

Green Data Center Design

Many organizations, as well as business enterprises, require a data center to be able to perform information technology operations and hold their equipment. Therefore, the data center is a physical building that institutions and organizations require to store their critical data and applications. The data center should then be designed to use computing network and storage resources to allow the transfer of shared data and applications. Data is fundamental in every organization, and every organization works to ensure their information is confidential and secure. However, data centers have advanced from the traditional infrastructure of physical servers to virtualized infrastructure. The development of green data centers is of great advantage in saving energy power and reducing environmental effects, therefore this paper will discuss the key concepts required in designing green data centers. The paper will also focus on how green credentials are measured as well as the future of the data center.

Energy consumption has highly increased, and therefore as IT experts, the only way to handle the issue of power shortage is to develop energy-efficient green data centers. The process of building green centers starts from the design phase, where the IT expert should first identify the goals of the center and identify areas of improvement. The process of controlling energy supplies in data centers has faced significant challenges including, the task of securing the supply of affordable and reliable energy and the revolution to the use of low carbon and environment-friendly system for energy supply. Several concepts need to be grasped during the design of green data centers; firstly, the designer needs to measure the data center infrastructure efficiency (DCiE) (Sari & Akkaya, 2015). The measure will enable the designer to find the percentage of the power input, which is used in the information technology loads hence unraveling it with the power that enters the cooling, power and lighting facilities. The designer has to have a real

infrastructure plan to be able to implement a green data center. Uninterruptible power supply (UPS) efficacy also has an essential impact on proficiency of data center due to overall power goes though it. Nonetheless, the designer should install a lot of information technology facilities in the data center power and cooling equipment. Therefore, the design should be based on scalable power and cooling system because the scalability of the cooling equipment decreases the fixed losses of power in the data center.

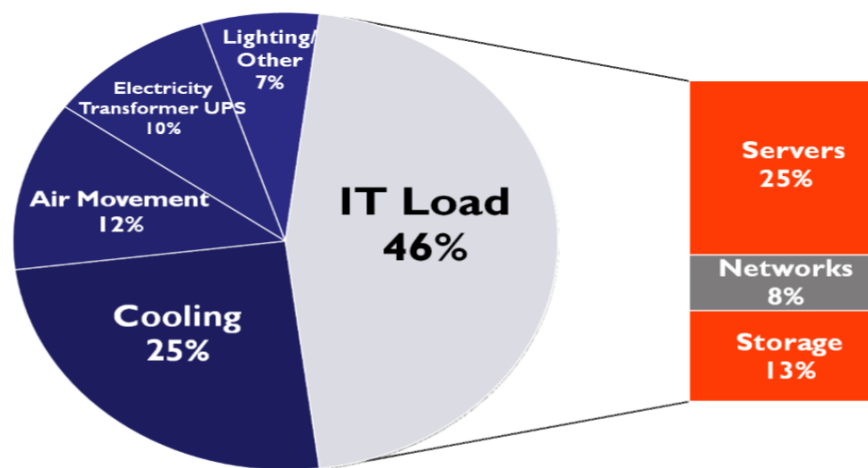


Fig. 1: Data Center Power Draws

On the other hand, before the implementation of the green data center, the designer needs to understand how the current data center works. Therefore, they will need to perform an energy audit (Subramanya et al., 2016). To effectively design a green data center, one must deliver a real-time evaluation of usage and efficiency as well as a benchmark for upcoming evaluation to control planning for long term use. Moreover, data centers involve different systems that are connected; it is, therefore, vital to dig down into people's operations to determine areas of inadequacies that exist in data center infrastructures. Identification of inefficiencies thorough

evaluation, the audit team should then find the effects of the weaknesses on the whole usage and develop a concrete and trackable solution plan.

Alternatively, the designer should have the concepts of green-friendly resources as well as environmental features. Going green in IT means conserving energy and developing systems that have less harmful emissions to the environment and easily recycled. Therefore, many influences have less carbon trail and support the usage of little energy such as the use of low emission supplies, power, and cooling sources, compact building, and waste recycling. To reduce carbon emissions, designers need to decide on the power supply to use in the data center (Sharma et al., 2017). Generation of power is critical in controlling the emission of carbon to the environment, for instance, some may decide to use solar power. In contrast, others choose to have a contract signed by the hydro energy supplier, nuclear or sustainable energy organizations, which guarantee that data centers operate in energy generation sustainability on a long term basis. Similarly, private data centers should be designed in such a way that they can be able to expand and reduce based on the amount of information attained. The ability to increase the space could lead to an increase in effectiveness as well as the carbon footprint. Focusing on future developments is also important because data is increasing day and developing data centers that have high temperatures required to improve on the cooling systems and decreasing carbon emissions (Liu et al., 2017).

The growth of technology used by end-users has highly increased. For example, computer-based users have increased, resulting in the innovation of new approaches for data centers to be able to serve all the users, such as server-based computing. Designers should, therefore, also base their concepts on shifting from developing high consumable power systems like personal computers to developing devices that consume less power like mobile phones.

However, if new devices will not be established with less energy consumption will lead to the development of more servers, which are not efficient and consume more energy hence resulting in a great challenge of creating green data centers (Zhang et al., 2016).

Besides, designers should also keep in mind how to dispose of computer equipment because of the significant effect it has on the environment regarding carbon emission. The process of waste management through recycling process is the best way for the designer to use. Although some states have set rules and regulations concerning the disposal of IT equipment's such as the waste electrical and electronic equipment (WEEE), IT specialist needs to find ways of recycling and to control the disposal of the machine. Recycling of IT equipment has some advantages, including a decrease in the volume of wastes that fill the lands and reduces the number of raw materials needed to manufacture new IT products. Computer refurbishment is also essential to other institutions and individuals who could not be able to purchase new equipment; alternatively, IT equipment can be recycled, including servers, personal computers, and monitors.

Other factors that might bring long-run changes in environment and progress green materials are through shutting down of servers, which are not in use, upgrading air compressors, transforming to LED lighting, and paper shredding. Institutions and organizations save a lot by constructing data centers by use of renewable resources sourced locally to power their servers and building in cold locations to allow free cooling. Designers need to build data centers that observe factors that do not affect the environment, especially power usage. Gartner predicts the cost of power to be increasing every year at a rate of ten percent because of the rise in the value of power attributed to the emerging demand for high power density servers (Sowmya, 2016). Designers should also use fundamental concepts of cooling servers. For instance, building a

server in a cold environment will facilitate servers to cool efficiently. The process also reduces power use because the operation of the cooling server will not rely on power use.

Similarly, other parts of the data center that generates a lot of heat should be isolated to allow them not to supply more heat to other parts of the building but to cool by itself. Finally, designers should understand modular data centers to enable improvement in speed, reliability, performance, and decreasing cost. The use of prefabricated data centers allows the organization to be flexible and able to be fulfilled in their computational needs at the same time, saving their resources as there will be no need to create another data center. Consequently, to make the green data center, designers should have to understand how the data center works and identify the inefficiencies in the infrastructure. Then, make smart selections in the green environmental factors and locations, check ways of reducing the usage of power, which decreases the cost to the organization as well as the use of modular data center, which facilitates installations with fewer disturbances.

The green credential is measured using Data Center Infrastructure Efficiency (DCiE) and cooling efficiency. The measure of DCiE aids in finding power used in information technology loads such as lighting and cooling in percentage (Lajevardi et al., 2015). The measure is used to find energy efficiency in the data center. DCiE metric was developed by a group of Green Grid Company which was responsible for data center energy efficiency. The formula for calculating DCiE is through entire dividing information technology equipment power with sum of facility power and then multiplies the result with one hundred. According to Brotherton (n.d), DCiE is presented in percentage form. To measure DCiE, the following steps should be followed, first identify the meter used to facilitate power to data center and record measurement. If data center

relies on a shared meter, ensure you estimate the energy amount used by other non-data center parts of building and subtract from the overall equation.

The last step is to identify the measure of IT equipment load, which should be found after power has been converted, and the switching and acclimatizing has been done. Therefore, to get the measure of equipment load correctly, it is best to use the output power distribution unit in the computer room. Power usage efficiency (PUE) is found by finding the square root of DCiE because DCiE is the reciprocal of PUE (Kushwaha et al, 2019). Therefore, to differentiate one green data center with the other, we need to differentiate using PUE measure because the best green data center should have at least 1.6 PUE, meaning that it will have the most efficient equipment and best practices.

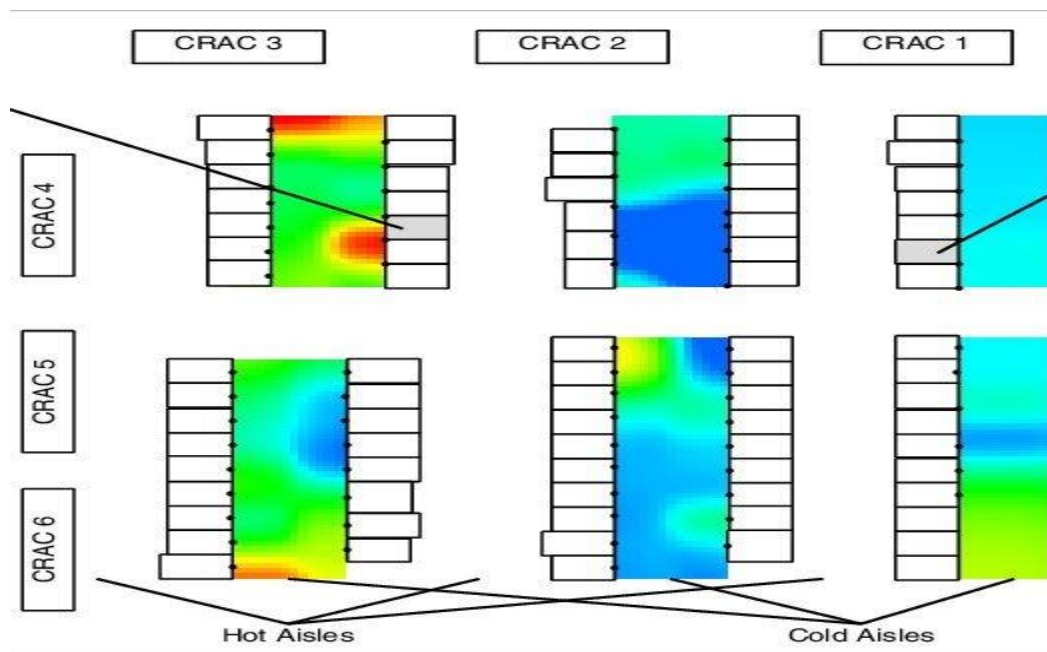


Fig. 2: Cooling efficiency overview of a data center. of IT equipment and the placement of workload within the IT equipment

The diagram above indicates the cooling process of data center and it introduces the next measure of green data center. Cooling efficiency can be calculated using by adding the useful cooling power with the power consumed and use the result to divide the useful cooling power. The green data center with the best cooling system and allows cold air not to mix with the hot air, cool air is supplied to the cold aisle while the heat contained is taken to the heat rejection room is the most greener data center (Rong et al., 2016). Another measure is by building the center underground, which reduces the need for using power to provide cooling services such as fans and hence saving energy, considering that a drop by one degree can increase power saved by four percent.

Every company deserves and is happy when it is experiencing positive growth, so does green data center design. The Green data center is expected to continue growing because of the increased internet services demand and the cloud. However, the future for green data science design is to design data centers that are reliable, efficient, and fast in providing services while using less energy consumption resources. The future of green data science is also to design systems that use IT equipment's which can be easily disposable without affecting the environment and recycled to other IT equipment efficiently with minimal material wastage (Schulz, 2016). Designers are expected to design green data centers that can use less than thirty percent of the world's energy as well as produce minimal carbon emission. The current society has the majority of people who demand to be served with internet services; therefore, green data center design is also expected to develop end devices that use less energy hence not overwhelming the servers. Finally, the future of green data center design is expected to investigate and develop new methods of cooling systems that do not require the use of air conditioning as well as building scalable data centers that require spaces when needed.

In summation, the green data center is the future for developing a computing environment that uses IT resources in a more efficient way, which will have a minimum impact on people and the environment. Green data center designers should have concepts of how the traditional data center system works and develop ideas and strategies for developing a data center with smart environmental ideas and green IT equipment. The location of the green data center should also be kept into consideration through decreasing of the energy and power consumption required as well as the carbon emission to the environment should also be minimized as much as possible. Green data center can also be measured using to metrics the DCiE and the cooling efficiency. Similarly, the future is based on the increasing design of building data centers, which have increased performance and reliability with reduction in energy consumption and also emission of carbon to environment.

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