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CS8078

Green Computing

Computer Science and Engineering

2023 – 2024 / IV Year

Created by:

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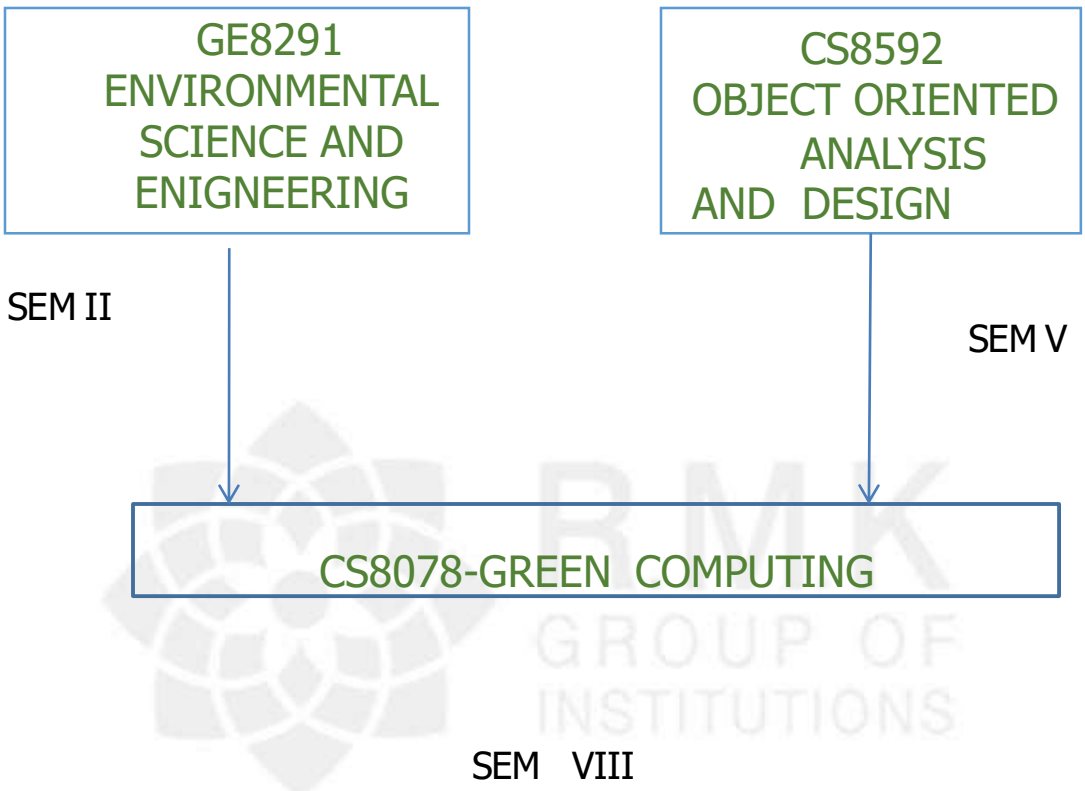
10-08-2023

Table of Contents

Course Objectives

- To learn the fundamentals of Green Computing.
- To analyze the Green computing Grid Framework.
- To understand the issues related with Green compliance.
- To study and develop various case studies.
- To explain the Strategies of Environmental Intelligence to Green Organization.

Pre Requisites



SYLLABUS

CS8078 GREEN COMPUTING L T P C
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UNIT I FUNDAMENTALS

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.

UNIT II GREEN ASSETS AND MODELING

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.

UNIT III GRID FRAMEWORK

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.

UNIT IV GREEN COMPLIANCE

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

UNIT V CASE STUDIES

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..

Course Outcomes

At the end of the course, the student should be able to:

S.No	Description	CO	HKL
1	Acquire knowledge to adopt green computing practices to minimize negative impacts on the environment	CO1	K2
2	Enhance the skill in energy saving practices in their use of hardware.	CO2	K3
3	Evaluate technology tools that can reduce paper waste and carbon footprint by the stakeholders	CO3	K3
4	Understand the ways to minimize equipment disposal requirements	CO4	K2
5	Explain the Strategies of Environmental Intelligence to Green Organization	CO5	K2
6	Summarize the controlling methods and tools to increase Green productivity of the Organization	CO6	K3

*HKL - Highest Knowledge Level

6. CO - PO / PSO MAPPING

CO	HKL	PROGRAM OUTCOMES												PSO		
		K3	K4	K5	K5	K3, K4, K5	A3	A2	A3	A3	A3	A3	A2	PSO1	PSO2	PSO3
		PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12			
C203.1	K2	2	1	-	-	-	-	-	-	-	-	-	-	2	2	1
C203.2	K3	3	2	1	-	3	-	-	-	-	-	-	-	2	2	-
C203.3	K3	3	2	1	-	2	-	-	-	-	-	-	-	2	1	-
C203.4	K2	3	2	1	1	2	-	-	-	-	-	-	-	-	-	-
C203.5	K2	3	2	1	1	2	-	-	-	-	-	-	-	-	-	-
C203.6	K3	2	1	-	-	1	-	-	-	-	-	-	-	-	-	-

Correlation Level - 1. Slight (Low) 2. Moderate (Medium)
3. Substantial (High), If there is no correlation, put "-".

LECTURE PLAN

UNIT 1 FUNDAMENTALS

S. No	Proposed Lecture Date	Topic	Actual Lecture Date	CO	Highest Cognitive Level	Mode of Delivery	Delivery Resources	LU Outcomes	Re Mark
1	07.08.23	Green IT Fundamentals	07.08.23	CO1	K2	MD1	R1	Understand the fundamentals of Green IT.	-
2	09.08.23	Business, IT, and the Environment	10.08.23		K2	MD1	R1	Understand basic concepts of business , IT and the environment	-
3	11.08.23	Green computing: carbon foot printting	11.08.23		K2	MD1	R1	Understand the Carbon footprint	-
4	12.08.23	Scoop on power	12.08.23		K2	MD1	R1	Understand the concept of scoop on power	-
5	16.08.23	Green IT Strategies	16.08.23		K2	MD1	R1	Understand Green IT Strategies	-
6	17.08.23	Drivers, Dimensions, and Goals	17.08.23		K2	MD1	R1	Learn the different types of Drivers, Dimensions and Goals	-
7	17.08.23	Environmentally Responsible Business	18.08.23		K2	MD1	R1	Learn the Environmentally Responsible Business	-
8	18.08.23	Policies, Practices, and Metrics	18.08.23		K2	MD1	R1	Understand the Policies, Practices, and Metrics	-
9	19.08.23	Green IT Readiness and CMM	19.08.23		K2	MD1	T1	Knowing current Green IT Readiness and CMM	-

ASSESMENTCOMPONENTS

AC 1. Unit Test AC 2. Assignment
AC 3. Course
AC 4. Course Quiz AC 5. Case
AC 6. Record Work
AC 7. Lab / Mini Project AC 8. Lab Model Exam AC 9. Project Review

MODE OF DELIVERY

MD1. Oral Presentation
MD2. Tutorial
MD3. Seminar MS4. Hands On MD5. Videos
MD6. Field Visit

Activity Based Learning

Activity Zone

A group of students are asked to do a presentation by How much Energy consumption in different components.

Class Notes

Unit 1 - Introduction

INTRODUCTION TO GREEN COMPUTING

- 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.
- When a reduction in carbon is allied with the economic drivers of a business, the search for justifying the moves to become relatively straightforward.

Definition of Murugesan: (2008) that is particularly comprehensive: "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 communications systems) efficiently and effectively with minimal or no impact on the environment."

- This definition can be interpreted as serving an organization's attempt to achieve economic viability and improve system performance and use, while abiding the social and ethical responsibilities.

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Lamb (2009): "Green IT is the study and practice of using computing resources efficiently."Carbon efficiency has to be imbibed in the overall efficiency and effectiveness of the organization.

- The time to explore, investigate, and experiment with the existing and future technologies and processes that can be used to dual advantage—business efficiency.
- This is so because starting right with an individual's attitude and working life style, Green IT is shown to affect the way the business is organized, its underlying infrastructure, and the formulations of its regulatory policies. Government rules and regulations, carbon off sets and carbon trading underpin both legal and economic requirements, which, in turn, are shaping the businesses of now and the future.

Yousif (2009) in his keynote Towards Green IT, says "serious Collaboration between technologists, developers, researchers, consumers and politicians is needed to achieve green and sustainable ICT."

The business and the environmental domain working together, the need to debate on real cause of climate change a lso starts fading.

- Environmentally responsible business strategies (ERBS) around a very practical viewpoint: "an efficient business, by default, is also a environmentally-efficient business."

An efficient business will, in most cases, emit less carbon in the environment.

- This can be the result of highly optimized data entry using mobile devices, obviating the need for any printing in the process or
- simply automated, digital authorization. Apart from the operational efficiencies that also eliminate the carbon wastage points, similar arguments also apply for the organization's long-term strategic assets and infrastructures including building and facilities, furniture and equipments, vehicular fleets, inventories, supply chains, human resources, and the overall administration of the business.

The Environment Today

- The facts are considered (and not necessarily the philosophical discussion as to who is creating this climate change), then it is plain and obvious that the Earth as it stands (or revolves) now will run out of coal and oil.
- This also implies that the source for plastics and related chemicals will dry up; but the pollution and wastage generated from these plastics will remain with us.
- The information technology (IT) affects business, which, in turn, influences the society and the overall environment in which the business exists.
- This direct influence of IT is seen in the massive proliferation of household gadgets, use of computers in schools a nd hospitals, the popularity of social networking, and the high level of communications technology (such as a GPS) in vehicles.

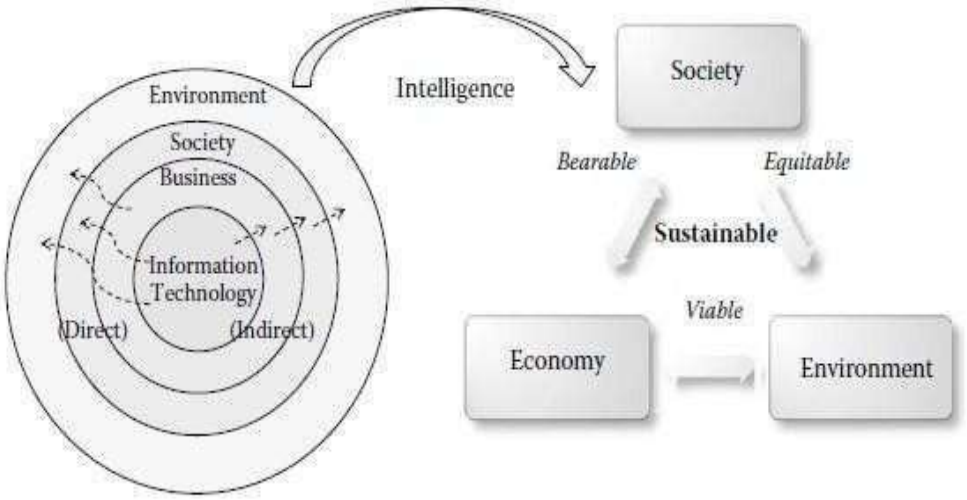

Figure 1.1 Information technology influences business, society, and environment—lead up to the sustainable triangle.

- This viewpoint is depicted on the right side in Figure 1.1, wherein the sustainable triangle of an organization is shown to be made up of a balance between society–economy (how much canthe society bear?), economy–environment (is the environmental initiative viable?), and society environment (is the environmental consideration equitable?). The quest for the answers to these questions forms the basis of *this* Green IT initiative—and its fundamental principle is to have the economic, social, and environmental factors in balance.
- This holistic, balanced approach to the business and the environment is strongly repeated through the thought processes of various consulting practitioners and researching academics.
- The varied viewpoints in that handbook range from the need to optimize supply chain processes, switching off computers when not in use, and designing low-carbon emitting microprocessor chips to creating long-term awareness about the environmental protocols and standards, incorporating carefully construed carbon metrics and measurements, and changing attitudes of users and employees through education and training.
- As Jonathan Lash and Fred Wellington advise businesses in their Harvard Business Review article (2007), "Companies that manage and mitigate their exposure to climate-change risks, while seeking new opportunities for profit, will generate a competitive advantage over rivals in a carbon constrained future."

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Information Technology and Environment

- The synergy between business and IT implies that grow thin business also implies corresponding growthin IT. This, in turn, also implies greater IT-based carbon generation.
- The greater the interactions between IT and business, the more are the amount of carbon pumped in the environment.
- The greater the intensity of business activities, the higher is the carbon generation.

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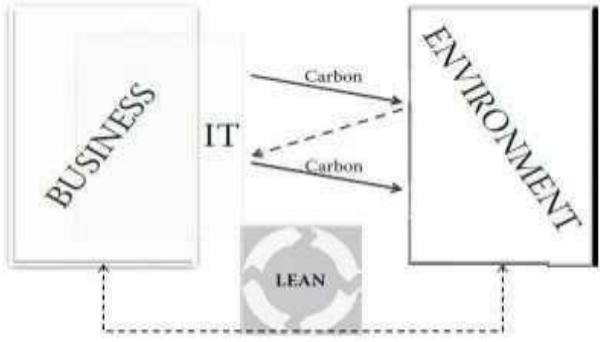

Figure 1.2 Interplay of business and environment through information technology.

- Attempts to depict this ongoing interplay between the business and the environment. The IT sheath that encompasses the business is shown on the left in Figure 1.2. 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: from the length of time, the depth of activity, and the breadth of coverage of the carbon effect.
- The lean approach to business is thus easily applicable to the Green IT strategies; as a lean business would also have a corresponding lean IT opening up the idea that lean is green.
- The concepts of lean business in the background, helps in ascertaining the areas of business that are particularly carbon intensive. Consider, for example, a simple web-enabled process for paying insurance premiums. The manual process of payment was by posting a cheque (check), whereas payment can now be performed using BPAY or credit card either online or on the phone. This electronic process will generate carbon that is direct result of use of IT in the process.
- These respective IT areas have a dual influence: the increase in business activities through these packages increases the carbon footprint of the organization, but the optimization of the business processes and backend IT servers and networks has the potential to reduce the carbon footprint of the organization.

Software Applications and Packages
Carbon Trading Applications
Green Enterprise Architectures Green Infrastructures DynamicSocial Groups
Green Peripheralsetc.,

Table 1.1 Major IT Area Influencing Environment

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

Business and Environment

- The business and the environment interact with each other primarily through IT. IT has served businesses well by enabling them to expand their capacities, providing them with global customer reach, and enhancing their customers' experience. IT has also enabled businesses to optimize their internal processes such as inventory management and HR management and cut their operational costs through process automation. Making them cost efficient and/or enabling businesses to grow and expand. Care in the use of IT to ensure minimal carbon footprint is now becoming a priority for both business and IT.
- Consider, for example, recent developments in IT (e.g., high-end data servers, sophisticated desktop computers with their low-power using monitors and myriad varieties of laptops), telecommunications (e.g., broadband Internet, mobile devices, transmission towers, switch gears), and associated technologies (such as the ever improving gadgetry of the ubiquitous photocopiers and shredders). These technologies have been used by businesses but an argument can now be made for those businesses to pay attention to the use of these same technologies to re duce their overall contributions toward GHG emissions
- An individual, or a single department, can always at tempt to become green by applying its own procedures a nd practices so l ong a s t he effects of these changes is not to increase in carbon and costs elsewhere.
- The increasing impact of legislation also implies that the directors a nd leaders of the organization would become responsible for the carbon emissions of the organization. This responsibility of the directors is akin to the responsibility of the directors for the financial performance, governance, and rep orting of the company's financial data. A nticipating a Sa rbanes-Oxley (discussed by Raisinghani and Unhelkar, 2007) type legislation that impacts carbon performance and reporting would not be out of place; a legislation that places personal responsibilities of the emissions on the directors.

Green Enterprise Characteristics

- The various levels and ways in which IT affects the carbon footprint of an organization.
- Green enterprise with different areas of IT directly responsible for emissions, and other areas that go beyond just the IT aspect of an organization's carbon footprint.
- Four layers of a Green IT vision of an enterprise,

IT as a Producer IT as an Enabler

Green Enterprise

Green Collaboration

Envisioning green enterprises—beyond Green IT

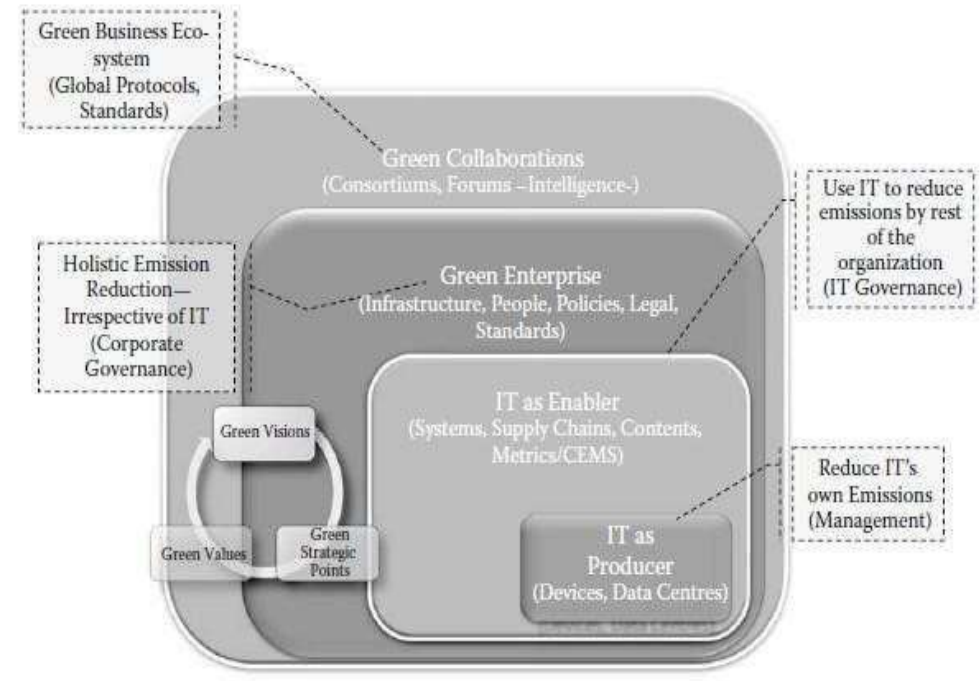

Figure 1.3 Envisioning green enterprises—beyond Green IT.

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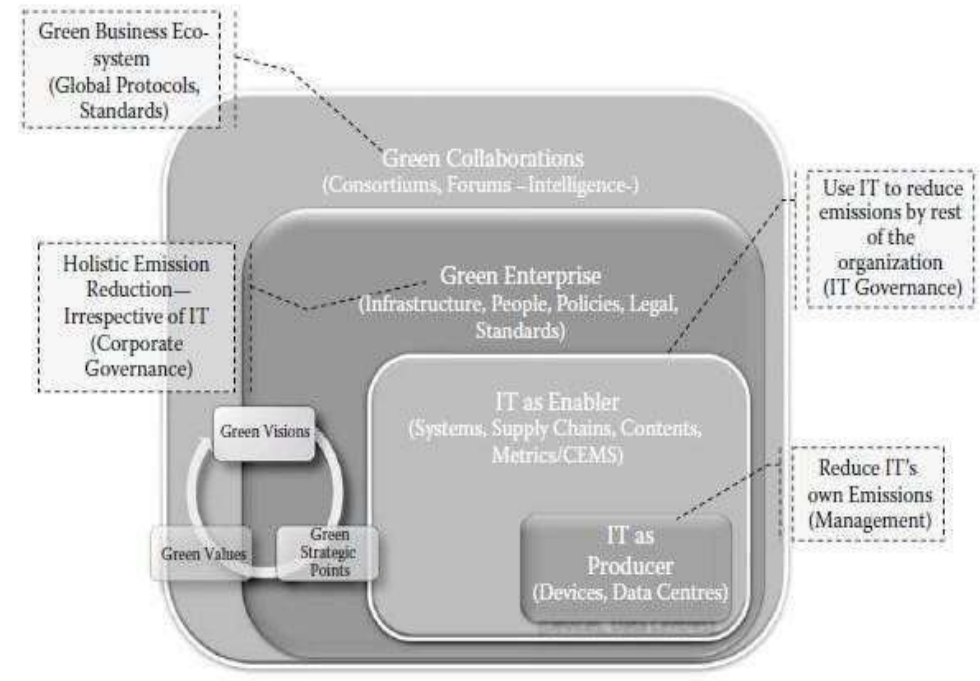

Figure 1.3 Envisioning green enterprises—beyond Green IT.

IT as a Producer

- An organization at Green IT is to handle the emissions produced by the IT gadgets themselves.
- Aims to reduce IT's own emissions.

IT as an Enabler

- IT includes its use to enable reduction of emissions across all areas of an enterprise.
- GEMS & IT governance play a role at this level of a green organization.

Green Enterprise

- The level of an organization that is holistically applying environmental strategies to all aspects of its business—irrespective of IT.
- Areas that may not be directly IT but are supported by IT.

Green Collaboration

- Going beyond a single enterprise, this is a collaboration of green enterprises .
- Aim to reduce carbon emissions across multiple organizations.
- The Green enterprise and the Green collaborations are the end result of effort that is long term and strategic.
- Moran and Riesenberger (1996) have expanded these elements into a number of core organization characteristics that can be called the vision, strategic points, and values.

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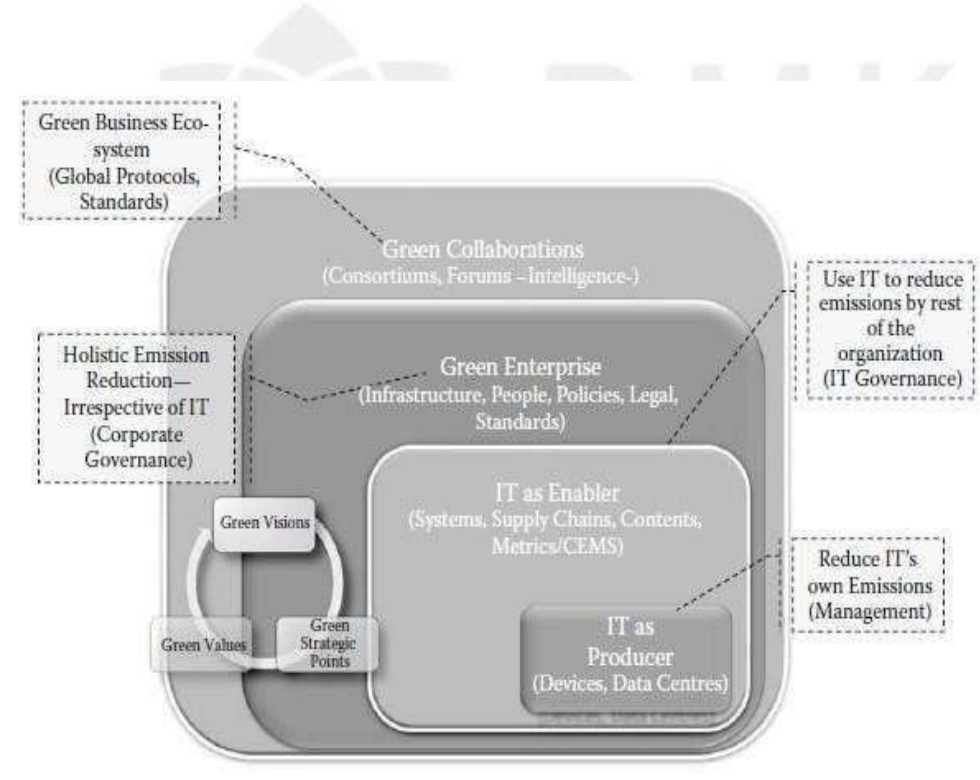

Figure 1.3 Envisioning green enterprises—beyond Green IT.

Green Vision

- A sectional or fragmentary approach to the vision will not lead to a green organization which
- the CEO, together withthe board, will understand and analyze the trend of environment factors and review the positioning of the enterprise as well as the industry in the context of these trends.
- Presentation and discussion withthe employees and the incorporation of their viewpoints also needs to be incorporated in this green vision.
- Vision can include not only what a carbonefficient organization will be, but a lso new avenues of business in the new green markets.
- Need acceptance and support across the organization, external stakeholders can also provide valuable input to this vision, especially if they have themselves experienced change due to their own green enterprise transformation

Green Strategic Points

- seismograph that w ill show ups and downs at many different spatial-temporalpoints within the organization.
- impact the structural and dynamic aspects global organizational context—have challenges, pressure points, and obstacles that are spread across the entire organization.
- For example, dynamic process aspect of an organization creates pressure by having wasteful processes with slack in them, requiring action by management. Temporally, the organization may do we ll at one time in one area of business but not so well at others.
- organizational structures and dynamics are continuously vying against each other, creating pressure points.

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- organizational structures and dynamics are continuously vying against each other, creating pressure points.
- If these pressure points can be identified, then those are also the precise points for action when it comes to green enterprises
- organization feels the pressure when forces pull the organization in different direction: static versus dynamic, structural versus process oriented, high throughput versus efficiency, and low costs versus low carbon.
- A green strategic plan is the core business plan of the organization but now produced withrespect to the green pressure points of the organization.

Green Value

- The creation of green strategies and their implementation is eventually meant to produce this long-lasting green value for the organization.
- This value is a combination of tangible and intangible benefits to its employees, customers, and shareholders
- Importance of green value to business has to be measured through appropriate ROIs.
- Some aspects of the green value may not be directly measurable— and may produce returns to the organization that may be intangible.

Green IT Opportunity

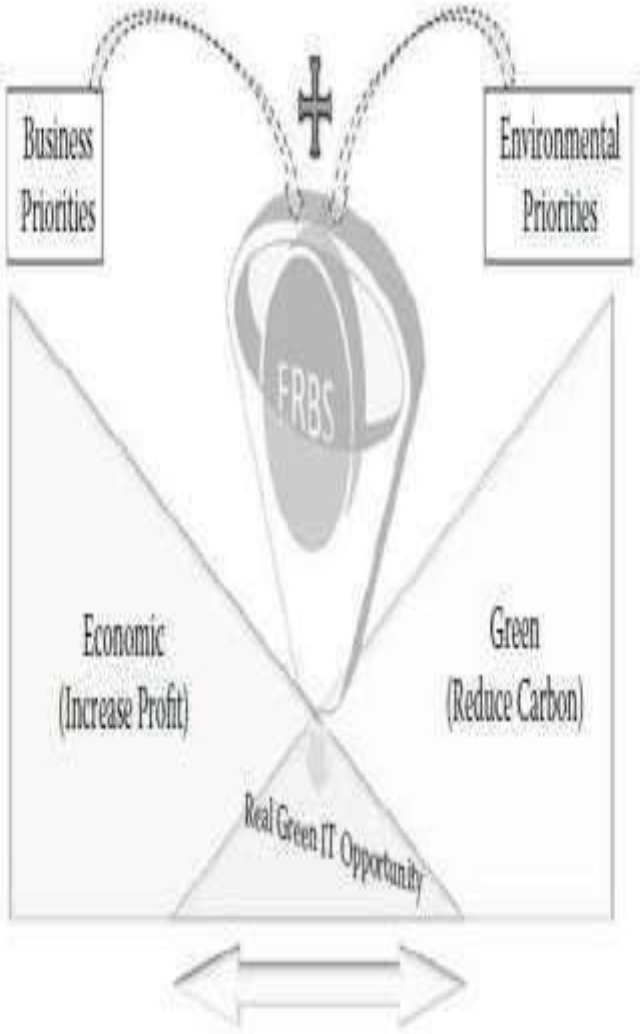

Figure 1.4 The real Green IT opportunity exists where the environmental and business priorities are complimentary to each other.

- Effective green metrics are achieved only withincreasing level of maturity of the organization and effective use of CEMS Continuous emission monitoring systems (CEMS).
- In order to reduce the pressure on the strategic points of an organization with respect to its green challenges, it is recommended that the intersection between the business priorities and the environmentpriorities be studied right at the beginning of the initiative.
- Strategically, once the organization moves into the overlapping areas, the challenges it faces from its Green IT initiatives start becoming more manageable by the entire organization.
- Survey indicated that IT as an industry is responsible for 1.52% of the total carbon dioxide emissions, as compared withroad transport—12.6%, metal production—2.3%, and the cement industry—1%. These figures indicated that it is the combination of IT and the non-IT aspects of a business that is together responsible for creating the carbon footprint.
- While the emissions that can be attributed directly to the IT gadgetry such a s the monitors, laptops, and data s ervers can be re duced by switching them off, the true value of a Green IT strategy will emerge only when IT is considered as a Green IT enabler across the entire organization.

Some Approaches

- Engagement of key stakeholders
- Green IT audits to ascertain the current state
- Setting of internal and external targets
- Developing and implementing Green IT strategies and indexing their own rewards
- Metering and recording systemfor regular monitoring
- Publicizing and promoting the green initiatives
- Improving the production capacity and making it efficient not only reduces costs, but also has a positive impact on the environment.

For example, using mobility to enhance the supply chain management system of a pharmaceutical company results not only in time and cost savings, but also benefits the environment.

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Challenges of a Carbon Economy

- The entire Green IT effort of an organization primarily emanates today from the inevitable obligatory nature of the upcoming carbon economy
- This implies a m andatory need to produce and implement a comprehensive program for the greening of the enterprise.
- The carbon economy revolves around rising energy prices, concerns about energy sustainability in the long run, and the ensuing pressure from society to reduce GHG emissions related to fossil fuels
- Carbon economies in the developing countries, however, are unlikely to respond to the carbon reduction challenge only through legislations or negotiations.
- Apart from the technical challenges, there are also social challenges associated withthe green initiatives. The basic challenge in this social context is the acceptance of the green initiative across the entire organization. In practice, some sections of the user groups are convinced of the effort, others are skeptics, and then there are some who may actively work against the effort. The reasons for this variation in Green IT support could be that the terms Green IT and sustainability are themselves susceptible to varying interpretations.
- The complex, subjective nature of Green IT requires further at tention to t he organizational context. While some generalization is acceptable, there is still usually a specific issue and a specific challenge that depends on the people, processes, and technologies within the departments of an organization where it is being applied.
- An interesting challenge that traverses boTh technical and social d imensions is that of t he terminologies within the environmental domain. For example, in this chapter itself, terms such as environmental responsibility, Green IT, sustainability, and green enterprise have been used. A separate section in this book at tempts to de scribe and, in turn, clarify the meanings
- Environmental sustainability requires definition of parameters for measuring the carbon footprints. Maturity levels and benchmarks of best practices in environmental management are also required. Lack of suc h b enchmarks and best practices cre ate obstacles in bringing about green enterprise transitions.

- Subjective nature of Green IT that depends on the context and also on the personal motivation of the individual
- Lack of robust metrics and measurements associated withGreen IT
- Lack of understandingof drivers for the environmental sustainability initiative
- Likely confusion due to number of motivators and drivers for a green initiative
- Lack of robust metrics and measurements across all dimensions of an organization
- Lack of availability of substantial “winning stories” and corresponding supporting metrics
- Uncertainty i n ter ms o f r ules a nd re gulations t hat c an b e ap plied a nd a dhered to with confidence
- Facilities like data centers cannot be replaced as quickly as the servers inside them due to high infrastructure costs—leading to a m ismatch between the hardware and the facilities that house them
- Skepticism from various sections of an organization including, occasionally, some part of the leadership
- Smart/auto meters not sufficiently integrated withthe CEMS
- Lack of choice in terms of strategies for cultural change

Environmental Intelligence

- The strategic, h olistic approach to environmental sustainability that is based on making the best use of the IT resources available to the organization.
- An interesting part of this extension and use of IT re sources comes from the extension a nd application of the concepts and technologies of business intelligence to the environmental initiative of the organization.

Business Intelligence

- For example, attempts are made to enable vast data warehouses to communicate through service-oriented technologies and expand to include analytics and correlations amongst otherwise unrelated information to produce actionable knowledge. Intelligence, in business, has been a summation of all these technologies and processes—and some more.
- Business intelligence derives knowledge, or insights, by analyzing an organization's information. This in formation can be of many different types including carbon data, financial data, environmental parameters, human relations data, and organizational s trategy data.
- The challenge for the organization is to correlate these varied pieces of information—and their subsequence a nalysis—in a w ay that provides opportunities for it to create actionable steps, including those that enable it to undertake a green enterprise transformation.
- Thus, increasingly, through the potential offered by BI tools, practitioners are considering BI as a suite of technologies that are well positioned to be used withregards to the environmental initiatives of the organization
- The systems and applications for BI include CRM packages, Supply Chain systems, Wikis and Blogs and Executive Dashboards. The se technologies make use of Cloud computing, Software-as-a-Service (SaaS) a nd Web X .0. Needless to s ay, this intelligence garnered by the business also has immense potential to improve its environmental credentials. This is so because, BI brings together an organization's existing as well as new carbon data and provides insights that can be used in timely decision making.

Application in Environmental Domain

- Combining BI withthe environmental factors results in an approach that is not based on treating carbon reduction only as a cost to business. Instead, the EI approach brings together the tools and techniques of BI to achieve the dual purpose of business and environmental efficiency.
- To reduce the organization's carbon emissions without sacrificing its core business goals.
- This is a sensible, long-term approach to sustainability in business.
- EI rests on the principle that if a business is honestly made lean and efficient, than in most cases it will be a carbon-efficient business.
- People, processes, and technologies in organizations correlates business efficiency to the environment

Table 1.2 Business to Environmental Intelligence Impact across the Technical Process, Social and Economic Dimensions of an Organization

Organizational Dimensions	*BI to EI Impact*
Technologies	Use of Smart meters; implementation of CEMS; modification to existing software systems and packages to incorporate carbon data
Processes	Equipment and infrastructure lifecycle to change—now including carbon factors in all activities and tasks. Green business process management
People	Attitude change brought about by training and education. Indexing personal growth to carbon reduction. Green HR
Economic	Reimagination of financial growth through carbon. Incorporating carbon calculations in micro- and macroeconomic functioning of the organization

- The organization needs to gain or import substantial practical application in converting, expanding, and applying EI in a way that does not reduce the existing Key Performance Indicators (KPIs) of the organization

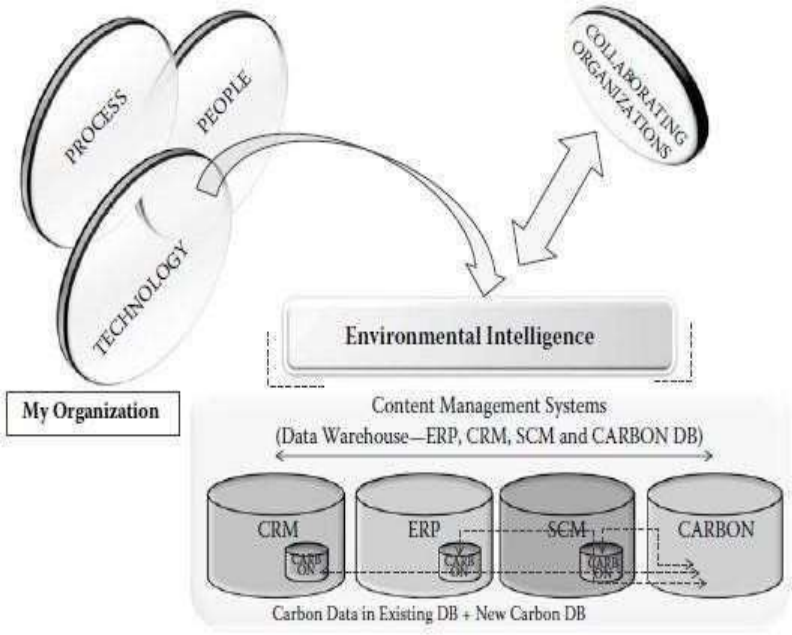


Figure 1.5 Environmental intelligence intersects people, process, and technologies, and creates new correlations in the organizational data warehouses.

- Collaboration with other business processes, upgrading the skills, emerging technologies and Organizational Dimensions.
- The organization that also includes consideration for its use of natural re sources such as water, air, and sunlight. The organization endeavors to reduce emissions across its entire value chain, including its suppliers, its operators, and eventually its disposal policies and practices.
- **Envisioning the Green Future**
- Future economy is the carbon economy
- Trust in a green future is a combination of skills, processes, leadership, technologies, and sound financial modeling for the future to keep the green credentials of the organization and its collaborating partners in mind.
- Certainly, the generation that is studying in schools today will be different to the Gen-X or Gen-Y or any such generation; it will be most l ikely a G en-G (for Green). These customers of the future a re most likely to be a green consumer and will expect the organizations of the future to be prepared for green consumers.
- The businesses of the f uture w ill be ready to handle the influx of not just new carbon generation equipments but the high-end, well- designed, and low-power emitting equipment that will require a different approach in their usage.

Green computing: carbon foot print

- A footprint is a personal thing — nobody else has a footprint quite like yours. In the same way, your carbon footprint is unique. It's the total of all the CO2 (carbon dioxide) that your activities directly and indirectly contribute to the environment.
- We can change the sizes of the carbon footprints we currently make. By discovering where you're currently using outdated technologies or accidentally or unconsciously burning fuel that you don't need to burn, you can reduce your footprint's size and be a little kinder to the earth.
- Taking a closer look helps you learn more about ways you can shrink your footprint — by making simple choices about things like lightbulbs and power supplies. And the best thing about that is that if we all make small, simple changes to the way we use energy, it translates to a whopping reduction to carbon emissions all over the earth.
- Online resources to help you calculate your footprint, and the sections in this chapter walk you through a couple of especially helpful calculators.

- **Knowing Y our Carbon Footprint ABCs**
- Focusing on carbon emissions is important because carbon dioxide is a greenhouse gas.
- You've probably heard about the greenhouse effect and know that it has something to do with global warming greenhouse gases, which are made up of carbon dioxide (CO2), methane, nitrous oxide, and fluorocarbons, trap a percentage of the warmth in the lower part of the atmosphere.

The carbon cycle:

- Green landscapes, including trees, grass, plants, and shrubs, all absorb the carbon dioxide we exhale and convert it to oxygen during photosynthesis, which is the process plants use to turn sunlight, water, and carbon dioxide into oxygen and energy.
- Photosynthesis also helps reduce other chemicals — such as nitrogen oxides, ozone, and more — that contribute to greenhouse gases.
- The emission and reduction of gases is all part of a natural cycle, but this cycle can handle only so much carbon. Many things people do contribute to excess carbon in the atmosphere.

- **Connecting fossil fuels to carbon emissions**
- Fossil fuels that we burn for energy are the largest contributors of the type of CO2 that we need to reduce these fossil fuels:
- Oil
- Coal Natural gas
-

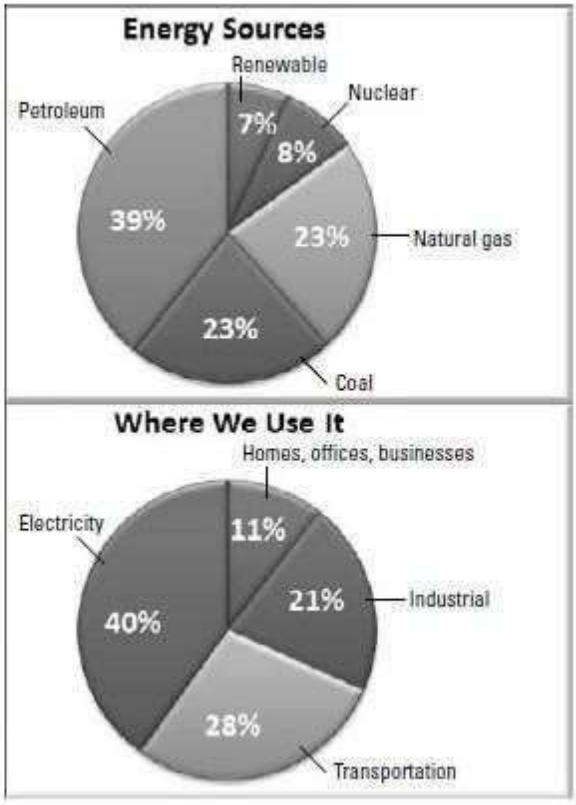


Figure 2-1: Where energy comes from, and where it goes.

- Figure 2-1 shows two charts based on data from the nonprofit group Institute for Energy Research; these charts break down of the ways that we produce and use energy in the U.S. As you can see, fossil fuels are the most abundantly produced resources, and electricity gets the lion's share of use. That's a great reason to get serious about reducing your carbon footprint!

- Half of all the electricity used in the U.S. comes from burning coal. And even though coal is a nonrenewable energy source (meaning, when it's gone, it's gone), there's no chance that scientists can turn that boat around any time soon. Coal is dirty (if you've ever poured charcoal briquettes into the grill, you know that), and when it burns, it –pumps bad stuff into the air, adding to global warming, creating acid rain, and polluting water.

A lump of clean coal in your stocking

- Clean coal technology puts the same dirty coal through a process that purifies it before it burns. Through techniques like coal washing and carbon storage, the damaging effects of coal can be dramatically limited (less acid rain) while other true green technologiesdevelop.

- World Resources Institute (WRI), an environmental think tank with a mission of working to protect the earth's environment, encourages a practice called carbon capture and storage (CCS). Using this approach, we can capture, transport, and lock away carbon in secure storage deep in the bowels of the earth (or, in scientist's lingo, "deep subsurface geological formations"), keeping the carbon separated from the planet's greenhouse gas layer, which is where it contributes to global warming.

Facing the Facts: Calculate Your Carbon Footprint

- Leave the computer on all day or turn it off before you leave for the office has an impact. Leaving your cell phone plugged in overnight when it's already fully charged really does matter. Using regular incandescent bulbs instead of energy-saving bulbs, forgetting to change your furnace filters, and buying lots of packaged foods has an effect — on your personal health, the health of your home, and the overall health of the planet.

The Nature Conservancy's carbon footprint calculator

- Home energy, driving and flying, food and diet, and recycling and waste — and it gives you the option to calculate your whole family's footprint.
- The point of calculating your carbon footprint is to give you a starting point of action, to find out where you can reduce and where you can conserve. The Nature Conservancy offers links to get you started on the road to increasingly earth-friendly choices.

Moving toward personal sustainability

- Getting a quick picture of your carbon emissions with the Nature Conservancy's calculator is a great place to start, but what if you look at the greening of your efforts as a long-term relationship? Like any other big thing we try to change about our lives, changing our thinking about our impact on the environment is an ongoing project.
- The site MakeMeSustainable.com helps you think through that kind of paradigm shift in your life, getting you in touch with how you feel about the environment. It provides you with fun and effective tools to help you manage it. A strong part of Make Me Sustainable is the community component, which helps you reinforce your dedication to green efforts by connecting with friends, family members, and like-minded people in your state, nation, or around the globe.

Make Me Sustainable calls its carbon footprint calculator the Carbon
and Energy Portfolio Manager (CEPM).

T allying your ecological footprint

- With just a little bit of searching, you'll discover another kind of calculator, one that measures your ecological footprint. The ecological footprint is different from a carbon footprint in that it measures the full range of human consumption of resources and compares that against the Earth's capacity to generate those resources.
- When you look at carbon emissions from a life-cycle perspective, you take into account all energy and resources used (for example, the metals, energy, plastic, and more used to create your computer) from the time the item is created until the time you responsibly dispose of it.

Reducing Y our Footprint

- Once you know the size of your carbon footprint, you can begin to look for ways to reduce the impact you're having on the world around you
- Basically, we're talking about making chances in three key areas:
- **The way you run your home:** In this arena, technology can help in many ways. PC power management, greener technology purchases, and more as insulation, landscaping, and building materials, are beyond the scope of a computing book
- **The way you use transportation:** Telecommuting and teleconferencing because they provide great ways to reduce your travel and thus your carbon footprint
- **The way you feed yourself and your family**: Offsetting your carbon habit Carbon offsets offer you one way to lessen the impact of your carbon footprint — by supporting projects that reduce CO2 emissions in a variety of ways.
- For example, might support a program that plants trees, refits power plants for green energy, improves energy efficiency in public transportation, or supports the development of new renewable energy sources.

The Straight Scoop on Power

- **Power issue** — what it is, where it comes from, and where it goes. You discover which appliances and gadgets in your house are using power right now and how you can better manage your power **Consumption** — through your choices and actions — so that the power you consume is more in line with your hopes for the earth.

- **Checking Out Sources of Electricity**

- The electricity that supports your lifestyle right this very minute is a manufactured product and not a natural renewable resource (one that we can continue to use and that replenishes itself naturally, such as wind). An electrical generator somewhere in your area uses a technology based on magnetics and copper wire to create the spark of life that keeps your technology going: the light shining on this page, the charge in your cellphone, the current keeping your laptop charged, and the electricity running the ceiling fan.

Creating electricity

- Electricity is a secondary power source — meaning that other primary energy sources are used to generate it. In the United States, electricity generated in 2008 came from multiple sources:

- 48.4 percent came from coal
- 21.4 percent from natural gas
- 19.4 percent from nuclear energy
- 1.5 percent from oil
- 9.3 percent from other sources, including wind, geothermal, and solar.

- We can generate electricity from many different sources, but all those sources, except solar technologies (which use photovoltaic cells to store energy), use a process in which a turbine spins and converts movement energy into electric energy.
- Steam, gas, and diesel turbine generators all use this process, as do nuclear power plants and alternate energy systems.
- When power plants create electricity by burning fossil fuels such as coal, oil, and natural gas, they boil water to produce high-pressure steam, which turns the turbines in the generator that creates the electricity.
- Nuclear reactors (which use nuclear fission to split atoms, releasing a great amount of energy) and hydroelectric power plants (which use moving water to generate electricity) use similar turbine-based procedures without burning fossil fuels.

1. Renewable versus nonrenewable energy:

- Today, you see the terms renewable and nonrenewable energy everywhere. The difference between the two (not surprisingly) is that one type of energy continually replenishes naturally (like wind and water) and the other doesn't — when it's gone, it's gone (for example, oil, natural gas, and coal)
- Scientists tell us that available oil and natural gas supplies are limited and dwindling, although coal promises a longer supply, with experts estimating that the earth's coal supply will last well into the next century.
- Because today coal is handy and readily available — and cheap — still doesn't mean it will always be around. It's still a nonrenewable resource. Also, mining coal is difficult and dangerous, as headlines often attest.

2.By-products of different energy sources:

- To generate electricity pump CO2 into the atmosphere, including any technology that burns fossil fuels
- The largest energy source in the United States — coal — has incredibly high costs: CO2 production, carbon monoxide, and soot (which is really just unburned carbon that's released into the air we breathe)
- That creating and using electricity does impact the environment, not only by using up nonrenewable fuel sources but also by releasing harmful by-products. The good news is that renewable energy sources can be replenished and have less hazardous by-products. The bad news is that renewable energy isn't widely available as a primary energy source — although in some places solar panels may be a worthwhile expense.

Thinking about renewable energy

- Green movement began to blossom in the U.S., the phrase renewable energy became popular. Today, we have options for the ways in which we generate electricity, many of which are considered renewable methods. But development is fairly slow, and the technologies still aren't widely adopted.
- Burning fossil fuel is still considered the easiest and cheapest way to power our homes and PCs, if you think in terms of short-term cost and not long-term environmental damage. But in 2008, 9.3 percent of the electricity used in the U.S. was generated with renewable energy technologies (hydroelectric, wind, solar, geothermal, and biomass).

Table 3-1	Types of Renewable Energy
Type	***Description***
Biomass	Organic matter, such as plant and animal waste, is burned or changed into gases to produce electricity.
Fuel cell	Chemical reactions combine hydrogen and oxygen to create electricity.
Geothermal	Pipes bring to the earth's surface dry steam or hot water, which powers a turbine that drives a generator to produce electricity.
Hydroelectric	Water flowing through dams turns turbines and generates electricity.
Solar	Photovoltaic cells gather sunlight and generate electricity.
Wind	Wind power turns two- or three-blade propellers mounted on rotors, which turn wind turbines that generate electricity.

- Solar electricity has been around for a long time, but it's been slow to catch on, particularly because it's incredibly expensive. (And also because solar panels used to be incredibly ugly. Did you see those solar homes in the 1970s?)
- Solar energy is harnessed mainly through photovoltaic (PV) cells, which collect and control the energy, converting it through the use of a charge converter and distributing sunlight-generated electricity (both AC current produced by an inverter and battery DC power) to electrical appliances, lights, and more. (See Figure 3-2.)
- In recent years, solar batteries have become popular for use in landscape lighting — no wires needed, no fossil fuels burned, and they're not too bad looking! But what happens when you have four or five rainy days in a row? Yeah, your landscape is pretty dim at night.
- One of the challenges of solar power is that it's still fairly expensive to produce. Although concern over burning fossil fuels is making solar energy power plants more appealing as a long-term sustainable energy source, estimated costs per kilowatt-hour are still higher than most consumers are prepared to pay.
- Another type of solar energy, called active solar heating, involves heating and storing water or air in a collector and then transferring the stored heat directly into the space or storage system. Commercialsystems are available in some areas and may help offset your other utility costs. It's worth a search on the Web, anyway.

Winds of change

- Windmillsto generate power on farms all across the globe, enabling them to pump water, grind grain,
- The air currents move the propeller-like blades (usually two or three), which turn on a rotor.

Water your world

- Held your hand under water as it runs out of the tap, you already know the basics of hydro power. Moving water generates force, and of course, the more water, the greater the force.
  Hydroelectricity technology harnesses the power of moving water (not necessarily falling water, by the way, although that really gets it moving!) and converts the energy into electricity.
- Case in point: Niagara Falls. Although people have been going over the Falls in barrels since seemingly the dawn of crazy human tricks, Niagara Falls is a nothing-short-of-miraculous energy source for the state of New York.

How Much Energy Are You Using, Anyway?

- The carbon footprint is different from an overall estimation of your energy consumption, however, because the calculations are designed to figure how much of an impact you're making on the environment in terms of greenhouse gas emissions.
- **Tracking your bills in a spreadsheet**
- 1.Gather a few month's worth of the bills
- 2.In a spreadsheet program, such as Excel, set up a grid like the one shown in Figure 3-6, with rows for each utility you want to track and columns for each month.

	A	B	C	D	E
1	How much power do we use?				
2					
3					
4		January	February	March	April
5	THIS YEAR				
6	Electricity (kWh)	3620	4017	3712	2693
7	Water (gals)	3900	3400	3520	3340
8	Gas (therms)	NA	NA	NA	NA
9					
10	GOAL				
11	Electricity (kWh)	3200	3500	3200	3000
12	Water (gals)	3000	3000	3000	3000
13	Gas (therms)	NA	NA	NA	NA
14					
15	LAST YEAR				
16	Electricity (kWh)	4140	4500	4250	4150
17	Water (gals)	4200	4350	4100	3000
18	Gas (therms)	NA	NA	NA	NA
19					

Figure 3-6: Every little bit helps, and tracking what you use is a good first step toward cutting back.

- To get a better look at where you're at and where you'd like to be, set up one table on the same spreadsheet that displays last year's energy use and another table that displays your goals.
- 4.Compare the three tables each month.

Calculatingcosts and savings with a home energy audit

- Identifying which items in your home use power, how much power they use, and how you can monitor and manage the energy consumption of those items
- To do a home energy audit, follow these steps:
- 1.Go to the Home Energy Saver site at http://hes.lbl.gov.
- 2.Type your zip code in the box provided and click Go.
- 3.Enter information to help fine-tune the cost calculation for energy use in your home.
- 4.Click Calculate to see the
- results 5.Click View Upgrade Report

Monitoring usage with pluggs and smart meters

- To empower consumers to make their own responsible energy choices, smart meters and ploggs were born. These smart devices plug into your electrical outlet and enable you to see easily how much power various devices in your home are drawing.
- **Kill A Watt power meter:**The meter tracks the electricity consumption
  and displays the result in kilowatt-hours
- **The Energy Detective:**Power meter that uses a transmitter and an LCD to track your energy use in real time and report it on the digital device.
- **Plogging along:**power meter and data logger that measures the electricity you're using and sends the data wirelessly anywhere in the world to a mobile PC, laptop, or desktop computer. 8051-compatible microprocessor, RAM, flash memory, a real-time clock, and Plogg Manager software that tracks instant and cumulative energy consumption

- **Connecting power education to action**
- Some pieces that have yet to be resolved before that capability will be available in all its glory.
- A typical electric bill includes your meter reading from last month, your meter reading this month, the difference in kWh from one month to the next, and how much that's gonna cost you.
- The Google Foundation announced a new green initiative designed to empower consumers by giving them real-time access to their power-use data, but instead of building a device like Plogg or TED, Google is creating an iGoogle gadget, Google Power Meter, to do the tracking. Imagine being able to login to your Google account and check the energy consumption going on at home while you're at the office. Now take it a step further and imagine that you can click the mouse and turn off the lights you left on in the morning! This technology isn't so far away!
- **Checking for Efficiency with the Energy Star**
- If you've purchased anything that draws electric current within the last 10 years or so, chances are that you've seen the Energy Star label on the box. Figure 3-9 shows you what that label looks like today.

Figure 3-9: Life feels better with an Energy Star.

- The Energy Star program started in 1992 as a collaborative venture between the U.S. Environmental Protection Agency and the U.S. Department of Energy.
- The purpose of the Energy Star is to create a standard for energy consumption and let consumers know which appliances and devices meet this standard. (The Energy Star can let you know that the refrigerator that you're thinking of buying isn't going to cost a year's college tuition to run and won't reduce a glacier to mush anytime soon.) www.energystar.gov offers a whole world full of information for consumers, businesses, manufacturing plants.

- **EnergyGuide— What's the difference?**

  EnergyGuide (the big yellow sticker shown in the figure) with Energy Star. These are two different programs, designed with different purposes gives basic information about the item you're looking at (manufacturer name, model number, capacity, and so on)

- EnergyGuide displays efficiency measurements differently for different devices.

- **Penning Up Energy Hogs in Your House**

  Conserving energy is often one of the easier and cheaper things you can do to lower your energy use.

- **Controllingpower flow to electronics: Managing your media**

- **Televisions**: An average LCD TV uses 213 watts of power when it is turned on. By comparison, a plasma uses 339 watts, and a rear-projection TV uses 211 watts.

- **Gaming consoles:** Adding an Xbox 360 heaps on another 187 watts.

  Playstation3? Even worse — that's an additional 197 watts, please.

- **Computers:** Oh, and how many computers do you have in the house?Three? That's another 234 watts (78 watts per PC). A new television, check out CNET's energy-use comparisons of high-definition TV makes and models.

- **Squealing over heat and air conditioning costs**
- Saving your hard-earned dollars. Saving greenhouse gas emissions. Saving the planet.
- It's possible that, depending on where you live in the country, half of your energy consumption comes from heating and cooling your home.
- Whether you live in a warm, cool, or moderate area,
- The size of your home
- Location and landscaping
- Your home's age and construction
- The number of doors and windows you have (and how tightly they're sealed)
- **Programmablethermostat**
- A programmable thermostat enables you to set temperatures for different times of the day, which regulates the amount of energy you use to maintain the temperature.
- For example, if you go to work every day, and you're gone from 7:30 a.m. to 5:30 p.m., you can set the thermostat to automatically drop the temperature when you leave in the morning and raise it to your favorite degree when you return at night. And yes, programmable thermostats are smart, so you can set different schedules for weekdays and weekends.
- **The 411 on filters**
- Changing a furnace filter is a simple task, and it can make a big difference in the way your furnace, air conditioning, or heat pump circulate the air in your house. If the filter is clogged and messy, the fan has to work considerably harder to try to pull air through it. For a happy fan, cleaner air flow, and lower electric use, replace your furnace filter

- **What kind of culprit is your air conditioner?**
- Many people don't know how air conditioners work (do they just pump cool air into your house?) or how to improve their efficiency. Your air conditioner is circulating cooler air throughout your home, but the air that it circulates is actually the same warmer air that you were sweating in before the AC kicked on.
- **You can do severalthings right away to reduce the amount of energy your air conditioner uses:**
- **Turn it off**. Consider cooling other types of efforts first. And then, if the heat is really unbearable, go ahead and use your air conditioner.
- **Raise the thermostat**. You may think you need the temperature set to 72 degrees when it's 95 degrees outside, but will a couple of degrees really matter that much? Won't 78 degrees still feel cooler than 95 degrees? It could reduce your electric consumption by as much as 3 to 5 percent.
- **Close the curtains.** Sure, it's beautiful to see the sun streaming in your windows on a gorgeous summer day. But if it raises the house's temperature 6 degrees, maybe opening the curtains in the evening is a better idea.
- **Use ceiling fans**. A ceiling fan uses a supply of electricity, but it's a smaller amount than an AC unit. Plus, a ceiling fan can reduce the temperature in a room by 5 to 8 degrees.
- **Improve your air circulation**
- Have you ever had anyone out to clean your ducts? No, it's not off-color at all; it's about maximizing air flow, which means that the blower motor in your fan has to work less hard to move more air — and that means a savings in power (not to mention a squeaky clean feeling).
-

- **Cutting the pork from appliances**

- First things first — if your appliances have energy-saver settings, use them! Dishwashers, refrigerators, washers, dryers, and standalone freezers may all have energy-saver settings.
- If you feel in the dark about a piece of electronic equipment or appliance you already own, you can use the Energy Star product list to see whether an item makes the cut.

- **Is your refrigerator running?**

- The amount of power required to regulate the interior temperature, with the opening and closing of the doors, is a steady stream of consumed wattage. In general, newer refrigerators are more energy efficient than older ones.
- Cool foods before placing them in the fridge. This means that the fridge doesn't have to work as hard to cool the food.
- Stop using the ice maker and drink dispenser.
- Make sure the door of the fridge seals tightly. Coolness could be seeping out without you knowing it.
- Clean the back of the refrigerator periodically. This helps keep the air flowing freely inside the appliance, which helps increase efficiency.

- **Heat food on the stovetop**

- The amount of energy you use when you cook, but heat is heat is heat.
- On an electric stove, choose the burner size that fits the pot you're using.
- Check the seal on the oven door because heat can leak out. Use lids on pots to keep the heat in.
- For energy-efficient stove, keep these ideas in mind:
- Electric stoves are more efficient than gas.
- Self-cleaning ovens are most efficient because they're well insulated and retain heat best.
- Magnetic surface stovetops are becoming more popular as an affordable green option

This is the way we wash the clothes

- That laundry just needs to be washed. That being said, however, you can adopt the following practices to reduce your consumption as you do your regular laundry loads:
- Keep an eye on your washer's water settings. The average load uses 40 gallons of water. Control the load selection based on what you really need and reduce the amount of water when possible.
- Insulate your hot water heater to help retain the heat.
- Reduce the temperature on your hot water heater to 120 degrees.

Keep the dryer's lint trap clean.

- Dry loads one after another. Stopping and starting actually uses more energy.
- An automatic sensor that ends the load when the clothes are dry

- Make sure you're using energy-efficient light bulbs! This is the year to make the choice to replace all those 60-watt incandescent light bulbs that burn out every eight months with 60to 100-watt CFLs
- Green batteries, which you'll see labeled as nickel metal hydride (NiMH) and lithium ion (Li-ion), can save you money, time, and consternation if you get in the habit of recharging and monitoring their use.

Trimming fuel consumption

Conserving fuel is another way to conserve energy and resources. Here are a few ways to reduce the number of gallons of gas that your ride guzzles:

Think through your trips and combine errands.

- Take shorter routes wherever possible. Plan your route so you won't sit in traffic. Use public transportation wherever possible. Share a ride with a friend.
- Ride your bike or walk when you can.

Green IT Strategies: Drivers, Dimensions, and Goals

Introducing Green Strategies

- 1, Green strategies outline a long-term and unified approach of an organization toward environmental responsibility.
- 2, The green strategic approach considers both internal and external organizational characteristics, including its structure, dynamics, macroeconomic incentives, compliance constraints, and the need to align corporate social responsibility with mainstream corporate business.
- 3, Green strategies have wide effect, not only on the way the business interacts with external and internal entities, but also with its internal organizational structure, attitudes, policies, and practices.
- 4, In comprehensive green strategy would also cover the organization's supply chain, reusable designs, production processes, recycling approaches, attitude of its people, and the risks associated with changes.
- For example, incorporating RFID tags in the supply chain will not only help the organization manage its inventories better, but will also open up opportunities to reduce its carbon footprint due to reduced material wastage.

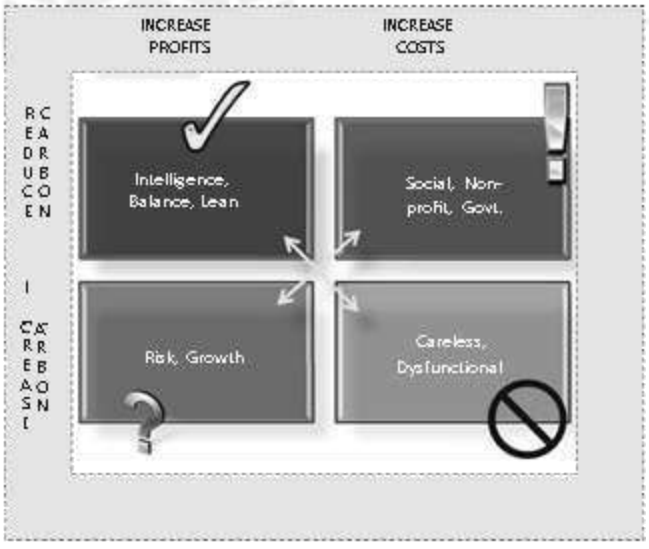
- , Green business strategies are combination of extending existing business strategies as well as coming up with new strategies that have a specific environmental focus.
- 6, Care needs to be taken to ensure that the new elements of a Green IT strategy are not too far removed from the core business strategies of an organization.
- Instead of coming up with a brand new green strategy that does not align with the core business of the organization, it is worthwhile considering the overall strategic approach to the environment as a business approach—Environmentally Responsible Business Strategies (ERBS, 2010; Unhelkar, 2008)—that are the business strategies.

Green Strategic Mindset

- The individuals in the organization would be reading, training, rewarding, promoting, educating, sharing, and encouraging everyone around them to develop further that green strategic mindset.
- A major benefit of developing an organization's green mindset is that it helps the organization manage the long-term implementation issues whilst achieving returns from the " low hanging fruits" of Green IT to show progress and what can be achieved. Indeed, it is important to immediately start switching off of monitors when they are not in use and immediately stop the wastage of printing paper.

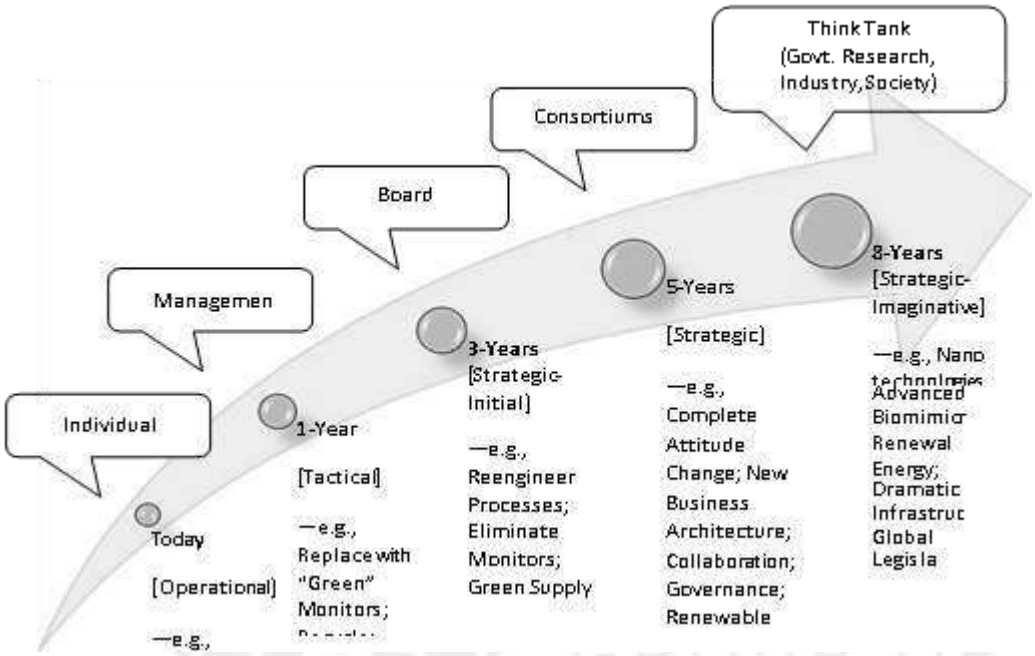
- Green IT strategies translate into policies that deal with energy reduction across all areas of an organization.
- For example, strategies indicate policy formation on energy consumption in data centers or optimizing equipment procurement and lifecycle processes. Eventually, policies translate into practice that requires accurate collection and reporting of carbon data and ensuring immediate compliance with the legal requirements.
- Strategic use of carbon data involves not only collection and reporting of data, but also identification of risks and opportunities associated with the green domain as also plotting of trends and patterns in terms of internal carbon savings.

- **PhilosophicalConsiderations in Green IT Strategy**



- ***Risky, Growing***: Strategies that directly improve the economic performance of the organization but also add to the carbon contents. Expansion of the products and services portfolio by an organization will increase its turnover, but at the same time, there is a very high possibility that its corresponding carbon contents will also go up
- For example, an airline expanding its services to new regions would expect to increase the carbon it produces as it flies to these new geographical regions but with new fuel-efficient aircraft, the increases can be minimized.
- ***Social, Government, Nonprofit*:** Strategies that improve the carbon performance of the organization but hurt the bottom line.
- For example, optimized insurance services by an insurance organization may imply shifting some aspects of such service to less powerful servers. Such strategies may reduce the carbon generation by those business processes but may also reduce the customer service. Such strategies can hurt the revenues and/or increase the costs.
- ***Careless, No Strategy:*** These are the less well-managed and even dysfunctional organizations whose activities hurt both their economic and carbon performance.
- For example, careless increase in the number of servers within a data center without proper estimation of their workload may laden the organization with unnecessary servers.
- ***Lean, Intelligent, Balanced****:* Strategies that improve both the economic and carbon performance. This is the core winning philosophy of an ideal Green IT strategy. The goals of the business are in balance and in sync with its environmental goals.
- For example, the same airline mentioned earlier, in its expansion strategy, would consider procurement of new, low-carbon-emitting aircrafts with less fuel consumption.

- Using the right philosophy behind the creation and implementation of the strategy is vital.



- The support for a strategic plan for Green IT, but also help develop an understanding of the timeframe where they will be all applicable. For example, the figures mentioned earlier indicate the support for policies, use of software and application of metrics that will provide tremendous value to a green enterprise transformation
  — and that value will itself be maximized by keeping a 3–5-year timeframe for implementing those strategies and plans.

Green Strategic Alignment

- Green IT strategies, especially in the 3–5-year impact range, are well poised to provide continuous alignment of the organization's business and carbon goals.
- Green IT strategic alignment is basically viewed as a resource allocation decision that, when deployed correctly, bring about action that brings the business and carbon goals close to each other.

Proactive Green Strategies

Green strategies can encourage the organization to bring about significant organizational change. These changes are based on an understanding of the various Green IT drivers by the organization's leadership.

These strategies, that are not enforced on the organization but are based on *prediction* by the leadership of the organization, can be considered as the proactive green strategies.

The organization's own understanding is translated into a Green IT initiative and is supported by most layers of the organization.

Reactive Green Strategies

- In addition to undertaking green transformation on its own volition, there are also significant elements of reaction by an organization to the external green influences on it.
- For example, the impact of government rules and regulations relating to carbon provide a major impetus for the organization to undertake green strategy formulations.
- External competition, outsourcing, globalization, and customer demands can all put the organization in reactive mode resulting in reactive Green IT strategies

Green IT Strategies Mix

- Drivers—these are the motivating factors for an organization to put together a Green IT strategy and undertake transformation. Six such drivers have been identified in the Green IT strategy formulation,

Table 2.1 Elements of an ERBS Forming the Green Strategies Mix

Drivers	Dimensions	Business	Systems
• Costs and revenu es • Sociocultural andpolitical • Regulatory andlegal • Enlighten ed self-interest • Responsi ble Business ecosyste m • New market opportuniti es	• Economic • People • Process • Technology	• Policies, practices,and procedures • Systems and support • Legalcompliance • Architecture • Environmen tal Metrics • Maintenance	• Data • Information • Process • Knowledge • Environmen tal intelligence • (EI implementation includes Green ICT)

- **Dimensions**—these are the various areas along which an organization undertakes transformation.

- **Business**—this is the domain of policies, practices, and procedures undertaken by the organization along each of the four dimensions.

Green IT Drivers

The drivers that impact the underlying motivations of a business for its environmental responsibility,

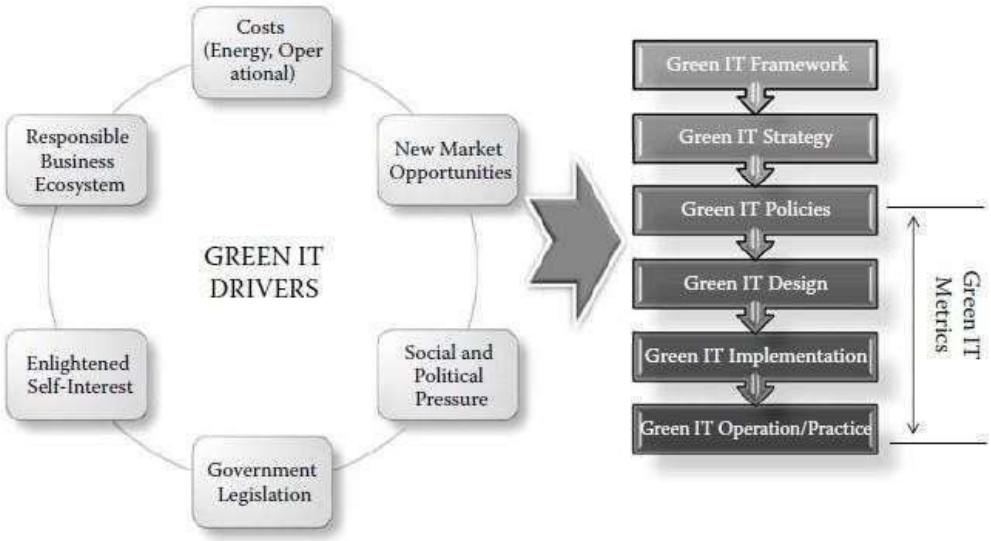


Figure 2.5 Drivers for environmental responsibility of business.

Figure 2.5 also shows a mapping between the drivers and the corresponding Green IT framework. The strategies, policies, design, implementation, and practice of Green IT are primarily driven by one or more combination of these drivers. These six groups of business drivers for environmental responsibility, as shown on the left in Figure 2.5 are the costs (including energy costs, operational costs); regulatory and legal; sociocultural and political; new market opportunities; enlightened self-interest; and responsible business ecosystem.

- ***Costs (Energy, Operational)***
- A good sustainable approach by an organization includes opportunities to optimize its processes, consolidate its technologies, and thereby reduce its costs.
- For example, optimizing a business process can eliminate the need for a desktop machine but, instead, there may be a need to replace that desktop with a mobile device.
- At the organizational level, costs associated with the green enterprise transformation program need to be factored in along with the anticipated reduction in costs due to the transformation.

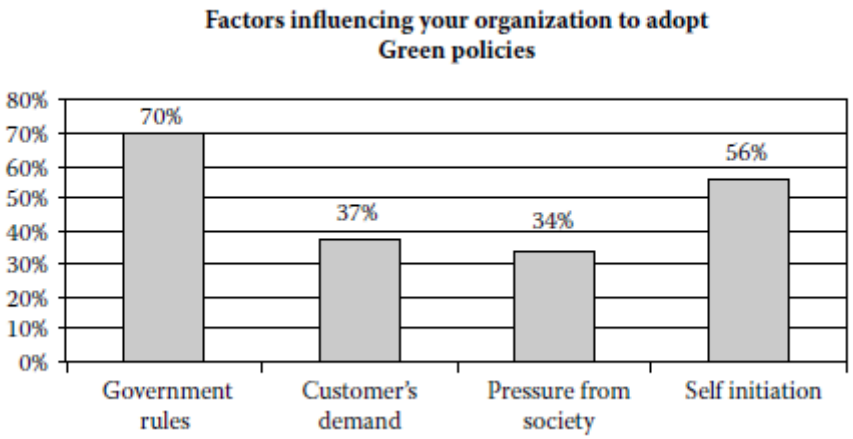
Regulatory and Legal

- Environmental legislations put together by governing bodies
- have a greater enforcing power among organization.
- For example, in Australia, it is now legally binding for an organization emitting more than 150 kT (kilo tonne) of carbon to calculate and report it to the government on an annual basis
- These regulatory and legal requirements now make it mandatory for organizations to comply with carbon emission requirements.

Sociocultural and Political

- This driver comes mainly into play when the society in which an organization resides accepts the environment as of significance in its value system. Such acceptance of the importance of the environment by the society brings pressure on the organization to change.
- For example, the increasing popularity of the *Earth Hour* (last Saturday of March), wherein almost all large organization and building around the world switch off their electrical power for an hour,
- As a result, the organization is forced to seriously reconsider its business priorities and processes in light of the environment.
- For example, pressure of social opinion is felt by the marketing department of an organization—by way of its needs to differentiate the products or services;

- ***Enlightened Self-Interest***
- This driver comes into play when an organization, on its own accord, realizes the need to be environmentally responsible, and creates or adopts a green strategy.
- The understanding of the decision makers in the organization that costs can be reduced and customers can be more satisfied with a self-interest approach that also helps the environment.
- The desire to have a brand recognition based around environmental sustainability or an understanding of its impact on business continuity also forms part of these drivers.
- Self-interest can itself depend on varying factors such as the size, sector, methods of production, climate, location, and even management decisions of the firm in question.
- Such a firm will be under no pressure from the government to fit environmental regulations—it would have already found a way to meet them.



Responsible Business Ecosystem

- This driver is based on the simple fact that if a large organization that has many different associations with its many collaborating smaller sized organizations changes its direction and priorities then those collaborating organizations have to change their priorities accordingly.

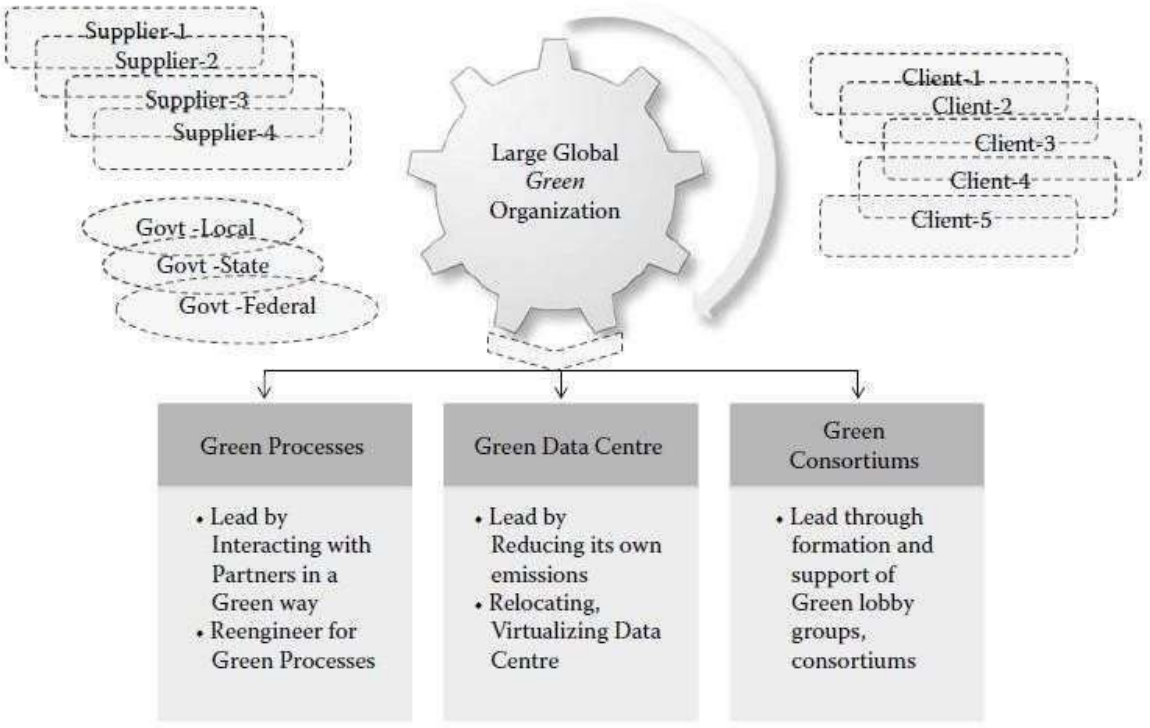


Figure 2.9 Green business ecosystem of a group of organizations—a large green organization, in its wake, influences its partners, customers, and even regulatory bodies.

- It has three major areas through which it can influence: Green Processes, Green Data Center, and Green Consortiums. When such a large, global organization changes to environmentally sustainability, an entire ecosystem made up of the business partners, suppliers, and customers and internal users organizations, together with the and industry corresponding business consortiums in which the organization exists are all affected.
- This scenario is demonstrated by HP, wherein not only are the environmental impacts monitored and managed by the organization, but also by virtue of its own management and active involvement with the members of its supply chain, the overall carbon impact of the activities of the suppliers to HP is also reduced.
- The impact of business ecosystem can also be felt in the reverse. Thus, for example, if a large group of collaborating organizations form a consortium and start moving together toward ERBS, then that will force even a large organization to follow suit as, otherwise, it would be left behind.

New Market Opportunities

- Global environmental awareness, corresponding legislations, and the sociocultural and political pressure on businesses has resulted in a new market that was not visible a decade ago.
- This new market is based on the suite of opportunities that have opened up for creating and providing services and products that *assist* other organizations in achieving their green initiatives and goals.
- we are talking not only about "businesses that are green" but "green as a business offering." For example, the CEMS is a new breed of software applications that are suddenly available in the market. The developers of these new software applications have discovered a market that did not exist earlier. Similarly, smart meters to measure carbon emissions, opportunities to apply new standards for optimization of emissions, and new architecture and design of low-carbon gadgets is a market that is likely to grow in the carbon economy.
- These drivers of a green strategy are usually interpreted by the organization in its own ways. Thus, in practice, these drivers will result in a combination of drivers for the business to initiate Green IT—depending on what it considers as its own key environmental as well as business issues. For example, a bank may interpret the social and political pressure as the most important initiator for it to undertake green initiative; a mining or a transport company may find it important to heed to the environmental legislations up-front in its approach to ERBS; or, an organization may attempt to create a green business ecosystem through a green broadband (such as done by Iprimus) or carbon-neutralizing your flight (such as booking air ticket on Qantas.com.au).

Green IT Business Dimensions (Factors)

- Once the drivers that provide the activity happen to the business for its green initiatives are identified and documented, they lead to the discussion on the areas of business that are likely to be affected by the changes.
- An organization changes or transforms along four different lines, or dimensions.

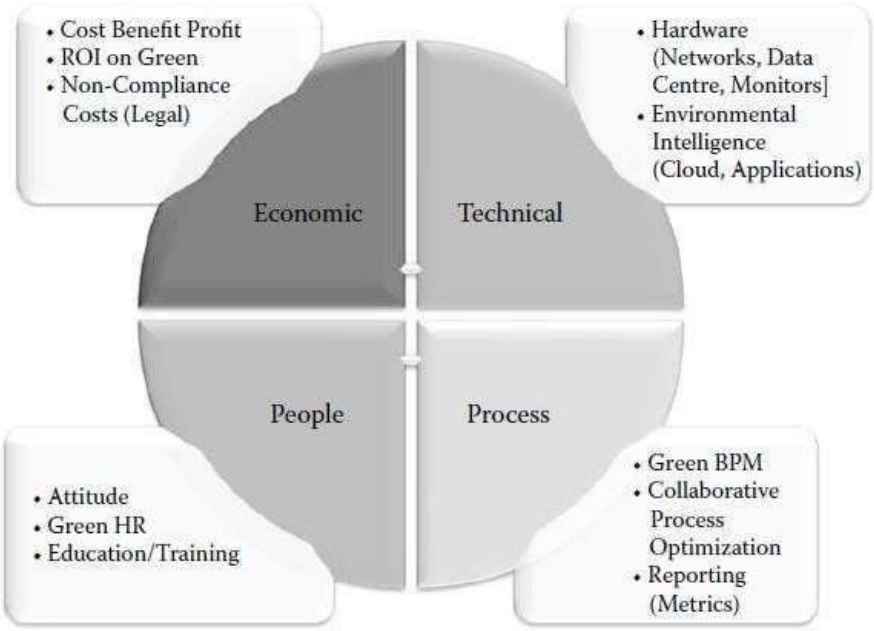


Figure 2.10 Economy, people, processes, and technology dimensions in an ERBS.

- Figure 2.10 highlights how each of these four dimensions comes into a play when an organization considers environmental responsibilities within its business strategies. These four dimensions/factors are:
- Economy,
- People,
- Processes, and
- Technology
- ***Economy***
- Economic considerations are one of the key factors in an organization's decision to implement environmental policies and systems.
- These considerations that deal with the costs associated with green transformations and the return on those costs, are the first ones to appear in the minds of the leaders and those in charge of the green transformation. Therefore, this is a primary dimension along which green transformation occurs in an organization.

Technologies

- Technologies primarily include the hardware, network infrastructure, software, and applications within the organization.
- Switching off monitors, virtualization of servers, and eschewing printing on physical paper are the initial, visible aspect of change that occurs along this dimension. This is then followed by the long-term strategic change in the way the data center is organized (including its physical building, the rack system, and the actual servers themselves) and operated.
- Emerging technologies, such as Service orientation, SaaS, and Cloud computing take this dimension to the next level—leading up to what is called "EnvironmentalIntelligence."
- Lowering the organization's carbon footprint through intelligent application of technology and greener infrastructure helps the organization further comply in the context of responsible business within its ecosystem of operation.

- ***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
- This work is made up of optimizing existing processes and that of introducing new green-aware processes that will not only reduce carbon emissions but also enhance customer experience. For example, organizations that are in the business of banking, insurance, airlines, or hospitals have a need to organize their support and maintenance processes around their IT assets and infrastructure.
- Proactive maintenance of devices and systems, outsourcing of noncore service function, precautionary actions such as installation of antiviruses and antispam, can all contribute to optimized support processes and reduced carbon generation.
- ***People***
- This is the most difficult and most complex dimension of a green enterprise transformation.
- 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 CxOs, plays a decider in an environmental initiative. Ā e involvement of senior managementin bringing about a change in this people dimension is vital—and it has to be done at an early stage of a green initiative.
- Finally, in this discussion, it is worth reiterating that there is no single driver, dimensions, or Green IT strategy that will fit all organizations.

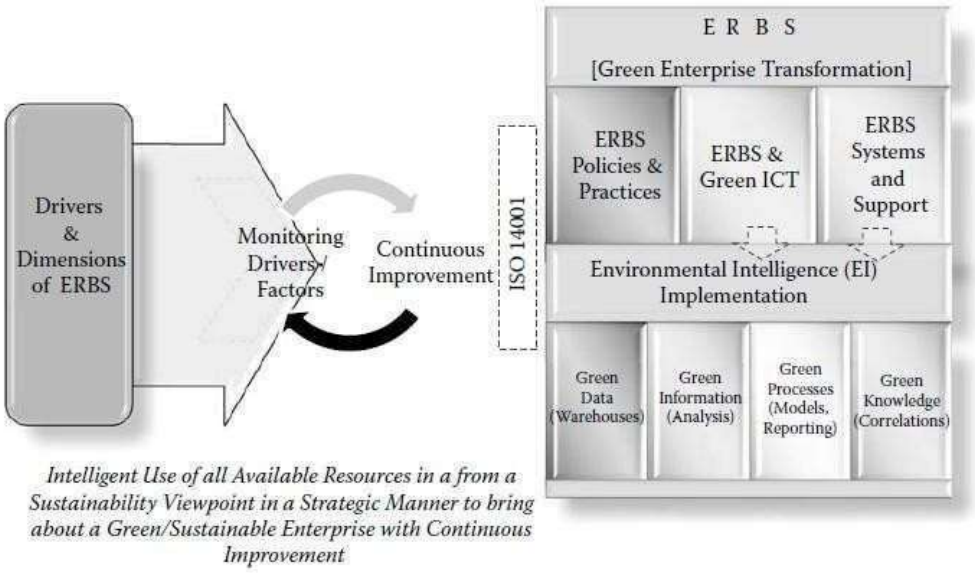


Figure 2.11 Drivers and Factors lead to an ERBS.

These aspects of Green IT drivers are applied in different combination and with varying emphasis. size and location of organizations bring variations in their Green IT strategies.

Developing an ERBS (Environmentally Responsible Business Strategies)

- An ERBS is the result of the strategic vision of the organization's Leadership this ERBS aims for strategies that will be relevant in a 3–5-year time period.
- Developing such a strategic vision refers to what the leaders of the enterprise would expect it to look like in the future.

Type of Organization	Major Green IT Consideration
Product (retailers, electronic goods vendors, vendors of consumables, packaging)	The unit of carbon-producing device or product is, however, easier to calculate. Therefore, economy and technology dimensions may be more handy to start with.
Service(banks, insurance,education/ healthcare)	People and their attitudes play a crucial role in service-based organizations. Therefore, process and people dimension of transformation become highly significant

- This input into the initial envisioning process of a green organization is provided by the drivers and dimensions of Green IT.
- The simple and direct vision, based on the drivers and dimensions translates into the strategic plan. The strategic vision and the ensuing strategic plan should be an actionable plan.
- Leadership and senior management need to be directly involved in the development of the green strategic vision for their enterprise.
- While a 3–5-year time period is a good starting point in terms of the impact of the strategic plan, still this period can vary from industry to industry.
- For instance, the oil industry may have a 10+ year strategic plan, whereas a dress manufacturer in the fashion industry may have only a strategic plan for Green IT that would be current for no more than a couple of years as the contents and expressions in that business sector changes rapidly.

Wide-Ranging Considerations in ERBS

- Development of an ERBS requires due consideration to wide-ranging organizational factors. Many of these considerations also appear in the development and implementation of a Lean IT strategy and framework

Figure 2.12 Various areas of influence of a ERBS.

- The above discussion indicates that a business striving to be green needs to create a comprehensive strategy that should include these wide-ranging considerations in it.
- In fact, depending on the type, size, location, and industrial vertical, many more factors will have to be considered in the development of a Green IT strategy.

Steps in Developing an ERBS

- The development of an ERBS requires active participation from the business leadership—including the CEO and the CGO (Chief Green Offi cer). The key stakeholders and create awareness of environmental issues in the green strategies for the enterprise

Figure 2.13 Steps in developing an ERBS.

Green Business Objectives

- The green business objectives are the core objectives for a business undertaking green transformation.
- Following are some of the points that can be used to formulate specific green objectives in the development of ERBS:
- ▪ Length of time for potential application—3–5 years being ideal
- ▪ Key drivers and dimensions that are impacting the organization
- ▪ Incorporation of government rules and regulations

- ***StrategyDescriptions***
- Describing the green strategy should be done in clear terms and with goals and KPIs that are measurable.
- Strategy descriptions include analysis of current business process, consideration to organizational values, and description of underlying IT systems and hardware.
- Strategy descriptions lead to green enterprise transformation
- projects that influence the organization for between 3 and 5 years.
- ***Policy-BasedConditions***
- Develop and implement a Green IT policy that aims to achieve higher utilization of your IT systems while reducing energy use and lessening your other environmental impact. You don't have to do all at once—adopt a phased approach.
- The Green IT policies of an organization are derived from its strategic descriptions
- ***ResourceRequirements***
- A green strategic plan has to have a suite of resources that are required to undertake and maintain green transformation. Resources include people, processes, and technologies that engender the green transformation as well as those that are affected by the transformation.
- ***TransformationPlan/Timelines***
- Development of a green enterprise transformation plan is the final and important step in the development of an ERBS. This transformation plan is a project plan that contains tasks, roles, and deliverables together with the timeline for delivery.
- ***Iterations and Risks***
- The development of an ERBS should not be a unidirectional process. Instead, it should be developed as an iterative process—going through the drivers, dimensions, risks, and metrics more than once.
- Ideally, there should be three iterations to arrive at the fi nal and comprehensive actionable Green IT plan. These iterations, over a period of 3–6 months, would also include observing the industry trends and new developments with respect to Green IT.

KPIs in Green Strategies

- Key performance indicator (KPI) provides information of an organization's performance against defined and measurable criteria.
- KPIs can provide help in measuring the progress of an organization in the area of environmental sustainability and Green IT.
- Since the progress of a green initiative must be measured against the stated goals, the KPIs provide an opportunity to ascertain whether the strategic goals have been achieved or not.
- The KPIs not only measure the progress but also provide indication of what needs to change during the course.

Table 2.4 Green KPIs in Four Groups

Primary Dimensions	*Example Goals/KPIs (Timelines, Lengths, and Depths) My Organization Will Experience the Following:*
Economic	Reduction in energy consumption by 10% of its current level per year for 3 years. Increase in green services (addition of one detailed service dedicated to green).
Technical	Use virtualized data servers for all its data warehouse; use smart meters to record, repost, and control emissions.
Process	Optimize SCM to reduce emissions by re-engineering individual processes.
People	Train people for Green IT at all levels. Telecommute once a week to reduce emissions.

Environmentally Responsible Business: Policies, Practices, and Metrics

- The strategic discussion of Chapter 2 is translated into policies and
- practices on carbon control for an organization.
- IT governance is shifting focus toward use of IT as an enabler of green initiatives across the organization.

  That extend the corporate governance to green governance, IT governance to incorporate the role of IT as a green enabler, and routine IT management to Green IT management.

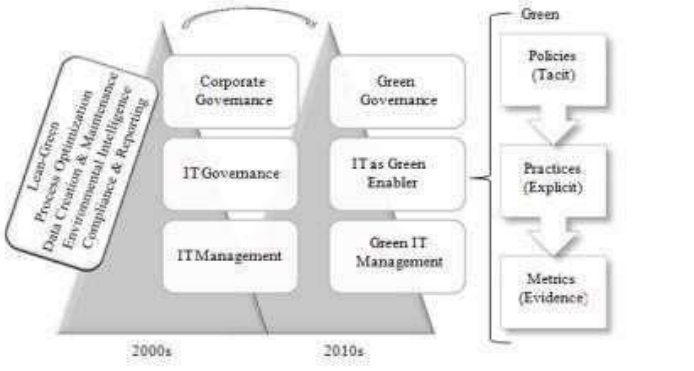


Figure 3.1 Green corporations based on green policies, practices, and metrics (shifting of IT function).

- Organizations address their green initiatives by defining sustainability policies and goals that align with the corporate objectives.
- These policies are then prioritized and applied in practice and their effectiveness measured against a base line.
- These metrics are developed to measure and report the carbon emissions resulting from various sources within the organization such as computers used by individuals, data servers, networks, and the business processes that use these devices.
- With increasing carbon footprints organizations a readding " green" aspects to their corporate governance resulting in "Green Governance."

- Thus, practices are the greater challenge than the formulation of green policies. Eventually, the success (or otherwise) of practices is judged based on metrics. Green metrics can measure not only the reduction in the carbon emissions per process but also the leanness of the business processes as a result of process optimization.

Figure 3.2 Green policies are implemented through practices, and proved through metrics.

- Green programs and projects result from the commitment of an organization to fulfill its policies. The correlation between policies and practice. While the policies a retacit, their implementation is explicit.
- The positioning of metrics in implementation of the policies in practice. Existing approaches to policy development and implementationin an organization can be used here.

Policies and Practices in ERBS

- A policy can be a high-level document that spells out what the organization will (and will not do) when it comes to business decision making. Green policies ensure that the decision making in the organization has carbon reduction as its integral component.
- Together these policies and practices drive the environmentally responsible activities of the organization.

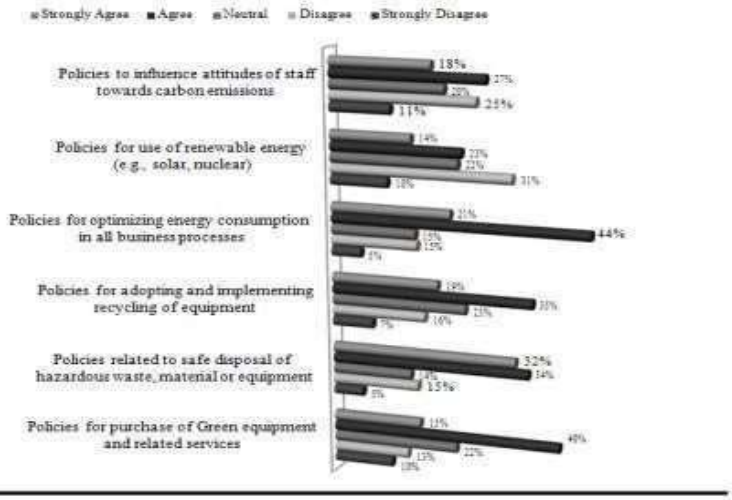


Figure 3.3 Environmentally responsible business policies.

Lean Impact on Green

- Policies for reduction, reuse, and recycling leverage the reduction of carbon footprints of an organization and the survey results depicts that most organizations are committed to adopting policies for environmental compliance.
- The decision makers bring the green strategic concepts to the green policies.
- An organization that successfully capitalize on its “lean” effort can be:

- ***Lean-green goal identification.*** These goals extend the business goals to incorporate carbon efficiency and reduced wastage.
- ***Alignment with green enterprise goals.*** Ensuring that the green policies and practices a realigned with the lean principles being applied in the organization.
- ***Product differentiation*** From the consumer's perspective, the perceived differences in value results in costumers comparing a green product with a traditional product, or comparing the same green product from one organization as against another one.
- ***Lean-green measurements.*** For example, extending the life of an old equipment may be a cost-effective decision but not necessarily a carbon-effective decision as the old equipment design may not be based on carbon efficiency. Therefore, all lean-green decisions and actions, relating to green business processes must be based on a set of measurable actions.
- ***Lean-green structures and interactions:*** Organizational structures define the way in which people and processes are put together.
- ***System support for lean initiatives:*** four layers—Business layer, Carbon Emission Monitoring layer, Service layer, and IT-infrastructure layer.
- ***Lean-green businessframework.***
- (1)assess and measure the extent of a concept (e.g., effectiveness of Green IT introduction project)
- (2)do a gap analysis based on a comparison between status
- (3)set policies and strategies of an organization with respect to the environmental challenges at all levels of the business framework

- **EnvironmentalAreas Covered**
- Policies and their practices can be viewed from three different angles—
  - thebreadth of coverage,
  - thedepth at which they operate, and
  - thelength of time they are influential within the organization.
- these three areas of consideration in the development of green policies.

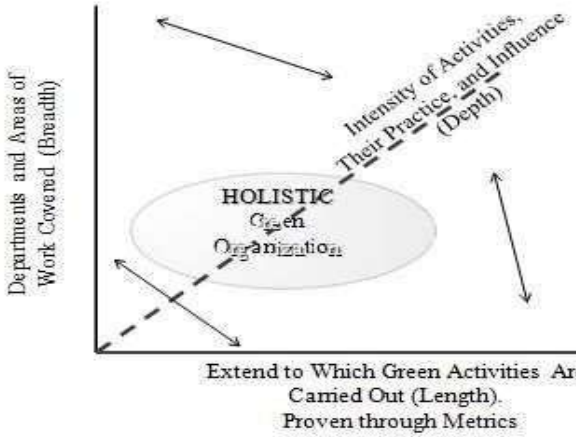


Figure 3.4 Green IT policies impact in three ways (length, breadth, depth).

	Policies	Practices	Metrics	Tools
Breadth	Departmentsand activitiescovered; collaborative partners	Number of activities;people and partners practicingthem	Green activitiesper departments	**Leadership techniques; administration**
Depth	Described intensity of activities	Reach—influence of each activity; honestyand seriousness	Carbon amount per activity;	**Smart meters; CEMS implementations.**
Length	**Period of green policy implementation**	**Sustainedperiod of practice by individualsand departments**	**Daily, yearly; other time units; staggered implementation periods**	**Durationon meters; time calculators; KPIs.**

Green Values in Practice

- The approach to converting the green policies into practice is through a combination of training, usage, incentives, and possible introduction of penalty risks.
- Examples of converting short-term policies into practice are as follows:

Typeof Green Value	Premise of That Value	Factors Influencing the Green Value	Techniqueto Achieving the Green Value
Green utility value	Based on the demand for green initiative	Quality; differentiation; marketing and relevance of the green initiatives	**Trend analysis and forecastingof green data and information; optimization of green processesfor quality**
Green exchange value	Based on the green market and their structure	Elasticity; demand and supply market structure; as impact green products and services	**Forecasting, estimating, and optimization of greenmarkets**
Green essential value	Based on social values of the organizationand its partners	Economicand social environmentthat promotes (or demotes) sustainability	**Forecasting, estimating and analysisof carbon datafortrendsin the context of green economyandsociety**
Green longevity value	**Basedon sustainable time duration—future**	**Integrationand innovation orgreen products, services, and systems**	**Forecasting, optimization, and trend data analysis from Green IT systems perspective**

- *Computing pow er m anagement.*
- *Use a blank screen saver*
- *Limited printing.*
- *Reuse and recycling of equipment and Single machine*
- **Green Practice: A Balancing Act**
- The green utility, exchange, and essential values discussed in Table 3.2 provide an understanding of the need to balance the green policies and their practice in an organization.

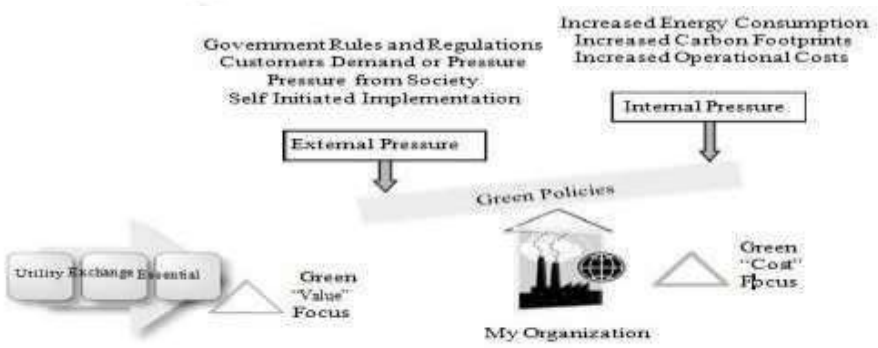


Figure 3.6 Development of green policies is a balancing act.

- The internal pressure on the development of these Green IT policies and their practices comes from the need to reduce both energy consumption and costs.
- These values, as shown in Figure 3.6, directly affect the "delta" green value— that is from the current green value of the organization to its future green value and form an important part of balancing act.
- The length, depth, and breadth of Green IT policy implementation come into play in expanding and enhancing the "delta" for both costs and values of the firm in terms of its sustainability effort.

- **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 travel, to most business processes.
- **Advantagesto Environment**
- Mobility offers location independence and personalization (Unhelkar, 2009a), 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.
- For example, mobility influences the way in which people access information on their location which in turn reduces people-movement and, therefore, influences the environment.
- The resultant environmentally responsible business has less need for physical movements and activities, reduced power consumption, lowered carbon emissions, and savings in time and space resulting from an overall wireless operation of business.
- **Challenges to Environment**
- 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.
- These stakeholders collaborate to provide unified services to customers, the collaborations themselves become very complex and dynamic. In such collaborations, enabled by mobile technologies, it is difficult to identify the precise contributors to the greenhouse gas emissions and pollutions.
- Furthermore mobile networks, mobile computers, and corresponding mobile devices consume significant amounts of electrical energy. While the devices themselves are small, their number are growing by the millions, especially in the earlier mentioned BRIC nations. This increasing use places a heavy burden on the electric grid that, in turn, contributes to greenhouse gas emissions, resulting in an imbalance in the environmental equilibrium
- **Relating Environmental Business Policies to Goals**
- The importance of policies and their practice is that they enable an organization to achieve its environmental goals.

Energy Consumption— Reducing energy consumption has to be incorporated within policy development as a business goal.

Energy Efficiency—The key of business sustainability is energy efficiency and the reduction of emissions.

Operational Costs—These are significant in all major business activities. These operating costs include sales and marketing, research and development, and administrative costs associated with business.

Organizational Reputation—Improvement in the reputation of the organization as a goal associated with carbon reduction is a valid and important goal to have.

Environmental Performance—Improved environmental performance as an international

business standard and foundation for competitiveness is increasingly a mandatory requirement for business.

Green Sustainability —Such goals need to be incorporated in

- the overall organizational policies and their practice.

Increased Revenues—Green initiatives could help in increasing overall revenues which in turn can help to provide good incentives to employees.

RenewableEnergy Resources

- 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 a s i s currently consumed within an organization.
- For example, if instead of oil or gas, the energy was generated from coal—will that make a difference in the way the organizational policies.
- The use of renewable energies will require the government and the regulatory bodies to p lay a vital role in encouraging its use by changing market levers through legislations and use of carbon offsets.
- Using renewable energy is one way that businesses can minimize their greenhouse gases. Consumers, businesses, and organizations may use renew- able energy to reduce the environmental impacts of conventional electricity generation.
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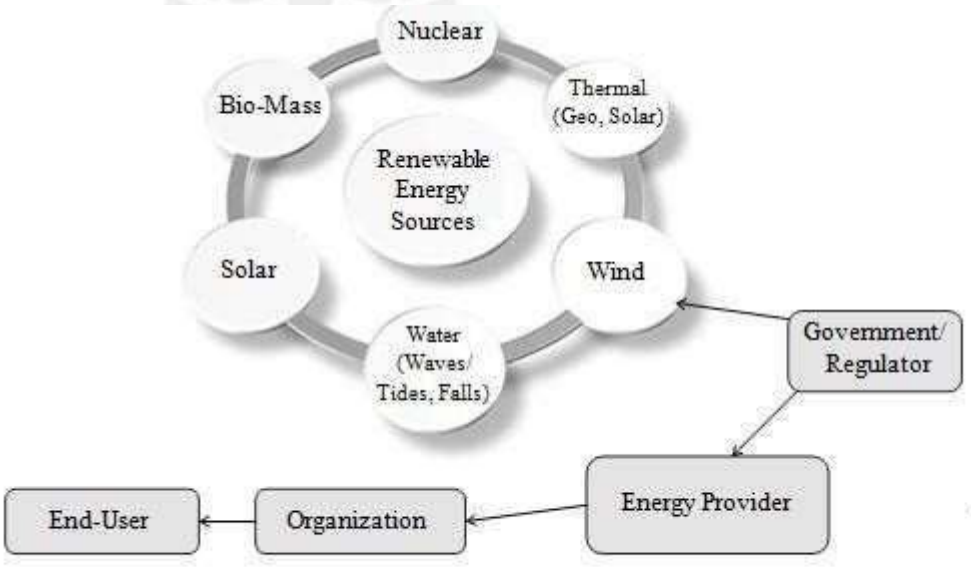


Renewable energy sources need to be increasingly incorporated in green policies.

Mind Map for the Roleof a Chief Green Officer (CGO)

- The Chief Green Office (CGO), also called the Chief Sustainability Officer (CSO), is the most senior person in the organization, working at the board level, responsible for green strategies, green policies, and green governance.
- The drivers and the four dimensions remain upper- most in the mind of a CGO. Green metrics provide the ability to justify the ROI. Technically, the CGO would coordinate with the CIO to exploit the potential offered by Environmental Intelligence

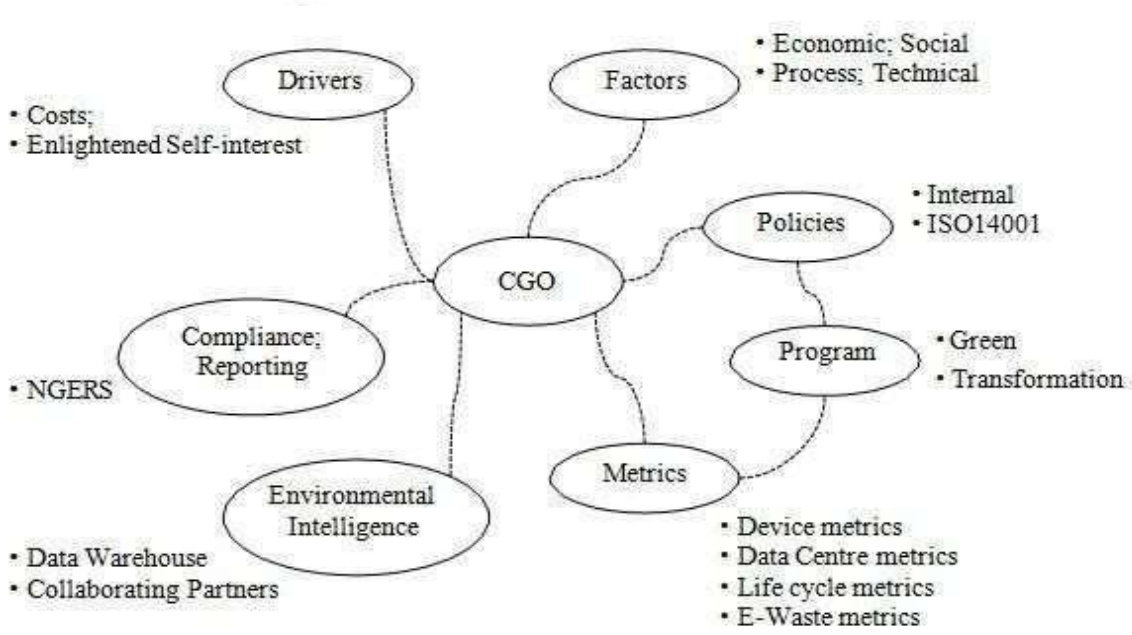


Figure 3.9 Mind map for the role of a CGO.

EnvironmentalPractices

- The CGO takes the responsibilities for green enterprise transformation as well as ongoing practice after the transformation is successfully achieved.

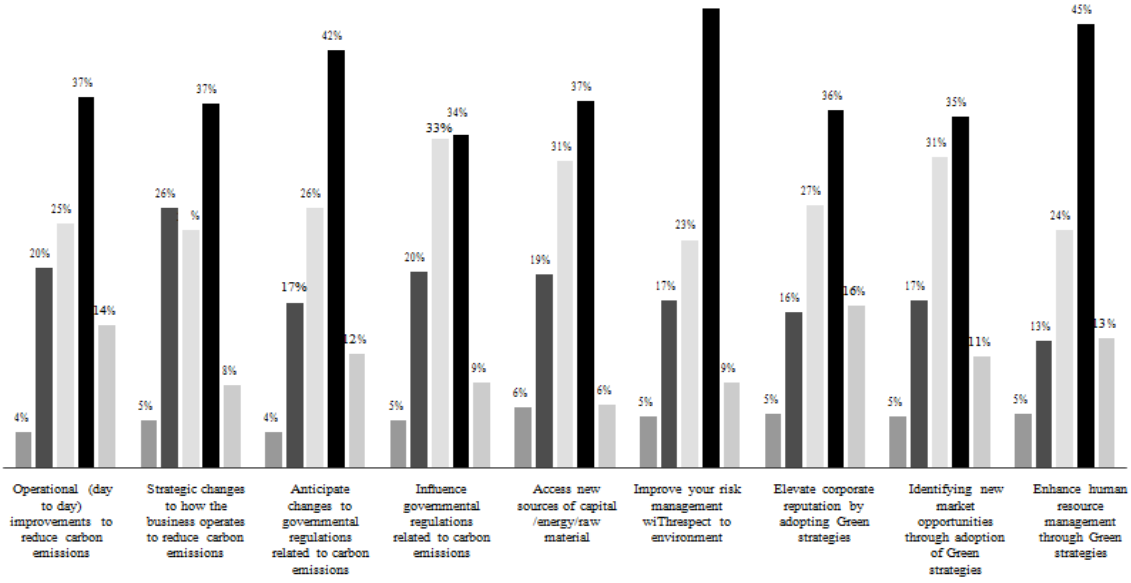


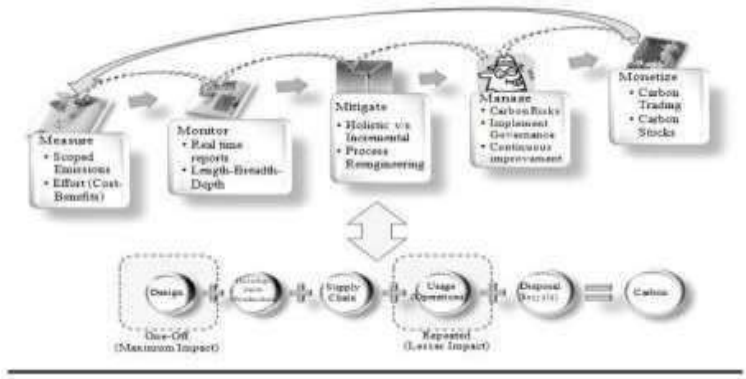
Figure 3.10 Incorporating environmental practices in green organization.

- Operational improvements to reduce carbon emission
- Strategic chan es t o how the business ope rates t o r educe ca rbon
- emission:
- Anticipate changes to governmental regulations related to carbon emission
- Influence governmental regulations r elated t o carbon emission:
- Access new sources
- Improve risk management
- Elevate corporate reputation

- **Green IT Metricsand Measurements**
- These measures should clearly identify reduction targets and measures in such areas as achieving energy savings, reducing carbon emissions, and improving recycling efforts.
- Metrics provide a sound basis for Green IT implementation that includes all stakeholders, employees as well as management, all coming from different perspectives and concerns and from sources both inside and outside the organization.
- Green IT metrics provide data that can be used in support of a formal business in case for green transformations.
- In order to use datas, it is important to measure such data on a regular and accurate basis, as also record, calculate, analyze, report, and use it for optimization purposes. Such green measurements/data and its analysis can be used to ascertain the Green IT readiness and maturity of an organization, its corresponding industry and at a global level measuring the carbon footprint of a product or service in an organization, of the extent of carbon generated and, therefore, providing a benchmark for current as well as reduction in the future of the carbon contents.
- Provide an ability to compare the carbon performance of one organization against another organization,
- Enable marketing of products and services not only for lower costs and higher quality, but also for reduced carbon generated
- Potential to trade carbon by measuring and storing the credits generated by optimized carbon performance
- Opportunity to mature the green processes in an organization thereby enabling increasing optimization on the green CMM scale
-

Carbon Metrics Coverage

- These five “M”s of carbon metrics determine the current and future state of a green organization
- ▪ **Measure-** which is to measure the emissions. Improved measurement and monitoring technologies and capabilities can help to identify and guide future opportunities for technology development.



- **Monitor**: Standards to monitor and verify carbon emissions with reference to a baseline need to be defined in advance. Task of monitoring emissions and taking appropriate actions.
- **Manage**: Taking the results of the measurement and monitoring process and determining from that data what should be done to improve the process.
- **Mitigate**: Mitigation strives for improvement in the process so as to result in permanent reduction in the emissions, performance tracking of reduction targets and improved energy efficiency.
- **Monetize**: Deals with converting the improvement of the organization over its carbon. Performance into monetary value such as through its marketing effort or on the stock exchange or through carbon trading.

Green IT Measurement Challenges

- Lack of formal metrics and associated measurements related to carbon performance of an organization, particularly at the end-user and the data center level
- Lack of availability of real-time data and corresponding defined metrics to calculate carbon performance.
- Lack of robust cost-benefit calculations
- Lack of experience and necessary expertise within the organization
- Lack of standards and agreements amongst a group of organizations
- Confusing rules and regulations
- Lack of proper motivation, especially at the top-end of the business leadership, to initiate and implement carbon control programs.
- Differences in calculations of carbon emissions based on electricity consumed from different sources.

Framework for Green IT Metrics

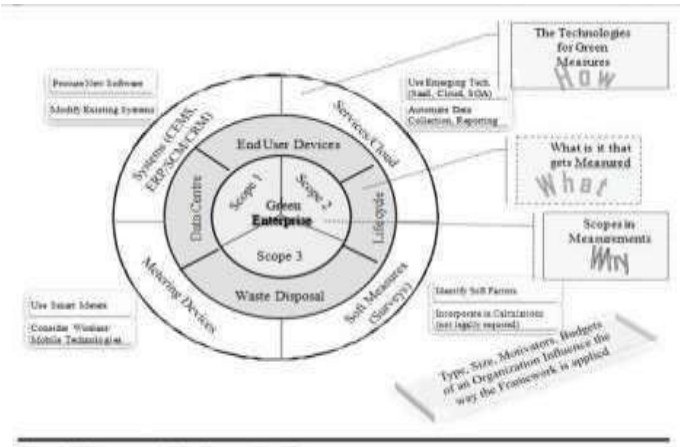


Figure 3.13 Framework for Green IT metrics.

- The need to comprehend how much of carbon is being generated by the business activities and, even more importantly, the lack of standardized and detailed measurements necessary.
- Detailed metrics and measurement program for carbon emissions requires a framework. Figure 3 .13 shows such an overall framework for measuring carbon emissions. In the center of this framework are the three scopes are measured across four areas of the organization: the end-user devices, the data center, the lifecycle, and the waste disposal.
- Greenhouse Gases (GHG) starts with an understanding of the six major types of GHGs—Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Perfluorocarbons (PFC), Hydrofluorocarbons (HFC), and Sulphur Hexafluoride (SF_6). GHGs are measured in Tonnes
- The energy consumed in producing those GHGs is calculated i n Joules/Terra Joules (TJ). When it comes to calculating the total emissions for an organization, these six greenhouse gases emitted by the use of materials and equipment, and execution of various processes by the organization need to be calculated and converted to CO_2e (Carbon dioxide equivalent). While CO_2e comprises only 0.05% of the atmosphere

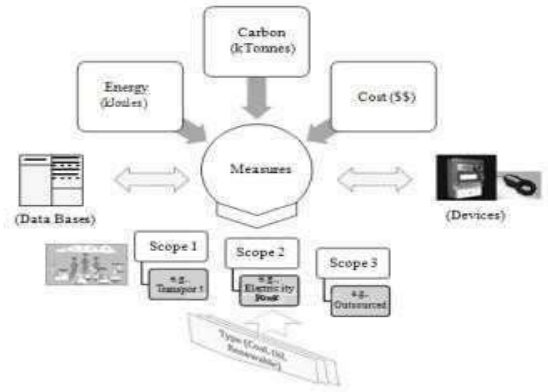


Figure 3.14 Elements and scopes of Green IT metrics.

- Scope 1 emissions are those caused by direct emissions of carbon dioxide and other green- house gases into the atmosphere, for example, vehicle exhausts, manufacturing emissions, and so on. These are the emissions resulting from manufacturing activities, physical movement of people and materials, chemical emissions, and so on.
- Scope 2 emissions are those caused indirectly through the usage of energy that causes GHG emissions in its generation. By far the most common Scope 2 emission is the usage of electricity from the power grid.
- Scope 3 emissions are those caused by the organization's supply chain, that is, the embedded carbon used in the manufacture of products it buys or services it uses.
- Carbon metrics have to measure and report on the TCCO (Total Carbon Cost of Ownership) measures for various groups of emissions (as shown in Figure 3.13) and eventually add them up for the organization

Measuring the Carbon Footprint of Your Organization

- There are divided into two major categories: the static measures and the dynamic ones.
- This fig. argues for the need to include both static and dynamic measures of an organization's environmental performance in order to arrive at a comprehensive carbon footprint of the organization. The overall footprint of an organization is represented by a "C" notation
- Dynamic measures change on a daily basis, and are made up of the emissions of the organization in its production line, service processes, and also include the impact of attitude and behavior of the people working within the organization.
- Static measures are a group of measures that are ascertained based on the procurement, design, and also the disposal aspect of materials and equipments in the organization the carbon emissions associated with the construction of a data center form occur only once at the start of the data center.

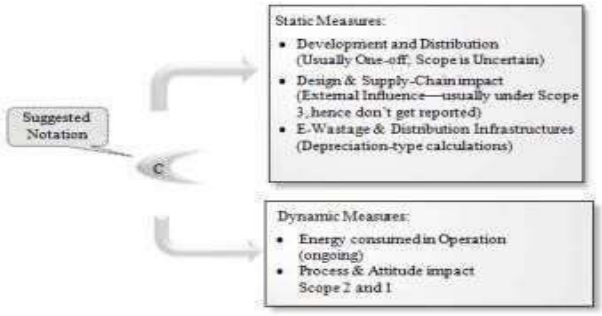


Figure 3.15 Measuring CO_2e.

Measuring Operational Costs in Your Organization

- The dynamic measures referred to in the previous section are mainly the operational measures of carbon emission in the organization. This is so because these dynamic measures encompass the carbon produced when an equipment (such as a computer monitor, a data server, or a network router) is operational or in use.
- Thus, operational carbon emission calculation will be a combination of the equipments in use and the various time durations for that use.

Green Balanced Scorecard

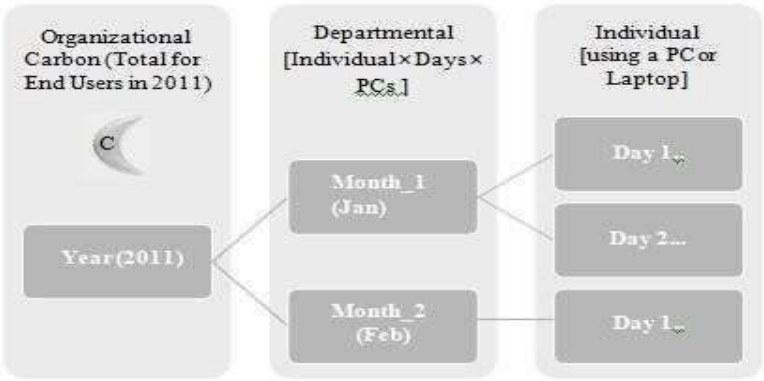


Figure 3.16 Typical breakdown in measuring carbon emissions (example of end-user devices).

- The concept of the balanced scorecard is valuable in Green IT as it builds on four perspectives: financial, internal business processes, customer, and learning/growth. The balance in these four perspectives is achieved based on the core vision and strategy of the organization.
- The financial perspective in a balanced scorecard is used to assess the business activities and financial standing of the organization that assists in identifying the strengths and weaknesses of the organization
- The internal business processes that comprise the operative aspect of the organization under-taking green enterprise transition are then recorded in the green balanced scorecard.
- **Green IT Readinessand CMM**
- Green IT readiness of an organization is measured across four aspects: attitude, policy, practice, and technology.
- Connection Research determines the Green IT maturity levels through a survey quizzing the participants on the aforementioned four (and metrics) aspects. Answers enabled a rating on a CMM scale from 0 to 5 .
- The results from the metrics are used to optimize the green performance of the organization. This is the “Best practice” level of an organization.

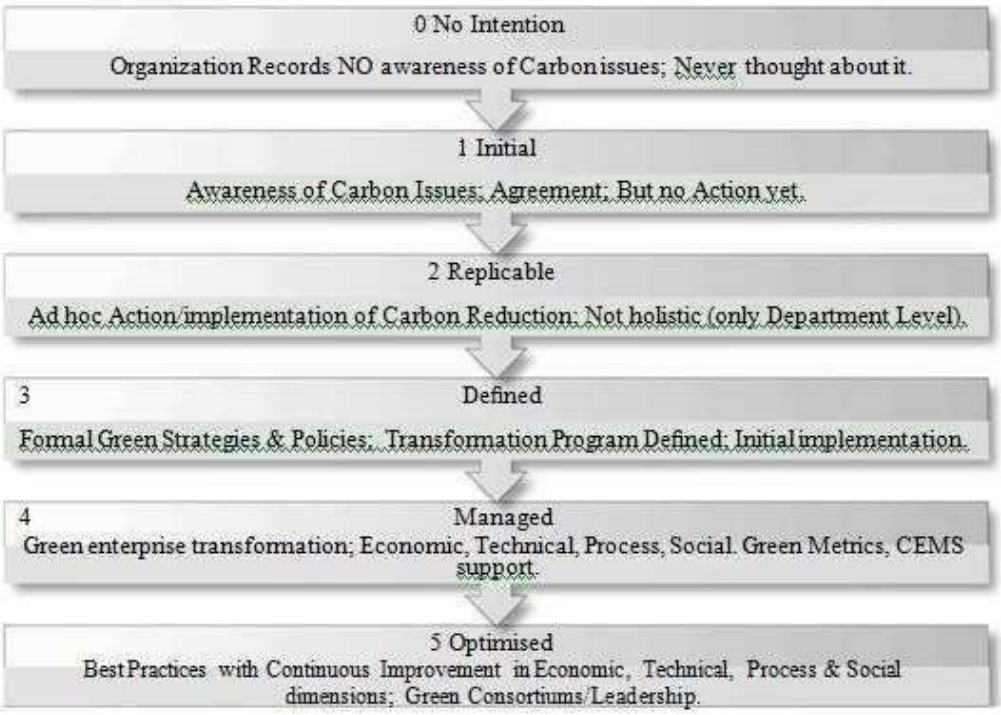


Figure 3.17 Green Capability Maturity Model. (Based on Philipson, G., www.connection research.com, 2009, accessed 15 October 2010.)

Context Sensitivity and Automation in Green IT Measures

- Automation assists in measuring and monitoring of emissions in real time. This is usually accomplished by means of smart meters at the data collection end of the Carbon Emissions Management Software (CEMS). Smart meters record and report on the carbon emissions from equipments and operations.
- The carbon emissions data from these meters are used by CEMS to analyze, plot trends, and provide alerts to the workers and the leaders in terms of emission and potential actions.
- One of the challenges of current carbon measurements arise from the context-sensitive nature of these measures. This context sensitivity extends from the specific nuances of an organization, its size, its physical location, and also its industrial sector (NGERS).

Metrics	Unit	Context
Cost of Green IT transformation for the enterprise **(Replacement costs of devices—primarily of IT domain)** **(Systemsupgrades, people costs—training and consulting)**	$ (or equi)	**Derived by close work with existing financial and inventory managementsystems.**
Costs associatedwithchange in business (possible loss of customers **Rewriting of SLAs; this will be usually outside of IT; need to calculate NPV of the carbon initiative for next 3–5 years)**	$	**Green IT may reduce the quality of service for some customers. Corporate customers may enforce rewrite of SLAs.**
Savings resulting from the Green IT transformation **Reduction in operational expenses (Scope 1)** **Reduction in energy expenses (Scope 2)**	$	**These savings need to be included in the budgets for greening of the organization. Carbon and cost are both reduced.**
Potential penalty costs (likely to change dramatically as the legislations mature)	$	**Green IT projects need to be budgeted keeping these potential penalty costs in mind.**
Green IT strategy within business strategy(can be measured in terms of the total number of elements within a strategic business approach, and the numbers within them that are relatedto Green IT/carbon emissions)	**%**	**Derived from the existing elements of strategic measures (a financial/ time measure in percentage).**

Enterprise Data Center Metrics

Metrics	Unit	Context
Carbon emission per megabyte of data stored on the servers	CO_2e	Relates the carbon emissions to the total electronic storage occupying the servers
Carbon emission per MIE (million instructions executed—time, or speed of execution, can be incorporated later after this metric is refined)	CO_2e	Relates the carbon emissions to the speed wiThwhich the data center is operating
Carbon emission of the data center per user (this needs to be divided into internal users/ employees versus external customers)	CO_2e	Relates the carbon emissions to the total users being served by the data center
Power usage effectiveness (PUE) (existing) versus PUE of outsourced data center (potential—the outsourcing vendors will have to provide this) (PUE or DCiE)	% or rati o	Well-known measure that provides a ratio of effectiveness of power consumption for data storage purposes

Assignment

•Discuss the various renewable sources of energy. How do these different energy sources impact the carbon emission calculations?

Unit 1 - Part A – (CO1, K2)

1.Define Green Computing.

—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 communications systems) efficiently and effectively with minimal or no impact on the environment.‖

2.What are the Four layers of a Green IT vision of an enterprise?

IT as a Producer
IT as an Enabler
Green Enterprise Green Collaboration

3.What is Green Vision?

A sectional or fragmentary approach to the vision will not lead to a green organization which benefits from the carbon reduction effort in the long term.

Vision can include not only what a carbonefficient organization will be, but a lso new avenues of business in the new green markets .

4.What is Green Value?

The creation of green strategies and their implementation is eventually meant to produce this long-lasting green value for the organization.

This value is a combination of tangible and intangible benefits to its employees, customers, and shareholders.

Importance of green value to business has to be measured through appropriate ROIs.

Some aspects of the green value may not be directly measurable—and may produce returns to the organization that may be intangible.

5. What are the Challenges of a Carbon Economy.

The entire Green IT effort of an organization primarily emanates today from the inevitable obligatory nature of the upcoming carbon economy

- This implies a mandatory need to produce and implement a comprehensive program for the greening of the enterprise.
- The carbon economy revolves around rising energy prices, concerns about energy sustainability in the long run, and the ensuing pressure from society to reduce GHG emissions related to fossil fuels
- Carbon economies in the developing countries, however, are unlikely to respond to the carbon reduction challenge only through legislations or negotiations.

6. What is Environmental Intelligence.

The strategic, holistic approach to environmental sustainability that is based on making the best use of the IT resources available to the organization.

- An interesting part of this extension and use of IT resources comes from the extension and application of the concepts and technologies of business intelligence to the environmental initiative of the organization.

7. What is Environmental Intelligence.

Business intelligence derives knowledge, or insights, by analyzing an organization's information. This information can be of many different types including carbon data, financial data, environmental parameters, human relations data, and organizational strategy data.

- The challenge for the organization is to correlate these varied pieces of information—and their subsequence analysis—in a way that provides opportunities for it to create actionable steps, including those that enable it to undertake a green enterprise transformation

8. What is KPI?

- The organization needs to gain or import substantial practical application in converting, expanding, and applying EI in a way that does not reduce the existing Key Performance Indicators (KPIs) of the organization.

9. Envisioning the Green Future.

- Future economy is the carbon economy
- Trust in a green future is a combination of skills, processes, leadership, technologies, and sound financial modeling for the future to keep the green credentials of the organization and its collaborating partners in mind.
- Certainly, the generation that is studying in schools today will be different to the Gen-X or Gen-Y or any such generation; it will be most likely a G en-G (for Green). These customers of the future a re most likely to be a green consumer and will expect the organizations of the future to be prepared for green consumers.

10. What is carbon foot print?

- A footprint is a personal thing — nobody else has a footprint quite like yours. In the same way, your carbon footprint is unique. It's the total of all the CO2 (carbon dioxide) that your activities directly and indirectly contribute to the environment.
- We can change the sizes of the carbon footprints we currently make. By discovering where you're currently using outdated technologies or accidentally or unconsciously burning fuel that you don't need to burn, you can reduce your footprint's size and be a little kinder to the earth.
- Online resources to help you calculate your footprint, and the sections in this chapter walk you through a couple of especially helpful calculators

10. Describe about the carbon cycle.

.

Green landscapes, including trees, grass, plants, and shrubs, all absorb the carbon dioxide we exhale and convert it to oxygen during photosynthesis, which is the process plants use to turn sunlight, water, and carbon dioxide into oxygen and energy. Photosynthesis also helps reduce other chemicals — such as nitrogen oxides, ozone, and more — that contribute to greenhouse gases

The emission and reduction of gases is all part of a natural cycle, but this cycle can handle only so much carbon. Many things people do contribute to excess carbon in the atmosphere.

11. Define the in three key areas to reduce carbon footprint.

The way you run your home: In this arena, technology can help in many ways. PC power management, greener technology purchases, and more as insulation, landscaping, and building materials, are beyond the scope of a computing book

The way you use transportation: Telecommuting and teleconferencing because they provide great ways to reduce your travel and thus your carbon footprint

The way you feed yourself and your family: Offsetting your carbon habit Carbon offsets offer you one way to lessen the impact of your carbon footprint — by supporting projects that reduce CO2 emissions in a variety of ways.

12. State the Power issue and Consumption.

Power issue — what it is, where it comes from, and where it goes. You discover which appliances and gadgets in your house are using power right now and how you can better manage your power .

Consumption — through your choices and actions — so that the power you consume is more in line with your hopes for the earth.

13. Renewable versus nonrenewable energy?

Today, you see the terms renewable and nonrenewable energy everywhere. The difference between the two (not surprisingly) is that one type of energy continually replenishes naturally (like wind and water) and the other doesn't

— when it's gone, it's gone (for example, oil, natural gas, and coal)

Scientists tell us that available oil and natural gas supplies are limited and dwindling, although coal promises a longer supply, with experts estimating that the earth's coal supply will last well into the next century.

Because today coal is handy and readily available — and cheap — still doesn't mean it will always be around. It's still a nonrenewable resource. Also, mining coal is difficult and dangerous, as headlines often attest.

13.What are the two types of Green Strategic Alignment?

1. Proactive Green Strategies
2. Reactive Green Strategies

14.Define Proactive Green Strategies.

Green strategies can encourage the organization to bring about significant organizational change. These changes are based on an understanding of the various Green IT drivers by the organization's leadership.

These strategies, that are not enforced on the organization but are based on prediction by the leadership of the organization, can be considered as the proactive green strategies.

The organization's own understanding is translated into a Green IT initiative and is supported by most layers of the organization

16. Define Reactive Green Strategies?

In addition to undertaking green transformation on its own volition, there are also significant elements of reaction by an organization to the external green influences on it.

For example, the impact of government rules and regulations relating to carbon provide a major impetus for the organization to undertake green strategy formulations.

External competition, outsourcing, globalization, and customer demands can all put the organization in reactive mode resulting in reactive Green IT strategies .

16.List the different Drivers.

Costs and revenues Sociocultural and political

Regulatory and legal Enlightened self-interest Responsible Business ecosystem

New market opportunities

17.What are four dimensions?

These four dimensions/factors are:

Economy,

People,

Technology

19. How Lean Impact on Green

An organization that successfully capitalize on its —lean‖ effort can be:

- Lean-green goal identification. These goals extend the business goals to incorporate carbon efficiency and reduced wastage.
- Alignment with green enterprise goals. Ensuring that the green policies and practices a realigned with the lean principles being applied in the organization.
- Product differentiation From the consumer's perspective, the perceived differences in value results in costumers comparing a green product with a traditional product, or comparing the same green product from one organization as against another one. .

20.What are the three different angles in policies and pratices?

- 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.
- these three areas of consideration in the development of green policies .

21.List out any four environmental goals.

- Energy Consumption— Reducing energy consumption has to be incorporated within policy development as a business goal.
- Energy Efficiency—The key of business sustainability is energy efficiency and the reduction of emissions.
- Operational Costs—These are significant in all major business activities. These operating costs include sales and marketing, research and development, and administrative costs associated w ith business.
- Organizational Reputation—Improvement in the reputation of the organization as a goal associated with carbon reduction is a valid and important goal to have .

22.Identify the Role of a Chief Green Officer.

- The Chief Green Office (CGO), also called the Chief Sustainability Officer (CSO), is the most senior person in the organization, working at the board level, responsible for green strategies, green policies, and green governance.
- The drivers and the four dimensions remain upper- most in the mind of a CGO. Green metrics provide the ability to justify the ROI. Technically, the CGO would coordinate with the CIO to exploit the potential offered by Environmental Intelligence

23. What are the Carbon Metrics Coverage?

- These five —M||s of carbon metrics determine the current and future state of a green organization

Measure
Monitor
Manage Mitigate Monetize

24. List the six major types of GHGs.

Carbon Dioxide (CO2), Methane (CH4), Nitrous Oxide (N2O), Perfluorocarbons (PFC), Hydrofluorocarbons (HFC), and Sulphur Hexafluoride (SF6).

25. Define different types of scopes.

- Scope 1 emissions are those caused by direct emissions of carbon dioxide and other green- house gases into the atmosphere, for example, vehicle exhausts, manufacturing emissions, and so on. These are the emissions resulting from manufacturing activities, physical movement of people and materials, chemical emissions, and so on.

- Scope 2 emissions are those caused indirectly through the usage of energy that causes GHG emissions in its generation. By far the most common Scope 2 emission is the usage of electricity from the power grid.

- Scope 3 emissions are those caused by the organization's supply chain, that is, the embedded carbon used in the manufacture of products it buys or services it uses.

Unit 1 - Part B - Questions: (CO1, K2)

1.How does IT relate to business? What is the impact of this close relationship between IT and business on the environment?
2.What are the likely repercussions of an EI approach to carbon reduction?
3.Are there mechanisms to automatically record and use carbon-related data?
4.How will you checking out your Carbon footprint?
5.Discuss the importance of consortiums in an 8+ year Green strategy.
6.What are the four dimensions a long which an organization can transform to a green?
7. Discuss the coverage, duration, and intensity of CO_2e measures.(6)
8.List with examples, the —why, what and How‖ of a Green IT metrics framework.
9.List and discuss any three elements in the mind map of a Chief Green Officer.(7)
10.What are the five purposes of Green IT metrics?

Supportive Online Courses

Relevant Online Courses

S. No	Course Title	Link	Platform
1	Green Computing	https://nptel.ac.in/courses/106/105/10610517/#	NPTEL / Swayam
2	Renewable Energy and Green Building Entrepreneurship	https://www.coursera.org/learn/renewable-energy-entrepreneurship	Coursera
3	A Green Computing Professional Education	https://www.tomw.net.au/technology/it/green_computing_professional/	Udemy
4	Corporate Sustainability. Understanding and Seizing the Strategic Opportunity	https://www.coursera.org/learn/corp-sustainability	Coursera
5	Enterprise Data Architecture Strategy - Build a Metadata Repository	https://www.experfy.com/training/courses/enterprise-data-architecture-strategy-build-a-metadata-repository	Experfy

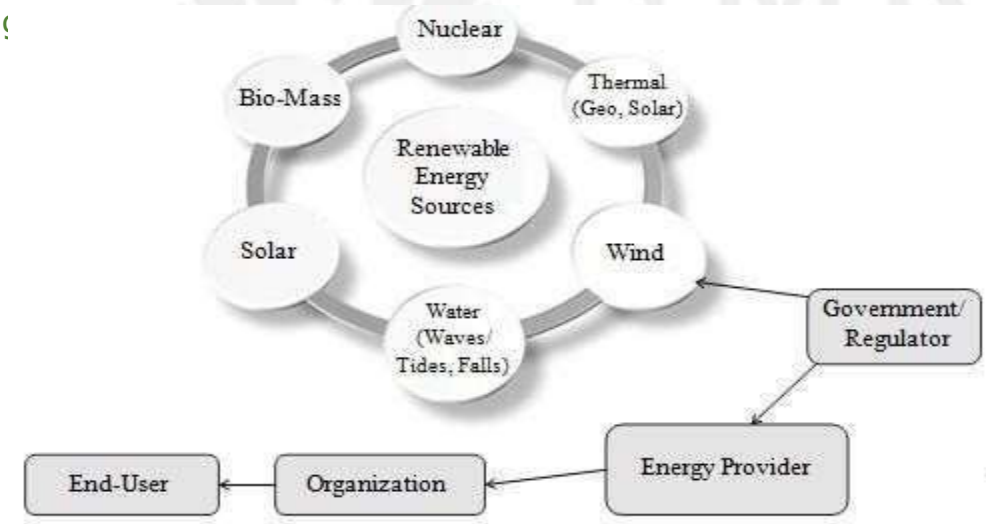
Real-time Applications

Real world Examples of Green Computing

- **Green Resource:**
  - Renewable Energy Resources
  - Green peripherals
  - Energy conservation
- **IT Sector:**
  - Data Servers Virtualization
  - Cloud computing Blackle
  -
- **Enterprise:**
  - Supply chain management
- **Smart meters**
  - CMES
  -
  -

Real Life Analogies

- **What would you prefer, Renewable Energy Resources?**
- 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—will that make a difference in the way the organizational policies.
- The use of renewable energies will require the government and the regulatory bodies to p lay a vital role in encouraging its use by changing market levers through legislations and use of carbon offsets.
- Using renewable energy is one way that businesses can minimize their greenhouse gases. Consumers, businesses, and organizations may use renewable energy to reduce the environmental impacts of conventional electricity



Renewable energy sources need to be increasingly incorporated in green policies.

Contents Beyond Syllabus

1. Green IT

- The essential elements of technology and the latest domain knowledge from Desktop to Data Center. In nine interactive modules students use text, video, and hands-on analytical exercises to master the fundamentals of sustainability for the ICT industry and specific techniques for applying that knowledge. The course includes in-depth work with the latest developments in —Green IT 2.0‖, the use of ICT to enable sustainable solutions across the enterprise. The capstone project is the creation of a practical plan for an enterprise Green IT initiative.

  The course is certified by the World Education council to meet the highest standard of online education. Instructors for the course have actual field experience in designing, leading and implementing Green IT projects.

- Students that successfully master the course content and pass the final examination earn a certification as Sustainability Professional – Information and Communications Technology (SP-ICT).

- It is designed to be beneficial to a broad audience, not just IT leaders and managers. The Green IT course content is essential knowledge for career success as Chief Sustainability Officer, Facility Manager. Architect and Building Design Engineer, Procurement and Purchasing Manager, and Corporate Social Responsibility leader. There is also increasing demand for professionals in Sales, Business Development, and Consulting who are knowledgeable about sustainability for ICT.

- The course requires approximately 100 hours to complete and costs $1,800 US, including materials, instructor support, exams, and certification.

- **Mastering the course content and receiving the SP-ICT certification gives professionals in many fields a unique competitive advantage for success in the technology-driven 21st Century world.**

2. Energy conservation

- The **industrial sector uses about 50% of the total commercial energy** available in India. Of the commercial sources of energy, coal, lignite, and oil and natural gas are mainly used. The Indian energy sector is highly energy intensive and efficiency is well below that of other industrialized countries. Efforts are made on a regular basis to promote energy conservation in these countries as this will help reduce the cost of production.
- There is considerable scope for improving energy efficiency in industries dealing with iron and steel, chemicals, cement, pulp and paper, fertilizers, textiles, etc. If such industries can promote energy conservation, it could lead to substantial reduction in their costs of production.
- Energy management is very important as all well-planned actions can help reduce an organization's energy bills and minimize the damage it does to the environment. The two main energy management strategies are conservation and efficiency. This requires the establishment of a system of collection, analysis, and reporting on the organization's energy consumption and costs.
- In the industrial sector, the major consumers of energy are fertilizer, textile, sugar, cement, and steel. It has been estimated that the **total conservation potential of this sector is around 25% of the total energy used** by it.
- **Conservation initiatives**
- Waste heat recovery systems, cogeneration, and the utilization of alternative sources of energy are also important for the conservation of energy.
- Technology, up gradation, modernization, and the introduction of control instrumentation are necessary to realize the full potential of energy conservation in industry.
- To motivate the industrial sector to take up energy conservation seriously, the government has from time to time introduced fiscal incentives such as cut on import duty for specific items. Effectively from 1983 certain tax benefits have been given to energy-saving devices and systems in the industrial sector such as cogeneration systems, power factor correcting devices, and specialized boilers and furnaces.
- The coal industry is both a source of energy and a consumer of energy. Energy can be conserved in both these areas. Coal reserves can be conserved through proper methods of exploration, improved recovery, and introduction of new mining technologies.
- Hydrocarbons continue to be the major source of energy. The conservation of this form of energy is essential as it will reduce environmental pollution.

ASSESSMENT SCHEDULE

- **Tentative schedule for the Assessment During 2023-2024 odd semester**

S.NO	Name of the Assessment	Start Date	End Date	Portion
1	Unit Test 1	22-08-23	28-08-23	UNIT 1
2	IAT 1	09-9-23	15-09-23	UNIT 1 & 2
3	Unit Test 2	09-10-23	14-10-23	UNIT 3
4	IAT 2	26-10-23	1-11-23	UNIT 3 & 4
5	Revision 1	06-11-23	08-11-23	UNIT 5 , 1 & 2
6	Revision 2	09-11-23	14-11-23	UNIT 3 & 4
7	Model	15-11-23	25-11-23	ALL 5 UNITS

Prescribed Text Books & References

Text Books and References

TEXT BOOKS:

- Bhuvan Unhelkar, —Green IT Strategies and Applications-Using Environmental Intelligence ||, CRC Press, June2014.
- Woody Leonhard, Katherine Murray,—Green Home computing for dummies ||, August2012.

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- AlinGales, Michael Schaefer,MikeEbbers,—Green Data Center: steps for the Journey||, Shroff / IBMrebook, 2011.
- John Lamb,—The Greening ofIT||,PearsonEducation,2009.
- Jason Harris,—Green Computing and Green IT-Best Practices on regulations & industry||, Lulu.com, 2008
- Carlspeshocky,—Empowering Green Initiatives with IT||, John Wiley & Sons,2010.

Miniproject Suggestions

Mini Project Ideas

1. Calculate the overall Carbon Emission from the Organization while building Data centers, Selecting location, Infrastructure design, and architecture has direct impact generated by the organization.
2. Identify the Green IT strategies that could be translated into practices in terms of Establishment, Operation and Disposes (P-O-D) of assets that leads to reduction in carbon emission.

Thank you

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