization can assume responsibility. IT governance—deals with overseeing the IT management and providing strategic and policy input i n t he process of greening an organization.

***Corporate Governance:***

Following are some of the processes and standards that come into play in the role played by Corporate Governance.

- Lean—will move toward Lean-Green, as was alluded to in the process.
- Six Sigma—will not only focus on quality but also the efficiencies in carbon reduction.
- TQM—Total Quality Management—will incorporate metrics for carbon reduction in addition to defect reduction.

- KPIs—the Key Performance Indicators are not only to enable corporate governance but also green governance.
- SIFA ( Skills Framework for Information Age), A IBA ( Australian Institute of Business Analysis) and PMBOK (Project Management Book of Knowledge) are examples of processes and frameworks that will all be modified to reflect the green awareness and green goals of the organization.

**Discuss how the four phases of green transformation process and their measures change when applied to a coal mine?**

**Planning for IT as a Low-Carbon Enabler for the Enterprise:**

Planning for the use of IT as a low carbon enabler for the enterprise requires plans related to Green IT, as well as planning the changes to the entire enterprise. This planning includes all previous dimensions and their planning as well as plans related to the business (not necessarily IT). The ROLES and ACTIVITIES for the planning process for the dimension of IT as a low carbon enabler are as follows:

***Green IT Champion***—Works with the business management, IT governance and, most importantly, corporate governance to plan out strategies for transformation to a green enterprise.

***Business Management***—Plans, along with the Green IT champion, to promote green activities across the business unit which, in turn, would result in a green organization.

***IT Governance***—oversees the planning process for technology upgrade across the organization. The IT governance is also involved in planning the use of emerging technologies (e.g., software as a service and Cloud) and how they can be used in low carbon enablement of the entire enterprise.

***Corporate Governance***—Participates in the planning process on how the corporate policies need to change—together with possible changes to the business model and the organization structure.

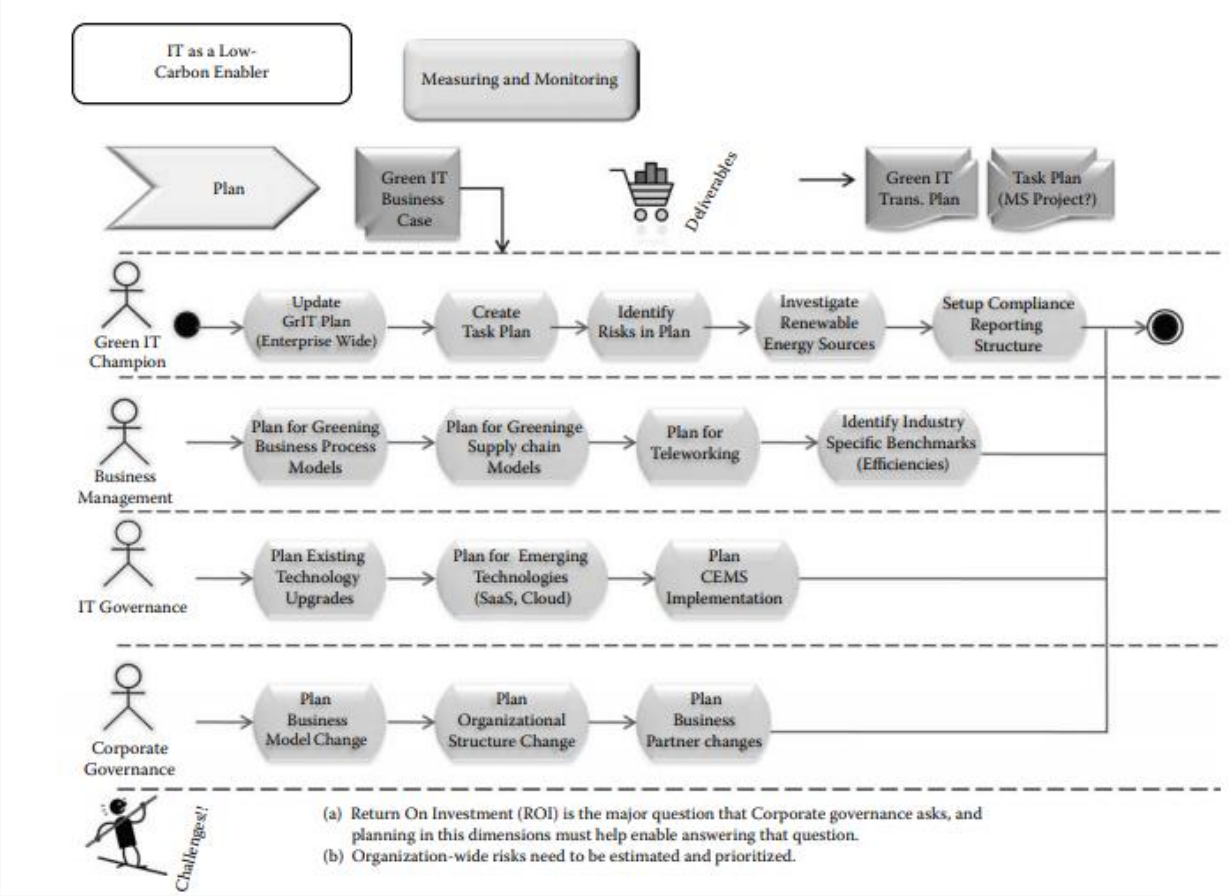



**Fig. Planning enterprise transformation enabled by IT.**

**Deliverables:**

***Input:***

Green IT Business Case.

***Output:***

*Green IT Transformation Plan:* Gets updated here with plan for the entire organization. This includes planning for changes to the business model, as well as structural changes.

*Task Plan:* Step-by-step tasks to be carried out in implementing the Green IT project plan.

***Challenges:***

- Return on investment is the major question that corporate governance asks, and planning in this dimension must help enable answering that question.
- Organization-wide risks need to be estimated and prioritized.

**4.6 GET: Enactment Phase:**

Enactment is the execution of the business transformation plan created in the previous phase. Enactment requires full garment of project management skills.

Following are issues to be considered during a GET enactment phase:

- Identification of risks during execution of the transformation plan, their priorities, and how to ameliorate them.
- Interrelationship amongst work areas, their dependencies and management of the lead work area as first priority.
- Measurements of the GET outputs. Use of metrics created during diagnosis and formalized during planning are used here to ensure common measures for comparison.
- Reporting to stakeholders and managing their expectations.

**4.6.1 Technology-Driven Enactment:**

The ICT-driven enactment of the GET results from technology as a lead dimension of transformation. This will have the organization's ICT systems, applications, and databases at the center of the overall transformation. The factors that affect these management levels include the standards, need for integration, the approach to testing and quality assurance, the contractual requirements and the deployment of the new ICT systems, applications, and databases.

**Customer Relationships Management:**

The CRM systems are updated during GET with the goal of combining "green" with "value" to the customers. This value includes reliable and good quality service (that will reduce

repetition), personalized attention to the needs of the customers, and interactive support due to changing customer needs.

**Supply Change Management (SCM):**

Supply Change Management applications undergo change to enable users, primarily employees of the organization, to perform many common warehouse, inventory, and shop floor related tasks in a holistic manner. A technology-led transformation will monitor and control materials, their delivery and order status. Similarly, procurement, including purchasing, transportation, warehousing, and receiving of goods will have processes that re quire technical integration with the underlying SCM systems. Reduced movement of goods, holding of inventory and accurate production estimates are achieved by the use Green SCM.

**Human Resource and Payroll Systems:**

The HR systems provide opportunities for Green HR to be implemented. These HR systems are upgraded to offer greater support to individuals and departments in terms of training, rewards, and career path. Personalization of timesheets and pay rolls, enterprise bargaining, subsequent agreements, and related responsibilities of HR may also have to be modified as a result of transformation.

**Business Partner's Systems:**

GET projects aim to improve the interactions, of the business with its partner businesses. WS based technologies change the way the business sources services. For example, one business can "plug" services from another "Carbon tax calculators," or source' Carbon emission limits' such as which could be offered by the government within its own systems.

***Integration:***

A major challenge of ICT-driven GET is the handling of integration issues. While integration is always a challenge in even routine upgrades of systems, during GET this issue becomes particularly challenging as a ll the work areas of the business are likely to change.

***Data Migration:***

Another major challenge across all ICT systems is that of data migration. Usually, existing data with the current systems is in silos; it is also duplicated. These GET projects have to plan for data migration to ensure its unification.

**4.6.2 Business Process–Driven Enactment:**

Business process-driven enactment of Green enterprise transition is yet another dimension along which the GE T can be enacted. Such GET is based on reengineering of business processes. Business processes, customers/partners, operational organization, ICT systems, and regulatory work areas provide the foundation of this particular business transformation. Broadcasting, informative, transitive, operative, and collaborative processes. Broadcasting and informative business processes are easy to transform as they have less security requirement but they are of less value to users. Transactive processes, the next a level of complexity, are mostly commercial in nature. Operative processes help in providing and ensuring efficiencies in different departments such as inventory, HR, and finance. Lastly, collaborative processes are most complex and require interfaces between business processes of external and internal business parties. It is recommended that the GET project should incrementally incorporate these levels of complexities of business processes—starting with the informative layer and moving gradually up to the collaborative layer of processes.

**4.6.3 GET: Review and Measure Phase:**

The review phase details with the outcomes and auditing them to check whether the stated objectives are reflected in the outcomes. 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. It is usual for the outcomes to be slightly different to the stated goals even in case of successful business transformations. The difference in the outcomes from the goals could be because both the business and environment has moved during the time the GET project is implemented.

## 4.7 GREEN COMPILANCE: PROTOCOLS, STANDARDS AND AUDITS:

For a Successful Green enterprise transformation (GET), the organization should understand, measure, and report its carbon performance according to the regulatory requirements of the carbon legislations in that region. Apart from measuring and reporting on the carbon compliance for an organization, there is also a need to validate the accuracy of those measures and reports. This is so because, increasingly, the future of an organization—will be dictated by its carbon measurements and reports. Therefore, formal and informal audits of the carbon measures and reports are part of the governance for a responsible green organization.

### 4.7.1 Protocols and Standards:

Green IT, green business, and industrial verticals in which the business exists are all influenced by the government and regulatory bodies. 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.

***Kyoto Protocol:***

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."

***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 GHG classifies emissions into three separate Scopes,

- Scope 1 emissions— the direct emission of GHGs by the organization.
- Scope 2 emissions—these emissions form the indirect consumption of energy such as electricity.
- 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.

**The ISO 14000:2004 Family of STANDARDS:**

ISO 14000 series of standards are set to play a key role in the environmental management of business. The ISO 14000 standard for environmental management provides a basis for organizational compliance with emission requirements.

| *Standard* | *Primary Focus* |
|---|---|
| ISO 14001 | Environment management systems (EMS); Their requirements and approach |
| ISO 14004 | Implementation guidelines for the EMS |
| ISO 14010–15 | Environmental auditing—of system, practices, and reporting |
| ISO 14024 | Environmental labeling—products, equipments, infrastructure |
| ISO 14031 | Environmental performance evaluation—of organizations and systems |
| ISO 14040–44 | Lifecycle analysis—primarily of equipments, but also any other aspect like products, materials |
| ISO 14050 | Terms and definitions—relating to the environmental management |
| ISO 14060 | Product standards relating to their environmental performance |
| ISO 18001 | Occupation health and safety |
| ISO 19011 | Auditing 14000 and 9000 (together with ISO 14010) |

The very first two standards, ISO 14001 and ISO 14004 deal with a system to manage environmental issues—including identification and control of the environmental impact of an organization's activities, products, or services. ISO 14001 provides the requirements for an environmental system and ISO 14004 gives general guidelines for the system.

**ISO 14001:**

An ISO 14001 standard provides basis for certification or an organization in terms of creation and implementation of Green IT strategies, metrics, reporting, and continuous improvement. This certification is provided after the organization claims to have implemented the standard and, subsequently, results from formal Green IT audits. The frequency of such audits would be based on site complexity and past performance. An ISO 14001 accreditation

requires time and budget to achieve. An organization seeking such accreditation needs to implement all aspects of the standard. The implementation should then be followed by formal audits.

| *Section* | *Relevance to Green IT Strategies* |
|---|---|
| Policy | Defining the environmental objectives of the organization (based on the drivers, and their combination) |
| Planning | The economic, process, technology, and people factors required for the green organizational transformation<br>Identification of the legal requirements and an approach to comply with them<br>Environmental risk assessment<br>Environmental intelligence repository (availability, budgets, etc. for CEMS and existing systems upgrade)<br>Product/service lifecycle assessment |
| Implementation and operation | Implementing environmental intelligence (EI) through CEMS<br>Integration with existing ERP and related company systems<br>Education and training programs for people<br>Communication at all levels of management<br>Potential HR changes (e.g., to company's organizational chart) |
| Checking and corrective action | CEMS—measure, monitor, and mitigate<br>Compliance audits<br>Process optimization and maturity |
| Management review | Reporting—internal and external<br>Continuous improvement<br>Monitoring external changes to drivers<br>Monitoring internal changes to factors influence carbon performance<br>Strategies for monetizing in future |

**Fig: Components of the ISO 14001 Standards and Their Relevance to Green IT Strategies**

### 4.7.2 Government Initiatives:

***Compelling Regulation:***

Compliance requirements for carbon emissions by businesses is going to drive new and formal carbon metrics and measurements. The legal and regulatory nature of the carbon compliance requirements are best fulfilled by adopting a standard, implementing reliable metrics

and measurements. Accuracy in the method of collection and analysis of carbon data and audits provide the proof of environmental performance.

***USA Energy Star—1992:***

Energy Star i s a voluntary labeling program designed to identify and promote energy-efficient products. The ISO 14024 standard provides the basis for creating the environmental labeling of products. The Energy Star rating system is implemented by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE). These Energy Star labeled products have potentially saved billions of dollars over the last decade by enabling energy-conscious decisions, especially by large businesses in procuring and operating products.

***EPEAT—Electronic Product Environmental Assessment Tool:***

EPEAT certification is a means of standardizing electronic goods in terms of their environmental performance. EPEAT provides information that is invaluable in setting up ongoing, large-scale IT procurement programs. EPEAT-based labels on PCs and products enable development of procurement policies that are measurable through KPIs in practice.

***EU RoHS—Restriction of Hazardous Substances Regulations:***

Restriction of Hazardous Substances (RoHS) regulates hazardous substances, including the one that are used in computer and mobile manufactures. This legislation was passed by the European Union (EU) in 2006, setting a list of criteria that limited the amount of hazardous substances that can be included in new electronic and electrical equipment. This restriction was aimed to en sure safety of users and eventually of people involved in disposal of these equipment's—as hazardous materials are required to be handled in both production and disposal.

***EU WEEE—Waste Electrical and Electronic Equipment Regulations:***

WEEE aims to reduce the amount of e-waste that occurs at the end of an equipment lifecycle. WEEE dictates limits and methods for disposal of electronic waste (e-waste) and includes many alternatives such as reuse, recovery, recycling, and treatment of the disposable

wastes. The WEEE regulations deal with separate collection, disposal, and recycling, standards for e-waste treatment at authorized facilities; and collection, recycling, and recovery targets.

### 4.7.3 Industry and Vendor Initiatives:

Apart from the government legislations, there are also industrial consortiums formed by like-minded organizations. These industry initiatives also go a long way in reducing carbon emissions—and much before the regulatory requirements come into play. Vendors of IT goods and services also get together to mutually agree on targets for emissions. Some of these initiatives are as follows;

***Green Grid—2007:***

A global consortium of IT vendors, including AMD, Dell, IBM, Sun Microsystems, and VMware, formed a nonprofit group named the Green Grid in February 2007. The aim of this consortium was to define and propagate energy efficiency practices in data centers and IT systems. The Green Grid collaborates with companies, government agencies, and industry groups to provide recommendations on best practices, metrics, and technologies that will improve IT energy efficiency.

***CSCI—Climate Savers Computing Initiative:***

CSCI is a nonprofit initiative of eco-conscious consumers, businesses and conservation organizations. The goal of CSCI is to promote development, deployment, and adoption of energy-efficient computers in active and inactive state.

### 4.7.4 IT Vendor Initiatives:

Vendors of goods and services have also created their own initiatives for reducing the carbon impact of their activities.

### 4.7.5 Global Reporting Initiative:

The Global Reporting Initiative (GRI) is pioneering the development of a sustainability reporting framework. GRI aims to make the disclosure on economic, environmental, and social performance as commonplace and comparable as financial reporting. GRI has stated two goals for the next decade. Firstly, environmental social and governance (ESG) reporting should become a general practice to help markets and society take informed and responsible decisions. Secondly, ESG reporting and financial reporting needs to converge over the coming decade.

### 4.8 Green IT Audits:

Green IT audits are formal, independent verification and validation of the carbon performance and carbon reporting of the organization. With increasing legislative demands on carbon reporting, these Green IT audits play a vital role in establishing the Green claims of the organization. Auditing of CEMS is a part of these audits. Most importantly, though, Green IT audits are likely to become audits in real time—that is, every carbon reporting and carbon related transaction will be audited through an independent module of the CEMS itself—that is owned and controlled by the auditors. Internal and external audits have slightly different roles to play in terms of carbon emissions reporting—internally, they provide the confidence to the decision maker on her investment in the Green project, and externally, they provide the legal backing required of any formal reporting of data.

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. The carbon management, governance standards, processes, and controls are audited in this area.

- **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:

- Validation 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-benefit 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.
- Cross-check on smart meters used for automatic reading and display of carbon data.
- Stocks take of the skill set, experience, and necessary expertise within the organization to put together a Green IT measurement and optimization program.
- Being part of the value proposition for business through its green initiatives both internally and externally.
- Reducing the confusion and, perhaps, duplication of calculations that may occur in a collaborating group of partners (particularly true with outsourced projects).
- Provision of relative benchmarks from audit to audit.
- Validating the measuring of degree of sophistication or maturity.

**Audit Types:**

Green IT audits are required to verify and validate the data collection mechanisms such as the smart meters, the underlying analysis of that data, carbon trends, and eventually the reporting on

carbon compliance by the organization. Green metrics and measurements used for this purpose need to be validated themselves.

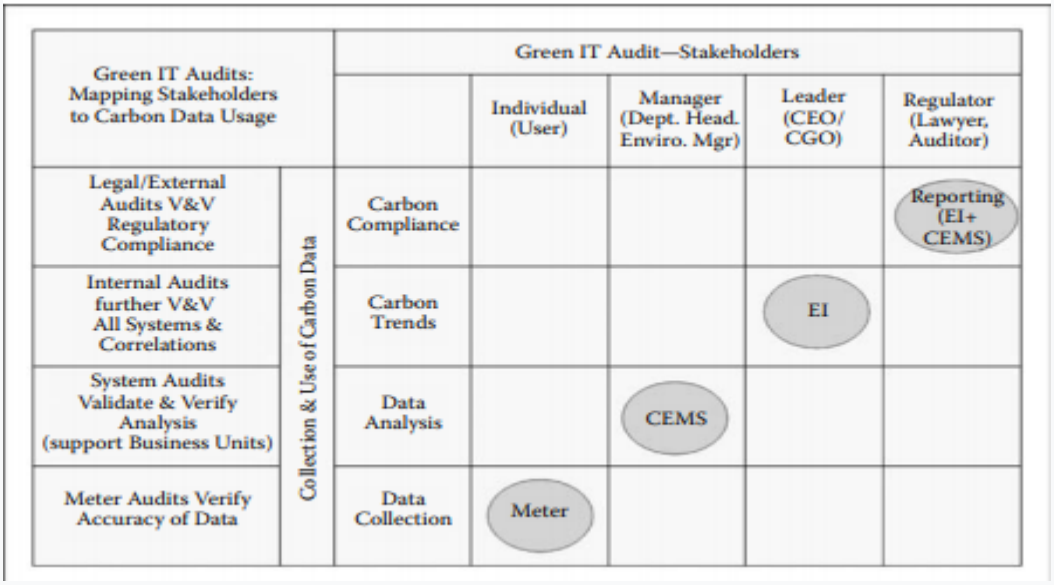



**Fig : Various elements and types in Green IT audits and their relevance to roles.**

- **Data collection** mechanisms and corresponding gadgets/ meters—A wide array of smart meters that read emission, measurement platforms, for those emission, their monitoring and inventory systems, come into play to meet the basic carbon emissions measurement requirements. These had to be checked for accuracy of their readings.
- **Data analysis** undertaken by software systems (typically CEMS)—Totals, averages, and distribution of carbon data, including those by the business partners re quires to be audited. Standards and metrics play a major role in facilitating CO2 comparisons.
- **Carbon trends**—plotting of the carbon trends, their accuracy and reliability will become increasingly important as the world moves toward a carbon-based economy.
- **Carbon compliance**— is a crucial aspect of green audits. Both internal and external auditing parties are involved in ensuring that the organization is indeed complying with the limits set for emissions by the regulatory bodies.

The primary stakeholders who are interested in the areas of audits described as follows:

- ***Individual users***—mainly interested in providing input into the data collection mechanisms. While users can span many different aspects of an organization, the individual users referred to here are mainly the staff and the customers who would access the organization's IT assets.
- ***Departmental heads***—particularly interested in the analysis provided by the software system (CEMS) dealing with carbon data. This analysis would show to a business unit or a department clearly the amount of carbon generated by its activities as well as potential carbon savings resulting from the greening effort.
- ***CEO/chief green officer (CGO)***—these leadership roles are interested in all aspects of the Green IT audits, but particularly in the environmental intelligence aspect of the organization. Thus, coordination between systems and data, analysis of that data, and EI-based indications of the future will be of immense interest to the CEO/CGO.
- ***Regulators***—these are primarily external parties that want to determine the accuracy and validity of carbon data reporting as undertaken by the organization. Almost all future carbon reporting will be based on software systems and applications.

## 4.9 EMERGENT CARBON ISSUES: TECNOLOGIES AND FUTURE:

The journey of exploring these new technologies and considering their application in Green IT is part of an innovative approach to understanding and handling the new carbon challenge. Technologies such as XML, SOA, mobile services, and collaborative web services across the industry verticals and with the regulatory bodies, virtualization, and Cloud computing are all opportunities for innovativeness. In addition to innovations in technologies, the business models themselves will undergo changes that will reflect the emergent carbon economy.

### 4.9.1 Future Carbon Landscape:

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.

| *Dimensions* | *Future Technologies and Impact* |
|---|---|
| Technology | Cloud, ternary, biomimicry, collaborative EI, mobile, SaaS, CEMS integration |
| Economy | Novice business models, carbon trading, legal framework |
| Process | Governance standards, updated on ITIL, Sarbanes–Oxley, metrics, symbols, ISO 14001, collaborative EI |
| Social | Social networks, rapidity of formation of new opinions, inbuilt environmental consciousness as a social value |

**Fig: Future of Green IT in the Four Dimensions**

The future of Green ICT is in innovation that makes use of social media networks, puts together groups of people and organizations in consortiums, enhances general opinion on the issues, and activates the Green HR function within the organization. Social networks relating to Green IT and environmental responsibilities can be formed at local, regional, and global level. Further to the external social media activities, organizations can also attempt at innovation internally in their Green HR function. This innovation requires due consideration to the mindmaps of the individuals operating with carbon reduction responsibilities within the organization, the tools and technologies used by them, and the way these individuals are trained, retained, and promoted.

### 4.9.1 Green ICT and Technology Trends:

Alignment of new and emerging technologies with business has been a key in delivering competitive advantage to business. This same alignment needs to be kept in mind when it comes to innovative use of emerging technologies and carbon reduction.

### Cloud Computing:

Cloud computing is an important part of an organization's approach to Green IT. Cloud computing has a lot more to offer in the future in the context of EI. 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. The opportunities to reduce the overall carbon footprint through dynamic collaboration are on the rise by creation of public and private Clouds. Dynamic collaboration on the Cloud enhances the opportunities to use the business principle of Cloud computing: "pay as you go" in terms of using computing services.

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. The carbon savings will result from the use of common hardware and also from the consolidation of data center buildings, their cooling energies, and their maintenance effort.

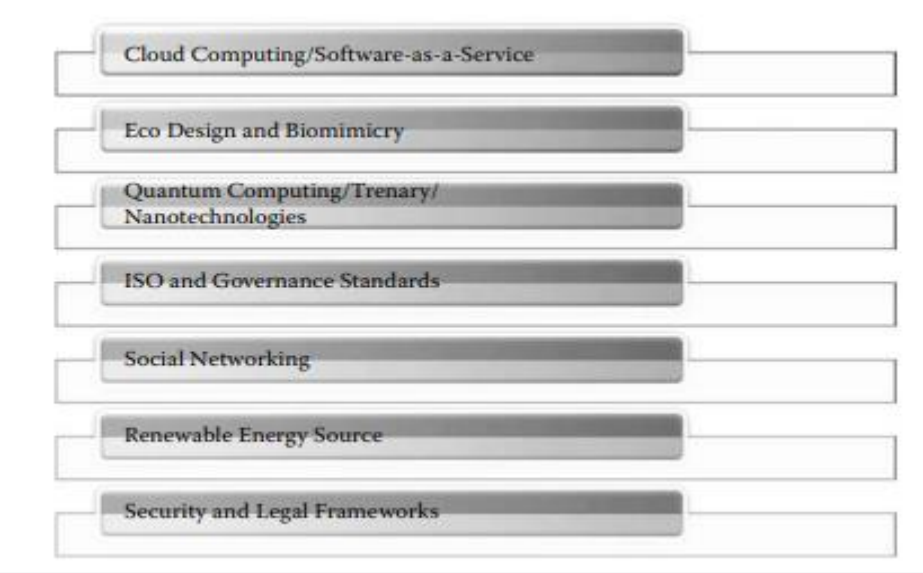



**Fig: Emerging technologies landscape and Green IT impact.**

**Applications development**—with the availability of a sophisticated Cloud, application development, including its modeling, testing, and deployment, can be put together in one place. The Cloud-based application components can be used to plug in to the newly developed systems, resulting in a much faster and energy efficient development

**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. Furthermore, as these applications are hosted in the Cloud, they reduce the effort at upgrades and maintenance undertaken by organizations. This reduces the amount of operational effort (and corresponding operational carbon) at the user end.

**Reusable Data service**—a 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. For example, currency exchange, interest rates, flight times, and weather patterns, are the types of data that are common to many organizations but are stored by them all separately. Cloud-based data services can eliminate that storage and opens up doors for their greater consolidation.

**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.

**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. The reduction in size requires considerable research effort—design, development, and production.

**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 ongoing 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.

**ISO—New and Upgraded Standards:**

The ISO 14001 standard, which specifies the requirements of an environmental management system, does so i n the context of a specific product or an organization. However, this standard does not contain requirements for that would handle environmental practices associated with collaborative organizations. The ISO 14000 series of standards need to be upgraded to include dynamically collaborating businesses or a new set of standards are required to cover the environmental practices of such collaborations. Furthermore, environmental governance standards that deal with embedding environmental management within corporate governance structures (based on ITIL and CoBIT, for example) are also required.

**Security and Legal:**

The current legal frameworks governing carbon emissions come out of the ratification of agreements at various international summits on the environment. However, a carbon emission in the context of IT is a global phenomenon—especially as Cloud, SaaS, and outsourcing continue to dominate the IT services sector. Therefore, while the real user of a service could be sitting in one geographical region, the emissions resulting from his or her work will be attributed to a totally different geographical region. a legal framework are the issues associated with security of carbon data. This is particularly so when the data is generated and owned by one organization, whereas it is stored, maintained, and backed up by a totally different vendor of such services.

Security of carbon data requires procedures, practices, norms, standards, and binding legal framework—not much of which exists now.

**Eco design:**

Ecodesign is based on environmental considerations in the very early conceptual stage of the architecture and design of products or processes. While environmental consideration is a product, lifecycle themselves are not a new thing, in depth consideration of the Green P-O-D is involved in this process.

**Bio mimicry:**

Biomimicry, as an emergent trend, requires substantial study, experimentation and usage in all areas of an organization's products and services. Biomimicry can be considered as a combination of science and art that aims to learn from and emulate nature, which is usually sustainable. Nature uses only the energy it needs to carry out a function, ensures that the functionality matches the form, recycles and relies on diversity.

## UNIT: 4

## GREEN COMPILANCE

## TWO MARKS

**1. Define socio cultural aspect of Green IT?**

The social dimension of green enterprise transformation {GET) is a subjective affair that needs to bring together the tacit knowledge and viewpoints of individuals including the explicit knowledge stored in database.

**2. What are the different levels of GET?**

- Society
- Government
- Industry
- Organization
- Business unit

**3. What is decision making in Green IT?**

The critical state of the world's environment, it is crucial to empty all the beneficial knowledge, technology, and tools that scientists, engineers and other professional can offer.

**4. What are the three individual priorities of Green IT?**

i. Business priorities
ii. Personal priorities
iii. Environmental priorities

**5. Define Green Ethics?**

A green ethic offers a set of standards and principles that we should systematically apply to nature.

**6. What are the potential advantages of Green IT?**

- Ensure ongoing effort at all levels of IT.
- Ensure ongoing effort to reduce carbon in procurement, operation, and disposal.
- Make the carbon state available publically.
- Maintain security and confidentiality of carbon data and information.

**7. Define Green Washing?**

Green washing is where a firm spends time and money advertising and marketing that their goods or services are environmentally friendly when, in fact, they are not. In other words, green washing is the act of making false or misleading claims about the environmental benefits of a product, service, technology, etc.

**8. What are the two major important areas of communication?**

- Within the organization
- Outside of the organization

**9. What are the six categories of communication channel?**

i. Personal
ii. Collaborative
iii. Mobile
iv. Asynchronous
v. Physical
vi. Group

**10. What is GET?**

A GET is made up of processes and frameworks. The green enterprise framework provides the “as is” and “to be” states, whereas the transformation process provides the activities, roles and deliverables that are employed in reaching that new state.

**11. What are the four dimensions of GET?**

a. Economic
b. Technical
c. Process
d. Social

**12. Define Green Transformation Process (GTP)?**

Green Transformation is one of the urban transformation processes. It is a system which puts emphasis on the use of renewable energy sources and green areas for the sustainable future of cities.

**13. What are the four phases of Green Transformation Process?**

i. Diagnose
ii. Plan
iii. Enact
iv. Review

**14. Define Green IT Audits?**

Green IT Audits are formal, independent, verification and validation of the carbon performance and carbon reporting of the organization. With increasing legislative demands on carbon reporting, these Green IT audits play a vital role in establishing the green claims of the organization.

**15. Write the five areas of green metrics?**

i. Measure
ii. Monitor
iii. Manage
iv. Mitigate
v. Monetize

**16. What are the advantages of Green IT audits?**

- Validation of entire organizations asset register from a carbon emissions prespective.

- Cross check on smart meters used for automatic reading and display of carbon data.
- Provision of relative benchmarks from audit to audit.
- Validating the measuring of degree of sophistication or maturity.

**17. What are the various types of Green audit?**

- ✓ Data collection
- ✓ Data analysis
- ✓ Carbon trends
- ✓ Carbon compliance

**18. Define Carbon Compliance?**

The carbon compliance unit is the maximum permitted amount of CO2 arising from an organizations heating, cooling, fixed lighting and ventilation systems.

**19. Who are the various key stakeholders in Green IT Audits?**

- Individual users
- Departmental heads
- CEO/Chief Green Officer(CGO)
- Regulators

**20. Define SaaS Computing?**

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.

**21. List out the areas of Cloud Computing?**

- Infrastructure
- Applications development
- Application execution
- Reusable data service

**22. Define 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. The reduction in size requires considerable research effort—design, development, and production.

**UNIT: 4**

**GREEN COMPILIANCE**

**16 MARKS**

1. Write in detail about Socio-cultural aspects of Green IT?
2. Explain in detail about Green users practices?
3. Discuss about attitude and subjectivity in Green IT?
4. Explain about Green IT ethics and code of conduct?
5. Briefly explain about Green Enterprise Transformation Roadmap?
6. Explain about the four dimensions of GET?
7. Briefly explain about Green Compliance, protocols, and standards?
8. Explain Green IT audits in detail?
9. Write about emergent carbon issues?
10. List out the process involved in Skills Framework for Information Age (SFIA) and Green HR?
11. Explain in detail the ISO 14000:2004 Family of standards?
12. Discuss how the four phases of green transformation process and their measures change when applied to a coal mine?

**********

# UNIT: V

# CASE STUDIES

***Syllabus:***

The Environmentally Responsible Business strategies (ERBS) – Case study scenarios for trial runs – case studies – applying Green IT strategies and applications to a home, hospital, packaging industry and telecom sector.

## 5.1 THE ENVIRONMENTALLY RESPONSIBLE BUSINESS STRATTEGIES (ERBS):

The objective of this study is to understand the contribution of ICT in environmental strategies of a business and its sustainable management. This includes understanding organizational and individual attitudes and policies towards Green ICT, wasteful and emissive processes, enablement of efficient use of organizational resources, metrics for monitoring and justification of the greening of the organization and implementation of environmental strategies in business.

The data collected through this survey will be analyzed and processed for the development and validation of a model for "Environmentally Responsible Business Strategy (ERBS)." This survey respects the privacy of the individuals and the confidentiality of the organizations. As such, the answers you provide here will only be discussed and analyzed collectively in seminars and publications. A short white paper of our results will be provided on your (optionally provided) contact details as a m ark of our gratitude.

## 1. Demographic Information

| **About You: (optional)**<br>Your Name: _____ Company Name: _____ Contact Details: _____ | | | |
|---|---|---|---|
| **Your Role**: | [ ] Decision maker<br>[ ] Advisor/Consultant<br>[ ] Engineer | [ ] Project /QA manager<br>[ ] Technical manager<br>[ ] Researcher | [ ] Environment regulator<br>[ ] IT consultant<br>[ ] Other _____ |
| **Company Size**: | [ ] Small (<20 employees) | [ ] Medium (20–200 employees) | [ ] Large (>200 employees) |
| **Business Type:** | [ ] Private/Corporate | [ ] Government/ Semi Govt. | [ ] Other _____ |
| **Industry Category**: (select any one; if 'Others' please clarify) | [ ] Agriculture, forestry, and fishing<br>[ ] Mining<br>[ ] Manufacturing<br>[ ] Electricity, gas, water, and waste services<br>[ ] Construction<br>[ ] Wholesale trade<br>[ ] Health care and social assistance | [ ] Retail trade<br>[ ] Transport, postal, and warehousing<br>[ ] Information media and telecommunications<br>[ ] Financial and insurance services<br>[ ] Rental, hiring and real estate services | [ ] Professional, scientific, and technical services<br>[ ] Administrative and support services<br>[ ] Public administration and safety<br>[ ] Education and training<br>[ ] Arts and recreation services<br>[ ] Other _____ |
| **Primary Region**: | [ ] India<br>[ ] North America/ Canada | [ ] Australia/NZ<br>[ ] Japan, Singapore, China | [ ] Europe/UK<br>[ ] Other_____ |

*Please indicate whether you agree or disagree with the following statements in terms of their importance in your organization* [SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree].

## 2. Business and Strategy Planning with Respect to the Environment

| **Understanding current business scenario: Your organization** | **SD** | **D** | **N** | **A** | **SA** |
|---|---|---|---|---|---|
| Has a higher power consumption than other similar organizations | [ ] | [ ] | [ ] | [ ] | [ ] |
| Assumes responsibility for its carbon footprints | [ ] | [ ] | [ ] | [ ] | [ ] |
| Measures its carbon emissions accurately | [ ] | [ ] | [ ] | [ ] | [ ] |
| Has a person responsible for environmental matters | [ ] | [ ] | [ ] | [ ] | [ ] |
| Is aware of the importance of Green metrics | [ ] | [ ] | [ ] | [ ] | [ ] |
| Uses devices and/or software to measure carbon emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| **Understanding your business policies with respect to environment: Your organization has** | **SD** | **D** | **N** | **A** | **SA** |
| Policies for purchase of Green equipment and related services | [ ] | [ ] | [ ] | [ ] | [ ] |
| Policies related to safe disposal of hazardous waste, material, or equipment | [ ] | [ ] | [ ] | [ ] | [ ] |
| Policies for adopting and implementing recycling of equipment | [ ] | [ ] | [ ] | [ ] | [ ] |
| Policies for optimizing energy consumption in all business processes | [ ] | [ ] | [ ] | [ ] | [ ] |
| Policies for use of renewable energy (e.g., solar, nuclear) | [ ] | [ ] | [ ] | [ ] | [ ] |
| Policies to influence attitudes of staff toward carbon emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| **The following factors influence your organization to adopt Green policies** | **SD** | **D** | **N** | **A** | **SA** |
| Government rules and regulation in implementing environmental measures | [ ] | [ ] | [ ] | [ ] | [ ] |
| Customer's demand or pressure for Green policies and Green products | [ ] | [ ] | [ ] | [ ] | [ ] |
| Pressure from society (physical/electronic groups) to adopt Green policies | [ ] | [ ] | [ ] | [ ] | [ ] |
| Self-initiated implementation of environmental policies | [ ] | [ ] | [ ] | [ ] | [ ] |
| (Increased) Energy consumption in your organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| (Increased) Carbon footprint in your organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| (Increased) Operational costs in your organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| **The following goals are defined by your organization to adopt Green policies** | **SD** | **D** | **N** | **A** | **SA** |
| Reduction of energy consumption in your organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| Reduction of carbon footprint in your organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| Reduction of the operational costs in your organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| Improvement of the reputation of your organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| Meet government regulations and legislation | [ ] | [ ] | [ ] | [ ] | [ ] |
| Meet the sustainability goals of your organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| Increase revenue and profitability due to Green initiatives | [ ] | [ ] | [ ] | [ ] | [ ] |
| **The following ICT practices have been adopted by your organization** | **SD** | **D** | **N** | **A** | **SA** |
| Videoconferencing | [ ] | [ ] | [ ] | [ ] | [ ] |
| Telecommuting/Teleworking | [ ] | [ ] | [ ] | [ ] | [ ] |
| Fleet and field force management | [ ] | [ ] | [ ] | [ ] | [ ] |
| Web and use of collaboration tools such as e-mails | [ ] | [ ] | [ ] | [ ] | [ ] |
| Mobile phones/PDAs | [ ] | [ ] | [ ] | [ ] | [ ] |
| Others (Specify) _____ | | | | | |

## 3. Technical Strategy and Planning

| **Your organization has the following practices regarding energy saving data centers and equipments** | **SD** | **D** | **N** | **A** | **SA** |
|---|---|---|---|---|---|
| Energy saving choice when purchasing new ICT hardware | [ ] | [ ] | [ ] | [ ] | [ ] |
| Reducing energy used by data centers (ICT) | [ ] | [ ] | [ ] | [ ] | [ ] |
| Uses open source system software (ICT) and applications | [ ] | [ ] | [ ] | [ ] | [ ] |
| Machine/Server Virtualization (ICT) | [ ] | [ ] | [ ] | [ ] | [ ] |
| Counts and monitors ICT devices for emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Replaces conventional devices with environment friendly devices | [ ] | [ ] | [ ] | [ ] | [ ] |
| Others (Specify) _____ | | | | | |
| **The following practices are adopted across the entire organization** | **SD** | **D** | **N** | **A** | **SA** |
| Reduce the use of paper and related materials (e.g., ink or toner) | [ ] | [ ] | [ ] | [ ] | [ ] |
| Reduce use of hazardous materials that can damage the environment | [ ] | [ ] | [ ] | [ ] | [ ] |
| Reduce number of high power consuming equipments | [ ] | [ ] | [ ] | [ ] | [ ] |
| Use of alternative energy source such as wind, solar | [ ] | [ ] | [ ] | [ ] | [ ] |
| Monitor emissions and evaluate on a regular basis | [ ] | [ ] | [ ] | [ ] | [ ] |
| Provide training to employees to implement and enhance Green practices | [ ] | [ ] | [ ] | [ ] | [ ] |
| Separately monitor the electricity consumed by the data center | [ ] | [ ] | [ ] | [ ] | [ ] |
| Encourage product innovation and environmentally conscious design | [ ] | [ ] | [ ] | [ ] | [ ] |
| Life cycle assessment of energy consuming equipments | [ ] | [ ] | [ ] | [ ] | [ ] |
| Maintain equipment and instruments in good condition to reduce wear | [ ] | [ ] | [ ] | [ ] | [ ] |
| **The following tools are used for measuring carbon emissions in your organization** | **SD** | **D** | **N** | **A** | **SA** |
| Dashboard displays attached to the devices to display emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Mobile gadgets attached to devices for measuring emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Surveys of employees and other stakeholders | [ ] | [ ] | [ ] | [ ] | [ ] |
| Inventory of the organization to identify unused goods | [ ] | [ ] | [ ] | [ ] | [ ] |
| Interviews of employees and stakeholders to ascertain carbon emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Others (Specify) _____ | | | | | |

## 4. Procurement and Supply Management

| **Supply management procurement—Your organization:** | **SD** | **D** | **N** | **A** | **SA** |
|---|---|---|---|---|---|
| Adheres to environmental criteria for approved suppliers | [ ] | [ ] | [ ] | [ ] | [ ] |
| Requires or encourage suppliers to undertake environment certification | [ ] | [ ] | [ ] | [ ] | [ ] |
| Builds environmental criteria into supplier contract conditions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Incorporates environmental conscious staff on sourcing team | [ ] | [ ] | [ ] | [ ] | [ ] |
| Keeps record of supplier environmental questionnaires | [ ] | [ ] | [ ] | [ ] | [ ] |
| Records and evaluate supplier environmental audits and assessment | [ ] | [ ] | [ ] | [ ] | [ ] |
| **ERP software: Your organization intends to** | **SD** | **D** | **N** | **A** | **SA** |
| Modify the current ERP system to meet environmental challenges | [ ] | [ ] | [ ] | [ ] | [ ] |
| Buy a new ERP software package that will meet environmental needs | [ ] | [ ] | [ ] | [ ] | [ ] |
| Seek external help for training and implementation of Green ERP | [ ] | [ ] | [ ] | [ ] | [ ] |
| **Compliance audits: Your organization has** | **SD** | **D** | **N** | **A** | **SA** |
| Well-documented model for carbon emissions that can be audited | [ ] | [ ] | [ ] | [ ] | [ ] |
| Regular updates and modification of environmental parameters | [ ] | [ ] | [ ] | [ ] | [ ] |
| Standard approach to accessing government rules and regulations | [ ] | [ ] | [ ] | [ ] | [ ] |
| Provides feedback to the government on carbon emission | [ ] | [ ] | [ ] | [ ] | [ ] |
| Periodically checks environmental documents of the vendor | [ ] | [ ] | [ ] | [ ] | [ ] |

## 5. Strategic Measures for Reducing Emissions

| **Your organization's business strategies will be influenced for next 3–5 years by** | **SD** | **D** | **N** | **A** | **SA** |
|---|---|---|---|---|---|
| Use of ICT in minimizing the organization's environmental footprints | [ ] | [ ] | [ ] | [ ] | [ ] |
| Government regulations that require organizations to limit carbon emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Implementing monitoring methods for carbon footprints in an organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| Use of alternate source of energy such as solar/wind energy | [ ] | [ ] | [ ] | [ ] | [ ] |
| Costs involved in implementing Green initiatives | [ ] | [ ] | [ ] | [ ] | [ ] |
| Formation of an executive body for overall responsibility for environment | [ ] | [ ] | [ ] | [ ] | [ ] |
| **Your organization plans for next 3–5 years to achieve Green targets** | **SD** | **D** | **N** | **A** | **SA** |
| Documented targets for carbon footprint reduction | [ ] | [ ] | [ ] | [ ] | [ ] |
| Investment funds dedicated to incorporate Green policies | [ ] | [ ] | [ ] | [ ] | [ ] |
| Training plans and budgets to help employees understand Green issues | [ ] | [ ] | [ ] | [ ] | [ ] |
| Seek external help for upgrades to a Greener business system | [ ] | [ ] | [ ] | [ ] | [ ] |
| Modify the current business processes to incorporate environmental needs | [ ] | [ ] | [ ] | [ ] | [ ] |
| Create power management policies to reduce energy consumption | [ ] | [ ] | [ ] | [ ] | [ ] |
| Methodology to undertake suitable and defensive power consumption | [ ] | [ ] | [ ] | [ ] | [ ] |
| Use of power management software | [ ] | [ ] | [ ] | [ ] | [ ] |
| Others (Specify) _____ | | | | | |
| **SaaS (Software as a service)/cloud computing: Your ICT strategies include** | **SD** | **D** | **N** | **A** | **SA** |
| Use of SaaS in reducing carbon emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Use of process reengineering to reduce waste | [ ] | [ ] | [ ] | [ ] | [ ] |
| Use of Cloud computing to implement environmental policies | [ ] | [ ] | [ ] | [ ] | [ ] |
| Use of new ICT initiatives as part of a strategy to reduce power consumption | [ ] | [ ] | [ ] | [ ] | [ ] |
| Others (Specify) _____ | | | | | |
| **ICT devices can play a significant role for checking emissions and waste in an organization as they can** | **SD** | **D** | **N** | **A** | **SA** |
| Provide real time statistical data | [ ] | [ ] | [ ] | [ ] | [ ] |
| Configured and managed from central services in an organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| Configured in any designated boundary in the organization | [ ] | [ ] | [ ] | [ ] | [ ] |
| **Are you currently implementing or planning to implement the following in your organization** | **SD** | **D** | **N** | **A** | **SA** |
| Operational (day to day) improvements to reduce carbon emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Strategic changes to how the business operates to reduce carbon emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Anticipate changes to governmental regulations related to carbon emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Influence governmental regulations related to carbon emissions | [ ] | [ ] | [ ] | [ ] | [ ] |
| Access new sources of capital/energy/raw material | [ ] | [ ] | [ ] | [ ] | [ ] |
| Improve your risk management with respect to environment | [ ] | [ ] | [ ] | [ ] | [ ] |
| Elevate corporate reputation by adopting Green strategies | [ ] | [ ] | [ ] | [ ] | [ ] |
| Identifying new market opportunities through adoption of Green strategies | [ ] | [ ] | [ ] | [ ] | [ ] |
| Enhance human resource management through Green strategies | [ ] | [ ] | [ ] | [ ] | [ ] |

## Questions: (To Enable)

**Question 1: Please explain two crucial reasons why a business like yours should adopt environmentally responsible business strategies.**

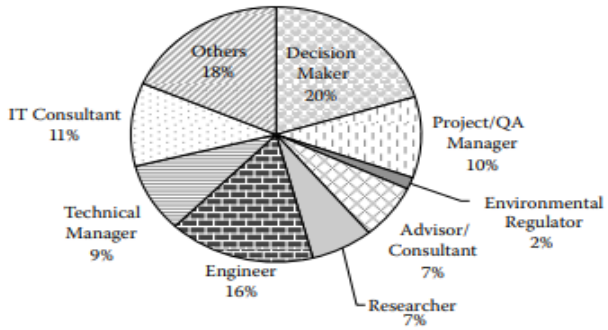
**Question 2: How do you believe emerging technologies (such as mobile, Web x.0, Cloud computing) should be incorporated in business to help to reduce the carbon footprint?**

**Question 3: What should be your organization's approach to incorporating Green issues into its business strategies?**

**Question 4: Suggest a crucial/critical action that could be taken by your organization to use renewable (Green) energy?**

**Question 5: What are the problems faced by an organization in collecting and validating environmental data (please include comments on methods, technologies, regulators, agencies, and business partners)?**

## Respondent Demographics:



## 5.2 CASE STUDY SCENARIOS FOR TRIAL RUNS:

**New Bank Carbon Scenario:**

New Bank is a hypothetical bank with head office in a large city on the Eastern coast of Australia. The bank has a large and established customer base, a 24,000 strong work force and a reputation to be proud of. The organization is supported with sophisticated suite of enterprise resource planning (ERP) software (including a SAP implementation, as also a powerful front-end customer relationship management (CRM)). Its past history indicates the bank has traditionally had close ties with the government. The senior management of the bank is keen to incorporate "Green IT" as an integral part of its business strategy.

**Following Is the Result of the Initial Green IT Audit Undertaken by the Bank:**

**Desktop Machines:**

- Numbers (total across the organization): 2 0,000 (12,000 conventional; 7,500 = laptops; 500 = thin clients)
- Value (current $): $1,200,000
- Status (how old/new, etc.): Most conventional PCs are between 2 and 3 years old
- Emissions data (as a rough estimate based on spreadsheet): 1,777,500 watts per hour
- Conventional = 12,000 × 110 w = 1,320,000
- Laptops = 7,500 × 60 w = 450,000
- Thin clients = 500 × 15 w = 7500

**Mobile Devices:**

- Numbers (total across the organization): 2 6,000 ( 2000 owned by the organization, rest individual)
- Value (current $): $250,000
- Status ( how old/new, etc.): those by individuals are new, the bank owned are averaging 2.5 years
- Emissions data (estimate): 10 w per day × 26,000 = 260,000 watts per day

**Printers and peripherals:**

- Numbers (total across the organization): 1000
- Value (current $): 500,000
- Status (how old/new, etc.): average age 4 years
- Emissions data: could not be estimated during the Green IT audit

**Data center IT and Communication Equipment:**

- Numbers (total across the organization): 12 + 4 = 16
- Value (current $): N/A
- Status (how old/new, etc.): 2-year old equipment
- Emissions data (if available—or estimate): 16 × 0.5 kW ph × 24 = 192 kw per day

**Network Devices: Routers**

- 10 devices
- 50 routers
- 20 switches

***Challenge:*** Apply Green IT strategies to New Bank to transition it to a green bank—with stated goals of 10% carbon reduction over every previous year for 3 years.

**Blue waters Travel Agency Carbon Scenario:**

Bluewaters is a small to medium travel agency operating out of New York. The company has an excellent, elite client base. The company is well-controlled and well-managed single-owner enterprise with approximately 25 employees. At any one time, the company has about eight computers running, together with associated paraphernalia. In addition, there are copiers, faxes, and shredders in the main office. Some employees do occasional telework, especially when they don't have to face a client.

**OpenAir Airline Carbon Scenario:**

OpenAir is a medium, regional airline operating out of the Asian region. The airline has been vulnerable to oil costs during most of its operation. However, with improved opportunities to fly to further destinations than the local region comes the challenge of controlling, reporting, and reducing the

carbon footprint. Following are the notes based on an initial investigation commissioned by the corporate board of OpenAir, in the context of carbon emissions.

- Economic viability of OpenAir is no longer independent of its carbon footprint.
- Passengers are expecting a much greater role from OpenAir in terms of carbon reduction than merely offering carbon off sets to passengers, especially as it expands beyond the Asian region.
- While electronic ticketing and check in has been introduced with some success, the board sees a need for mobile ticketing and check in.
- Need for sophisticated IT systems on the rise, especially in supporting the growth in passenger travels, especially in the business market.
- Fuel efficiency metrics are not tied to carbon metrics.
- Scheduling of flights, variations to those schedules, and rostering of staff (pilots, stewards) is not optimized. Besides, there is practically no telework culture within the organization.
- There is some understanding within the organization about carbon emissions from airline fuel, but hardly any acknowledgment and understanding of internal IT emissions.
- OpenAir has about 2000 desktop computers, 300 laptops provided by the organization to the employees, and unaccounted mobile devices. There is a single data Centre catering to all the IT systems requirements, with a non-real time off site backup that is a major risk to the airline's business.

## 5.3 APPLYING GREEN IT STRATEGIES

### Applications to Home:

**Peering through a green lens at your home office:**

The basic principles of greening involve reducing your consumption reusing what you can , and recycling the rest. This approach works not just for technology but also for the surrounding environment that supports. The following lists of questions help us look at the needs for office space through a green lens.

**Reduce:**

- Can you consolidate the area you use to create a compact but comfortable workspace?
- How can you use natural lighting to reduce the amount of electricity pumping into that area?

**Reuse:**

- How can you share resources in a way that benefits the rest of the house?
- What items in the attic could be given a second life in a home workspace?

**Recycle:**

- Are you planning to recycle all office supplies you can? Tonner, inkjet cartridges, paper, books and more.

**Choosing your office Location:**

- You do not 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 and each other.
    - Create your workspace in an area that is well ventilated and gets fresh air whenever possible.

**Talking Green Furnishing:**

- A desk, a chair, and maybe a bookshelf
- A small printer / router etc..
- Lighting
- Windows

**Find the Chair:**

- Use materials that are safe and healthy for the environment.
- Employ materials that can be reused, recycled, or composed.
- Use renewable energy in the manufacturing of the chair.
- Maximize energy efficiency in manufacturing.

**Bookcase and more:**

- Wood is beautiful and warm, and it adds beauty to the room. But if you had the option of looking at the beautiful tree growing outside your window or seeing that same tree across the room holding your books, which would you prefer?
- Today's green furniture designers dis agree cutting down of trees. They use cardboard shelves. The cardboard design company uses a honey comb cell shape to create furniture that is very sturdy and light weight as well.

**Lighting:**

- The lighting in your workspace may have a lot to do with. Using natural blinds both helps reduce glare and reflection of light into the room.
- Painting the walls in light color helps to brighten the room and makes use of natural light.

**Plants:**

- Decades ago research showed that plants have feelings and respond to other life forms in their environment.
- The lady palm has a fan like leaf that can get very large. It is resistant to insects and cleans the air very effectively.
- The bamboo tree cleans the air of toxins such as formaldehyde and humidifies the air.

**Sustaining Green Practices:**

Part of keeping your workspace green involves making sure your daily work practices stay green as well.

- ***A print plan :*** Only , print items that you review on the page and only use paper with a high percentage of post-consumer recycled material.
- ***An Energy use plan****:* 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.
- ***A Resource use plan :*** Use rechargeable batteries whenever possible for devices.

**HOSPITAL:**

**Good Mead Hospital:**

Good Mead is a hypothetical large hospital in a metro city, providing public sector medical services. These services cover various areas of health including the standard outpatient department providing regular consultation to patients, as also various specialties 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 of electronic patient records ( EPR),

laboratory equipment management, medical drugs and material management, and management of equipment's and buildings were undertaken.

Initial opinion of the auditors and that of the tentatively appointed chief green officer (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. Further to the attention on processes in terms of their carbon reduction, the initial investigation also highlighted that Good Mead 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.

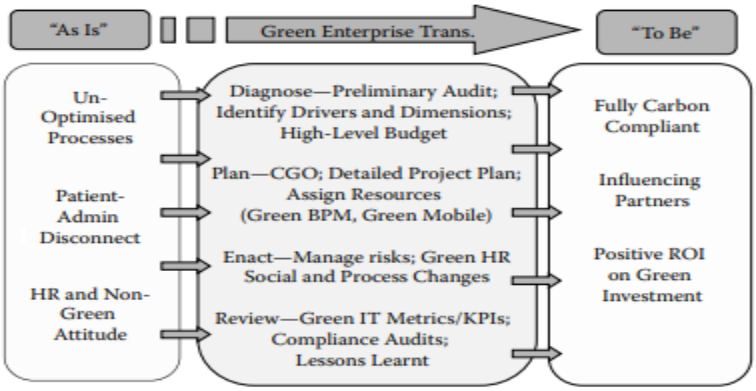
**Preliminary Green Investigation:**

Following is a list of the noteworthy findings from the preliminary Green IT audit of Good Mead 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 peripherals—such as printers. 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.
- 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 times happening manually.

**Green Business Objectives:**

The green business objectives of Good Mead hospital are based on the results of the preliminary investigations into its Green IT maturity level.




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. This "to be" state of the hospital is based on the formation of green objectives of the organization.

Following are the important objectives of Good Mead 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.
- 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.

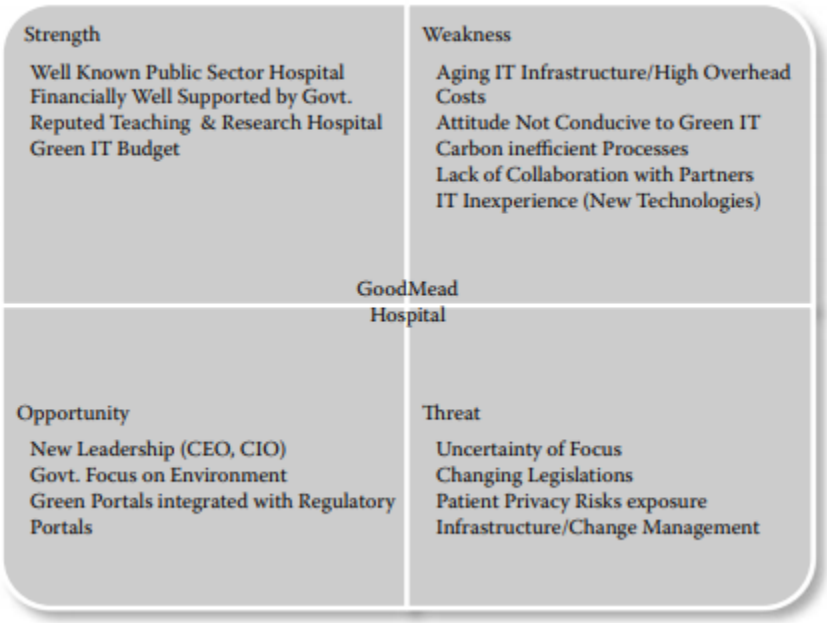
**SWOT of Good Mead Hospital:**

SWOT analysis is helpful in understanding the approach that can be taken for the GET. A SWOT analysis makes it easier to understand how to capitalize on the inherent strengths of the hospital.

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

***Strengths:***

- ***Well-known public sector hospital***. This is popularity of the hospital is an important impetus for the hospital to undertake GET. The impact of such transformation will be far reaching, beyond the hospital. There is significant support to the hospital in terms of patients and corporate.
- ***Financially well supported by government***. Good Mead has been a flagship hospital in the region, with sufficient funding from the government over the last decade, enabling it to undertake its services, together with its research and training.
- ***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***. There is an atmosphere of research and experimentation. Therefore, 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***. The preliminary Green IT audit finds that the data center is more than 10 years old and the average server is 4 years in use. This implies a rapidly aging 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 few volunteer staff indicated clearly that the attitude within Good Mead 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 inefficient processes.*** Numerous processes were identified at the organization level that was carbon inefficient. These processes included patient management, inventory management, and staff rosters. The IT systems supporting these systems were also not carbon efficient. There were no technology innovations within the systems such as use of Cloud computing or web services.
- ***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. Therefore, there was little initiative from the current IT management to undertake major changes relating to carbon reduction.

***Opportunities:***

- ***New leadership (CEO, CIO).*** One of the most significant opportunity Good mead has to develop and implement environmentally responsible business strategies are the formation of the new leadership team.
- ***Government focus on environment***. The regulatory bodies are now getting a push through government initiatives on carbon reduction. As a result, new legislative requirements are about to be implemented, making it mandatory for large organizations in particular, to calculate and report their carbon emissions.
- ***Green portals integrated with regulatory portals.*** The push from the government for carbon reduction is not only an opportunity for the hospital to transform its business models, portfolios, and data centers, but also upgrades its IT systems and portals with carbon data and information.

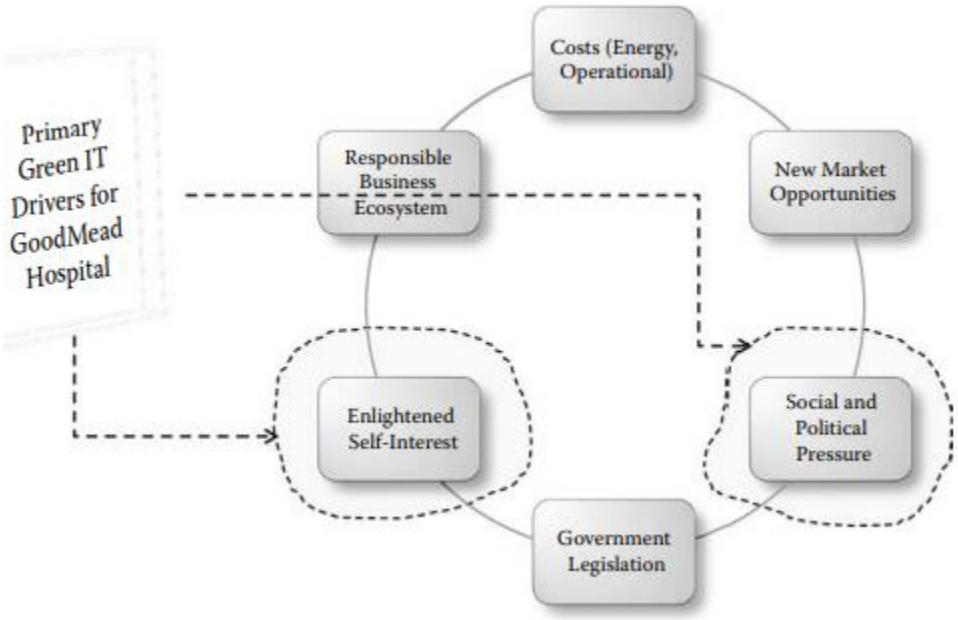
***Threats:***

- ***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.
- ***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:**

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

Social political pressure, and enlightened self-interest as the two key drivers for ERBS. These two drivers are described as follows:

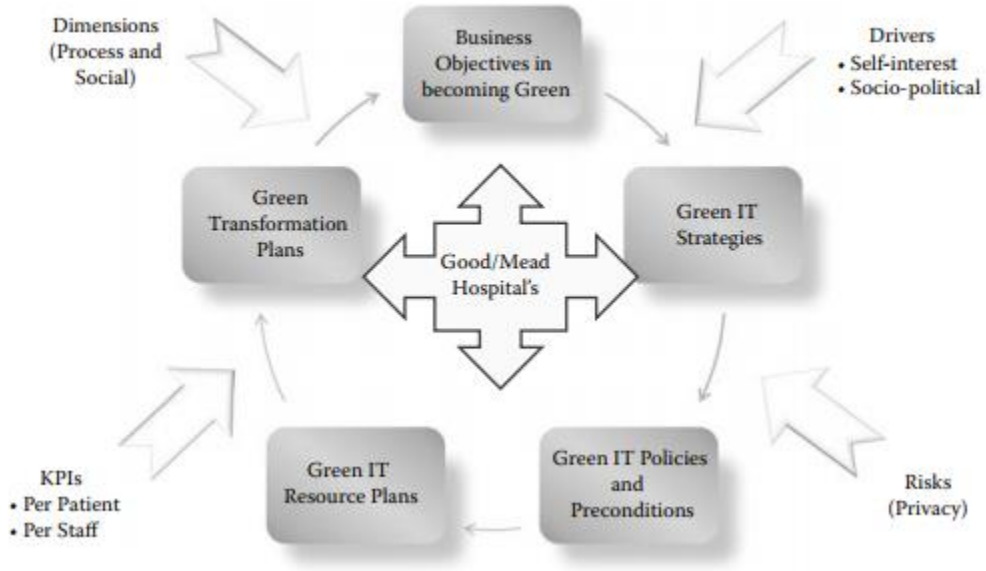



- ***Sociopolitical pressure***: The hospital has a substantial standing in the community. Besides, it is also a flagship hospital within the region. There is significant social and political pressure on the hospital to demonstrate its environmental credentials. This pressure comes from the general

community that views the hospital as a symbol of good service-based organization and cross-section of patients (e.g., youngsters, sports-people).

- ***Enlightened self-interest***: The senior management of the hospital, the leaders/decision makers is keen to take up the challenge of changing their processes and internal social attitude to a positive, green attitude.

**Steps in Developing a Hospital's ERBS:**

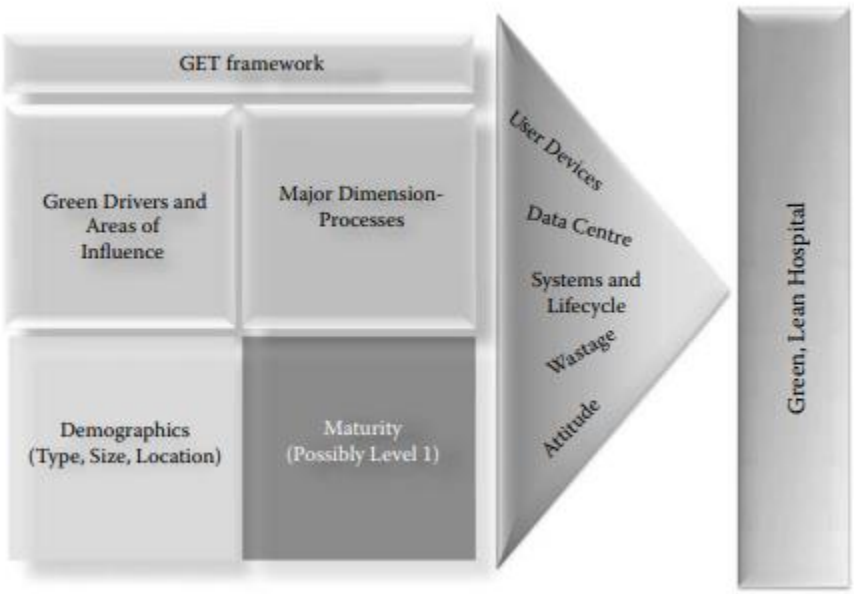



Here the figure not only serves as a reminder for the steps in developing an ERBS for the hospital, but also shows the key drivers, dimensions, risks, and metrics for this Good Mead ERBS.

- ***The business objectives of the hospital in becoming a green hospital were identified earlier on***. These objectives and visions provide the initial direction for the hospital in its strategy formulation. The drivers for the objectives are enlightened self-interest and sociopolitical pressure on the hospital.
- ***Green IT strategies****:* These are the medium terms (3–5 year) strategies that are 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:*** These are the policies that are formed at the departmental level and are implemented in practice by the departmental heads and/or process owners.
- ***Green IT resource plans:*** These include details of resources required in undertaking transformation.

- ***Green transformation plans:*** These are the business transformation and change management plans that will focus on the dimensions and the work areas.

**Green Transformational Elements:**




- The major dimension along with the GET will take place. This is the process dimension also supported by the social dimension for transformation.
- The demographics of the organization can play a role in deciding on the type of transformation, its budgets, and its resources. In case of Good Mead hospital, these demographics are large-sized service organization in a metropolitan city of a developed region.
- Maturity of Good Mead in terms of its Green IT performance is very basic.

Once these aforementioned aspects of Good Mead are ascertained, the transformation of the hospital can be undertaken as follows:

- ***User devices***—Measuring, upgrading, and recycling monitors, PCs, laptops, and 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, treatment, prescription, and education; Equipment procurement, installation 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.

**Case Study in applying Green IT Strategies to the Packaging industry:**

**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 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. The carbon emissions from its production lines are on the rise, and also the electronic and other wastages. The 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. The local regulatory authorities are also showing interest in AuPack's carbon footprint. The products of AuPack include variety of packages that are made up of materials such a s cardboard, foam, plastic, choir, and rubber. These packages or containers are sold to other manufacturers who use them to wrap, store, and distribute their own products, including food (raw, finished, liquids), medical drugs, equipment's, and electronic goods (such as TV, computers, toys). The 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. These are business processes that are a combination of manual, paper-based, and electronic (local, spreadsheet based, and system supported) processes.

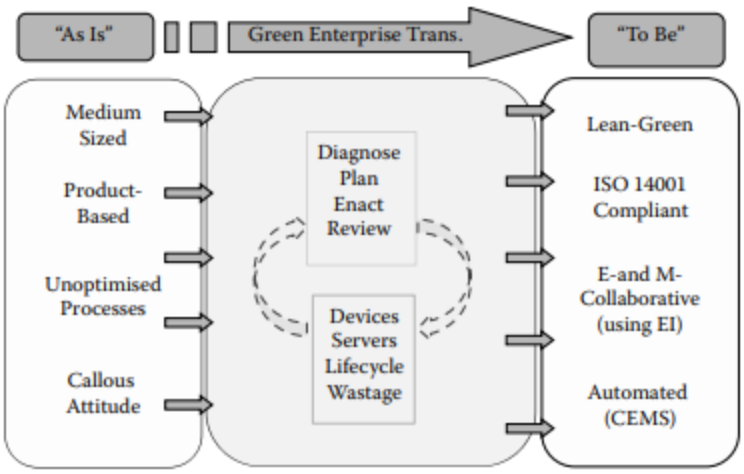
A recent internal audit revealed that the organization has around 350 desktop machines, close to 100 laptops, and two large data servers in a small, backend data center. Most PCs have been in use for 5

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. The 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.
- Workers are dedicated to the company. However, most workers have had very basic education, and in some case no education at all.
- 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.
- 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)

The following figure summarizes the overall approach to Green enterprise transformation (GET) of AuPack. The "as is" state is ascertained through an initial investigation based on an early, approximate Green IT audit. The "to be" or desired state, according to the initial vision statement of the CEO, is for AuPack to be a lean-green organization. This term indicates that the organization is interested in both cost and carbon issues and not one over the other.




**AuPack's Green IT Strategies:**

As a result of the initial audit, the CEO has appointed a new CGO—the chief green officer. This lady, with an IT background, currently leads the computer-aided design (CAD) department of AuPack. This department has been heavily involved in the use of computers to create new packaging design based on customer requirements. The CGO has gone through the initial Green IT audit report, discussed it with the auditors and also with the CEO and has immediately formed a working group. This working group will become the GET team that will undertake the change. The approach taken by the CGO is summarized in the following Figure.


- Immediate focus on use and capitalization of technologies with the creation of a Green IT portal.

- Launching of a GET program that is going to enable compliance with ISO 14001 standards; however, this program has to work alongside the existing ISO 9001 compliance and certification program of Au Pack.
- Understand the growing environmental awareness of all its customers—with the input 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 greenness.
- Develop a green market that will be specifically based on the lean-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.

**SWOT of Au Pack in Green Context:**

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 Au Pack's Green IT challenges and capabilities.

***Green IT Strengths:***

- The incoming CEO realizes that for Au Pack to survive and prosper in the carbon economy there is a need to create and implement a comprehensive Green IT strategy. This visionary leadership in itself is strength of the organization and is recognized by the CGO who is able to work closely with the CEO.
- Au Pack is progressing well financially with its business and its profit margins are on the rise. This 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 distribution network includes strong partnership with local and overseas transporters.

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

***Green IT Weaknesses:***

- The 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.
- The software systems for Au Pack have proliferated as there was little control over the purchase and installation of computers.
- The 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. The shift managers are the only people from the shop floor who make use of the IT systems for production planning.
- Most workers of Au Pack are not serious about environmental issues. This is not their personal weakness, as the socioeconomic background from where they come had little opportunity to consider the environment.
- Noticeable wastage in packaging products and IT—this wastage is derived from the non-optimized production processes that are unable to capitalize on the production planning and execution systems of the organization.

***Green IT Opportunities:***

- Leadership of Au Pack 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 leap 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. This 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.
- Inexperience i n undertaking GE T in the region—there is hardly a known organization in the developing region where Au Pack is located, that has undertaken successful GET. Therefore, there are risks associated with this transformation.

**Diagnosis in Au Pack:**

The initial investigation of AuPack in terms of its green credentials, and the SWOT analysis provides impetus to carry out the full GET. Formal diagnosis of AuPack will lead to a detailed understanding and formalization of the drivers and the ensuing dimensions of GET.

- The 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. Thus, 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.
- Regional environmental legislation requires AuPack to monitor and report its overall carbon emissions. The 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.

The 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.

**Planning for GET:**

- 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.
- 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.
- Operational organization and green HR resulting from changes to the people structure as a result of green initiative.

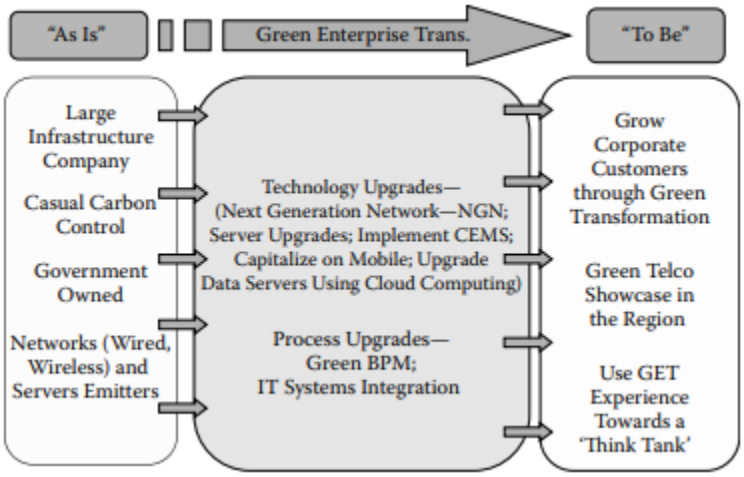
## APPLYING GREEN IT STRATEGIES AND APPLICATIONS TO THE TELECOM SECTOR:

**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 focus of ZeeTel's business has been the creation of the telecom platform that provides the backbone for communications infrastructure in that geographical region.

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). There 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. 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 a year ago, mainly in response to the growing demands for environmental consciousness from

its corporate customers. The following figure summarizes the overall approach to GET undertaken by ZeeTel.




Following are specific highlights of business and technology advantages of the GET approach of ZeeTel.

- Growth in business, particularly with corporate customers, due to carbon reduction and 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.
- 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. Penalties and fines are not only costly exercise, but also create a loss of face for the organization and its leadership position.
- Make good use of mobile technologies and services which, while requiring additional power to operate, also create opportunities to significantly reduce carbon.
- Create and promote policies to help the corporate customers with their own Green IT strategies, such as recycling of handsets.

**SWOT of ZeeTel—Environmental Context**

**Strengths:**


- Government owned and supported organization that is aware of the upcoming legislations in the carbon context. This 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.
- Excellent channel relations including corporate partners and government representatives.
- Growth forecast for ZeeTel implies an opportunity for steady revenue that frees the organization to focus on its Green IT effort. This growth in telecom users, however, also brings in the challenge of handling the corresponding growth in carbon.

**Weakness:**

- 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. These IT systems are in siloes that do not “talk” with each other, requiring considerable effort at maintaining them.

- 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.
- Business shift to mobile platform resulting in reducing needs for physical wired connectivity and corresponding reduction in the required infrastructure.

**Threats:**

- Resistance to change resulting from a large, strong, unionized 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.
- 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.

## UNIT: V

## CASE STIDIES

**PART-A (*2 Marks*)**

1. **List out the understanding of current business scenario in your organization?**
    - The way people use the processes.
    - The current product or service portfolio.
    - Underlying technologies that support business.
    - Identify KPI of business.
2. **List out the terms adopted by your organization to adopt green policies?**
    - Reduction of energy consumption.
    - Reduction of carbon foot print
    - Reduction of operational costs.
    - Improvement of reputation of organization.
    - Meet government regulations and legislation.
3. **Give the ICT practices that have been adopted by your organization?**
    - Videoconferencing
    - Telecommuting
    - Fleet and force management
    - Web and emails
    - Mobile phones / PDA's
4. **Illustrate the practices regarding energy saving data centers?**
    - Energy saving choice when purchasing new ICT hardware.
    - Reducing energy used by data centers.
    - Use open source system software.
    - Machine server virtualization.

- Replace conventional with electronic friendly devices.

5. **Define the term compliance audits?**

   ✓ Well documented model for carbon emissions.

   ✓ Regular updates and modifications of environmental parameters.

   ✓ Standard approach to accessing government rules and regulations.

   ✓ Provides feedback to government.

   ✓ Periodically check environmental documents of the vendor.

6. **List some strategic measures for reducing emissions?**

   ✓ Use of ICT.

   ✓ Use of Government regulations.

   ✓ Implement Monitoring methods.

   ✓ Use solar / wind energy.

7. **What are the 4 major phase of transformation in Green Mead hospital?**

   i. Diagnose

   ii. Plan

   iii. Enact

   iv. Review

8. **Write some objectives of Green Business?**

   ✓ Reduction in carbon emissions across all departments and process of the organization.

   ✓ Aim for a comprehensive and holistic GET that is futuristic.

   ✓ Create positive green attitude across the entire staff through Green HR.

9. **What are the steps to develop a hospital ERBS?**

   i. Business Objectives in becoming Green.

   ii. Green IT Strategies.

   iii. Green IT policies and preconditions.

   iv. Green IT resource plans.

v. Green Transformation plans.

**10. Define AuPack scenario?**

AuPack is a hypothetical organization in the business of manufacturing packages and containers that in turn are used by other manufactures of goods and products.

**11. What are the two drivers for environmental business?**

i. Sociopolitical Pressure.

ii. Enlightened self-interest.

**12. List out the Weakness of Green IT?**

i. The technical infrastructure of the organization is aging.

ii. Most workers of AuPack are not serious about the environmental issues.

**13. What are the GET areas in AuPacks?**

i. Customers and partners.

ii. IT systems and applications.

iii. CEM's (Carbon Emission Management Software).

iv. SLA's (Software level Agreements)

v. External and internal business process.

vi. Operational Organization.

**14. Define the Scenario of Zeetel Telecom Service?**

Zeetel is a hypothetical large telecom company operating in the African region. It is responsible for the core telecom infrastructure in the region, I addition to offering some land based and mobile services.

**15. List the noteworthy findings from green IT audit undertaken by bank?**

- The preliminary Green IT audit reveals that the bank had a significant carbon foot print.
- Reviews of systems, printers, consumers and workers were undertaken.
- Opinion of CGO officer will reduce the carbon foot print.

## UNIT: V

## CASE STUDIES

**PART-B (*16 Marks*):**

1. Write in detail about ERBS with a case study scenario?
2. List out some of the case study scenarios for trial runs to experiment with their Green IT Strategies?
3. Briefly explain about the application to a home in Green IT Stretegies?
4. Briefly explain about the guidelines for preliminary green investigation, Green Business Objectives and SWOT of Good Mead Hospital?
5. List out the steps in developing a hospital ERBS?
6. Explain AuPack Scenario, strategic approach and SWOT in Green IT?
7. Briefly explain about Telecom Scenario and SWOT for ZeeTel Telecom services?

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