Unit-2

GREEN ASSETS AND MODELING

2.1 GREEN ASSETS

The green assets and infrastructure comprise substantial part of that long-term approach to managing the carbon performance of the organization. The three major phases or activities associated with the lifecycle of these assets is depicted: the way they are established or procured, the manner in which they are operated or run, and eventually the strategies for their disposal or demolishment. The assets made up of building, data centre, devices and vehicles. The three major activities relating to infrastructure assets has the following carbon repercussions:

Establish (Procure) - deals with the green credentials of the asset in terms of its design and development. For example, the original design of a car engine or a mobile phone that makeit carbon efficient.

Operate (Run) – deals with total carbon contribution of the organization by means of operation of assets.

Dispose(Demolish) – deals with the eventual phase of an asset and impacts the overall carbon footprint of an organization.

Figure 1: Green assets need to be organized in an efficient way throughout their lifecycle.

Types of Assets	Impact on Environment
Buildings and Facilities	Long-term impact as major environmental considerations should be during architecture and construction. Purpose of buildings, people movements, geographical locations (weather), and durability of the building impact their overall carbon contribution.
Data Centre	This is a special purpose building to house data servers. In addition to the standard building considerations, the ratio between power usage by the servers versus the rest of the power is a popular environmental consideration
Devices	Design, development, procurement, operation, and usage of devices is considered here.
Vehicles	Direct fuel emissions, pollution level of the type of fuel, design of the engines, and so on. Procurement, operations and disposal activities apply to vehicles used by the organization

Table 1: Types of Assets (Categories) and Their Impact on the Environment

2.1.1 Green Building

–Green‖ Buildings are high performance structures that also meet certain standards for reducing natural resource consumption.

–Green‖ or –Sustainable‖ buildings are characterized by:

- efficient management of energy and water resources
- management of material resources and waste
- restoration and protection of environmental quality
- enhancement and protection of health and indoor environmental quality
- reinforcement of natural systems
- analysis of the life cycle costs and benefits of materials and methods
- integration of the design decision-making process
- –Metrics‖ for such –green‖ benefits are articulated and certified by LEED, BuiltGreen or other organizations
- Green standards measure different environmental qualities of buildings
- Each has a different emphasis and purpose

Green Building standards include:

- **Leadership in Energy and Environmental Design (LEED)**
- **Green Globes**
- **Model Green Homebuilding Guidelines**
- **BuiltGreen**
- **Energy Star**
- **Living Building**

Why go –Green‖?

Green makes business sense

- Increased flexibility to allow for longer building and TI useful life and reuse of materials
- Improved building performance
- Increased revenue (higher rents/sales price, improved productivity, fewer/shorter vacancies)
- Lower cost (utilities, costs of conversion)
- reduce carbon consumption,
- energy independence,
- encourage community,
- preserve natural systems

Table 2: rating Building features to environmental factors

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

Green IT Hardware

The Hardware aspect of Green IT deals with the design and architecture of IT hardware and the manner in which it is acquired and operated.

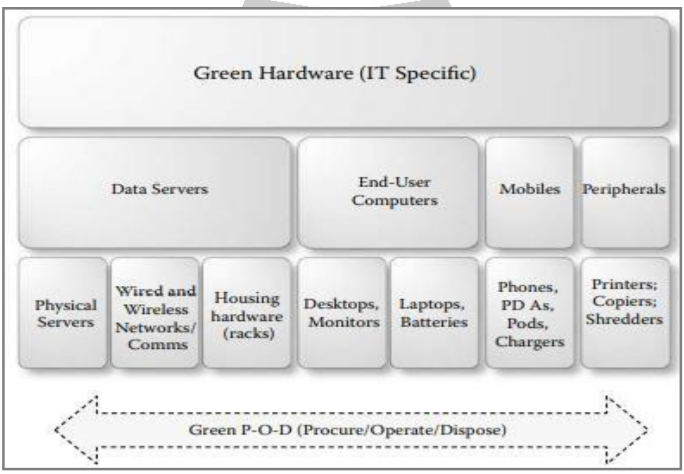


Figure 2: Range of Green IT hardware generating carbon

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

- **Data servers—** deals with the physical machines and the specific buildings in which they are housed. These servers also have both wired and wireless networks and corresponding communications equipment associated with them that are directly emitting carbon.
- **End-user computers—** laptops, desktops, their capacities, operational efficiencies, and their disposal (especially as the lifecycle of a computer is getting shorter by the day) need to be discussed from their P-O- D (Procurement – Operation – Disposal) viewpoint.
- **Mobile devices—** the mobile devices and associated hardware (e.g., extension leads), their batteries including the recharging mechanism and disposal of the batteries and the policies and actions when the devices become outdated (quickly).
- **Peripherals—** printers, photocopiers, shredders, and so on. These electronic gadgets are of immense interest in Green IT due to their large numbers, their potentially unnecessary overuse.

2.1.2 Green Data Centre

What is green Data Centre?

A green data centre is a repository for the storage, management and dissemination of data in which the mechanical, lighting, electrical and computer systems are designed for maximum energy efficiency and minimum environmental impact. These centres use more energy-efficient servers and most importantly the design technology to reduce energy demands for cooling and lighting.

Need for Data Centres:

1. Data centres are heavy consumer of energy, accounting for between 1.1% and 1.5% of the world's total energy usage in this decade. The Green data centres are energy efficient data centres that better utilize energy and increases performance.

2. Green Data centre reduces both operating costs and capital costs since they eliminate the need of additional power and cooling demands.

3. Green data centres reduces the technological impact on the environment and use of natural resources, thus helps environment to be sustainable.

4. They improve business by improving their corporate image and social image by meeting compliance and regulatory requirements.

5. They utilize resources such as office space, heat, light, electrical power etc, in an environmental friendly way.

Who are using Green data centres?

Steps to make a data centre Green.

- Turn off the dead servers and make few basic changes to existing data centres.
- Upgrade to energy-efficient servers.
- Switch to high-efficiency power supplies.
- Redesign cooling system
- Redesign air management
- Better environmental conditions are crucial for smooth running of data centre.

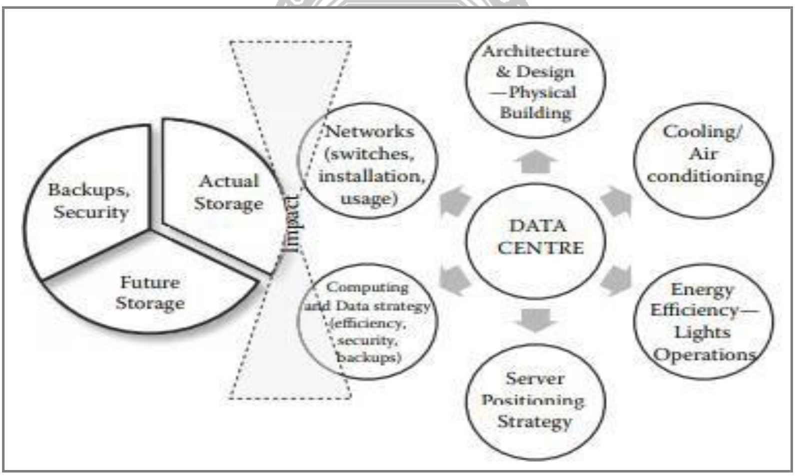


Figure 3 – Factors influencing Green data centre

Data Centre Building—Design, Layout, and Location

The challenges in handling data centres from carbon perspectives arises from the fact that the data centre buildings themselves are based on a ROI over 15–20 years.

Whereas the internal equipment, the data servers andother computing equipments themselves are usually Green Assets upgraded every 3 –5 years.

Therefore, the data centre building, together with thedata centre‘s non-ICT infrastructure, can quite easily consume more power than the equipment within it.

This is because of the architecture and design ofthe infrastructure and facilities that may not have kept up with the server technologies themselves.

Following are the specific design, layout, and location consideration for data centres.

- **Physical (geographical) location of the building.** This includes the weather patterns of the geographical region (such as warm or cold), proximity of the data centre building to water and air (for cooling) and the ease of access to the staff.
- **The building that houses the data centre**. This may be a dedicated stand-alone facility, or it may be purpose-built within a larger facility, or it may be retrofitted into existing premises. Whatever the case, there are a number of aspects of the built environment that will have an eff ect on power consumption, such as insulation.
- **The power supply**. Data centres usually have dedicated power supplies, and very often more than one. Ā ei r efficiency varies enormously. Data centres can also generate their own power, and backup power supplies are common for business continuity.

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

- **Server and storage virtualization**. This technology is meant to reduce power consumption as it reduces the overall number of devices; however, in practice the power consumption of data centres can rise as the virtualized servers may be more powerful and may use greater electricity.

- **Facilitation of new and emerging technologies**. The building of the data centre should be conducive to wireless communication, Cloud computing-related communication, and such best practices.

Data Centre ICT Equipment—Server Strategies

Servers are powerful computers that form a significant part of the IT assets of an organization. Increasingly these powerful servers provide the organization with the ability to access, provide, analyze, and store data, information, knowledge, and intelligence in myriad diff rent ways. As argued earlier, there is ever increasing demand for more powerful servers with increased storage and processing facilities. With more powerful processors and proliferating number of servers the power consumption continues to climb rapidly

Following are a list of green server strategy considerations that need to be expanded in detail in practice:

- Online, real-time list of server inventory that enables location and uses of the servers.
- Power consumption bill in real time—mapped to carbon generation that provides operational feedback to the entire organization.
- Bit to carbon ration as part of comprehensive—data strategy—that provides metrics on not only the used –bits‖ but also the carbon generated by the provisioned bits.
- Pue, DCiE—these popular metrics providingcomparative data over a length of time, as also across theindustry.
- Mirroring backup strategies that are balanced by the –acceptable risks‖ of the data centre director.
- Data capacity forecasting. Server capacities need to be estimated on a continuous basis as the business changes. The correlation between business change and growth,and corresponding data centre capacity, is ascertained based on statistical analysis, trend spotting, and estimating the impact of technological innovativeness.
- Carbon-cost visibility. Lack of visibility of server costs and particularly its mapping to individual or departmental use of space.
- Efficient decommissioning. Once the purpose of a server is consummated, there is a need for a formal yet quick way of decommissioning the server. Manual processes for decommissioning and lack of confidence of the data

centre director/manager can lead to servers lying around and consuming power for no apparent purpose.

- Incorporation right redundancy. Earlier discussion on bit-watt indicates the crucial need for optimum redundancy.
- Enhanced server distribution. Need to distribute, through proper assignment, the use of the data space across and between various departments/users. This would also enable server sharing between operational development and test environments.
- Incorporate server switching. Data servers should be capable of being switched from one type of usage to another (e.g., from test usage to production). This also enhance capacity sharing and peak load performance.
- Incorporate Cloud computing and server virtualization.

Data Servers Optimization

Optimization of servers deals primarily with the numbers, usage, and collaborations amongst the servers.

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

It is worth noting that the cost associated with cooling of servers is much more than the initial cost of procurement and installation of the hardware.

Furthermore, power consumption of the servers themselves is rapidly increasing.

Therefore, the costs associated with the cooling of the servers are equally on the rise.

There is a discrepancy between the advanced technologies used in the servers, the supporting rack level infrastructure of the data centre, and the lagging air conditioning and building infrastructure of the data centre.

Data centres are also heavily occupied and are stretched for their cooling capacity as these buildings are catering for far more sophisticated servers than they originally are designed for.

More techniques that could be considered by an organization for server optimization are described as follows:

- Undertake intense and iterative capacity planning for the data centre. This will involve management, anticipation, and optimization of storage capacities of the data centre.
- Undertake in-depth optimization through identification of unused capacity of servers and storage disks within them.
- Implement full storage virtualization that will enable hosting of multiple data warehouses on the same server. This will include conversion of existing physical servers to –virtual servers‖—partition servers that can operate in parallel without any interference.
- Efficient server operations. For example, a server that is on but idle would consume half the power it needs when

being used fully. Therefore, instead of operating multiple servers, some of which may be idling, optimization and management of servers will enable running of servers as closer to their maximum capacities.

- Efficient management of air-conditioning and cooling equipment that require, at times, even more power to cool the servers than required to operate them.
- Decommissioning servers once their service level agreement has expired.
- Applying virtualization during architecture and design of the servers, corresponding operating systems, and even applications. Enabling virtual servers easily will enable efficient capacity management and reduced hardware maintenance costs.
- Making use of infrastructural and hardware economies of scale. This can be achieved by implementing Cloud computing and making use of services or software services from an already existing repository. This will significantly reduce the amount of resources being used in order to provide a software solution or a result.

What is Virtualization?

- Virtualization is one of the hardware reducing, cost saving and energy saving technology that is rapidly transforming the IT landscape and changes the way people compute.
- On a server or a desktop PC, it allows multiple operating system and multiple applications to run on a single computer.

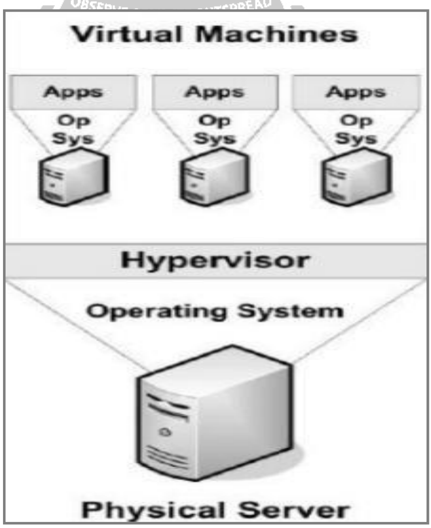
- The software that makes this possible is known as hypervisor.

Why green computing uses Virtualization?

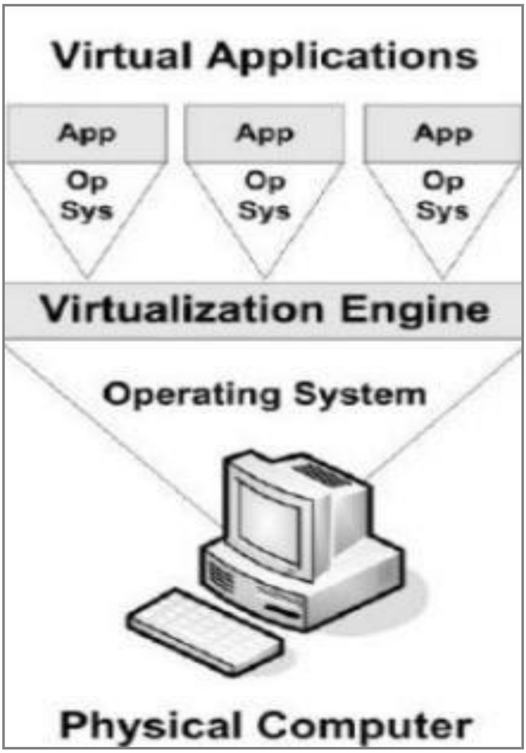
- **Decreased energy use–** reducing number of physical devices, the amount of energy required to operate the devices is decreased as well reduces the cooling system power requirement.
- **Reduction in toxic waste–** number of hardware devices are reduced so huge reduction in e-waste or toxic wastes.
- **Reduction in facility requirements–** decrease in number of system is directly proportional to reduced number of data centres.

Types of virtualization

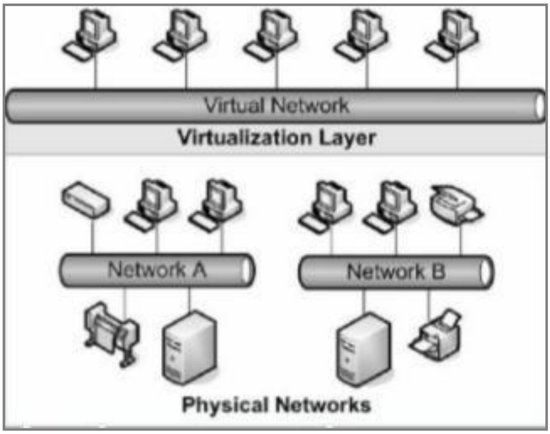
- **Server virtualization–** many servers run on single physical server. Helps decrease energy usage and provides more floor space.



- **Application virtualization** – applications can be run independently of the underlying host operating system. Since no device drivers are installed can run application without administrative rights. Applications can be run from portable media, if not compatible can be executed on physical machine.

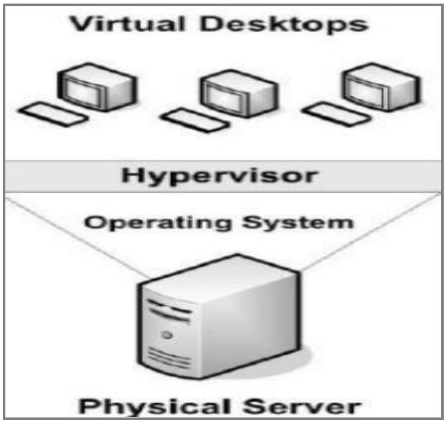


- **Network virtualization** – It allows us to combine all of the resources available on a network by splitting up the available bandwidth into independent channels. Consolidation of many physical networks into one virtual network. Partitioning of single physical network into many virtual networks is allowed.



- **Storage virtualization** – allows multiple storage devices to be combined as a one large storage device. Easier administration, monitoring of storage growth is possible.

- **Desktop virtualization** – allows virtual desktops to be centrally managed on a server and run by the end user on a thin client machine. Can access multiple monitors, USB devices, device recovery is simplified.



Green Assets – Devices

Sustainable steps by researcher

- Compaq EOS sustainable Desktop
    - Designed by Cody Stonerock, made of recycled aluminium & biodegradable resins by HP. Low cost PC with no screws or fasteners.
    - Monitor and other components are easily removed. Designed with fewer features with only basic computing power.

- Igglu modular PC concept
  - Looks like a book rack, updating is easy like replacing books in a shelf, since hard drives, PCI drivers, RAM etc. are placed like books in a book shelf.
  - Designed for maximum energy efficiency and resource usage.

- _Bento‘ Solar-powered concept computing system

- Batteries are powered by solar power, they come with integrated with solar panel and ITB hard drive.

✸ Sustainable Computer _Froot‘

- Bio degradable starch-based polymers constitute the _main frame‘ which are recyclable along with electrical components.

- High end-laser and projecting technology to beam a screen on the wall and keyboard.

✸ EVO PC concept

- This has two parts – First EVO client module which sits on the second part which is a docking unit for this module.
- Client has low processing power, low memory and low RAM.
- The client communicates with the server via broadband, thus server does the actual computation.
- The remote access comes with a cost, the client is recyclable and company provides a replacement.