

# Green Database : An Initiative to Enhance Renewable Energy Efficiency

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## ABSTRACT

The paper is throwing light on the critical issue of saving the nature and its limited resources by using renewable energy resources or green energy supply for boosting the efficiency of the database. Today technology has spread to its dimension in every area. Everything is being automated. With automation and use of internet in cloud, databases are highly used for storing and fetching the information. It calls for the design of a technique which can enhance the efficiency of a database in eco-friendly way. The paper proposed ReinDB i.e. Renewable Energy Integrated Database which is an initiative towards minimizing the brown energy consumption of databases.

**Keywords:** Green Computing, Green Database, Rein DB, Green IT, IOT.

## I. INTRODUCTION

We, human beings are fortunate enough to be blessed with nature. But with the expeditious growth of technology, the degradation of environment is apparent. So today is the time to payback to environment in terms of little contributions towards getting 'Green'. Green is a term emphatically associated with environment. Technically stating, Green is related to the eco-friendly use and re-use of the limited resources that we are gifted with. But greening also includes the activities or tasks that directly affect environment. No doubt, Information Technology has made our computations fast and convenient but it is also posing threat to our environment in the form of carbon footprints and GHGs (Green House Gases) emissions. IT practitioners have to ensure that the technology they are using or developing as well, will not affect environment in bad manner.

“Green computing is the environmentally responsible and eco-friendly use of computers and their resources. It is also known as green information technology (green IT)” [1].

In other words, we can say Green Computing is a movement towards proficient use, reuse, recycle and repair of electrical, electronic equipments which thusly controls the a dangerous atmospheric deviation. With Green Computing, many functionaries are focused on discovering laws, procedures, agreements and treaties in order to reduce the illegal activities related to dumping e-waste thereby promoting eco friendly use of Electrical Electronic Equipments to fabricate programming items effectively with least effect on environment.

## II. GREEN DATABASES

We deal with huge amount of data everyday while storing, managing, searching and transferring bulk of

data by using databases, web engines, social networking sites and mail servers over internet or on a company's intranet. Such data processing tasks consume tremendous energy and disseminate heat that adds up to the carbon footprint of a datacenter. A better alternative is to go for 'Green Databases'.

*"A green database refers to the repository of data with minimal effect to the environment. It is an environment friendly database unlike the present day data centre"*[2]

The database efficiency directly affects data searching and flow of data over network which also supplement overall computational power of the system. The traditional databases, although make our paperless transactions easier and efficient but in other way, they are affecting our mother nature. Getting a step further, we should plan for the solution by taking into consideration the core **reasons/issues** that lead us to switch to Green Databases:

#### 1) Heat Emission during Database processing

Heat is emitted from Datacenters while processing the database transactions. The fetch, store and load cycle consumes energy and while getting the final results, some amount of energy is also dissipated in the form of heat. If such emission would be controlled effectively, the efficiency of the database and the whole system would be increased as a consequence.

#### 2) Energy Consumption during database query processing

The amount of energy consumed during planning and processing of database queries acts as a key factor in calculating efficiency of a Database. The more the energy is consumed while processing a general database query, the less efficient a system would be considered. In distributed computational environment, energy efficiency techniques can be deployed to ease the data processing and handling tasks. Two types of techniques are broadly used for improving the energy efficiency in such kind of data

processing environments. The "Global" technique is all about bringing little change in whole system. Just like, we reschedule the jobs to attain better energy efficiency. The "local" technique focuses on individual nodes for bringing changes in order to increase the energy efficiency.

### III. BUILDING GREEN DATABASES

The main concern is to create a Green repository of data that have less negative impact on environment and will save the effective store-fetch-display cycle. As the impact of datacenters is multi crease, we need to have multi level arrangement for saving environment. To accomplish green, we require an appropriate preparation and approach [2].

For managing data with green IT, efforts are required for calculating and comparing different data management strategies along with their efficiencies before starting the designing process. The next step would be to design the green database by keeping into consideration the green characteristics. The resultant database would be energy competent, which would offer better performance as energy management is a serious issue while dealing with DBMSs. Only experienced personnel are deployed for designing such databases. Database designers can contribute majorly in power utilization by applying normalization in queries supplied and procedures used. Following steps are taken into account for building efficient and eco-friendly databases (refer

**Figure1):**

- 1) Analysing Datacenter Requirements: The actual energy requirements of a data center are estimated and calculated in order to achieve the desired result.
- 2) Designing a Plan: After acquiring the requirements, a plan is needed to be developed for up gradation of data warehouse.
- 3) Optimization: In order to attain the highest or maximum energy utilization, load-balancing techniques are appropriately applied in server rooms.

- 4) Achieving Virtualization: Virtualization is achieved to enhance the performance of server.
- 5) Efficiency Measuring: Efficiency metrics are applied in order to compare the efficiency of database after applying different optimization techniques.
- 6) Managing and Reporting: The final step is to manage the huge data and report to authorities.

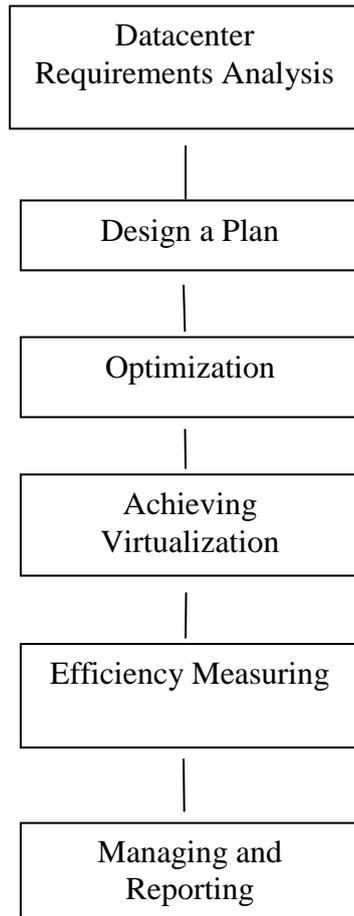


FIGURE 1. GREEN DATABASE BUILDING STEPS

**IV. EXISTING GREENDATABASE**

To achieve energy efficiency, various techniques have been proposed. The aim is to minimize the brown energy (that comes from traditional energy sources which will exhaust) usages of databases and to promote use of green energy (renewable energy). Researches [6,7,8,9,10] have shown that there is a mismatch or gap between green energy supply and actual workloads in datacenters due to which brown energy is used excessively. To fill this gap,

researchers from Singapore and China put hands together in 2013 to propose the concept of ReinDB, i.e. Renewable Energy Integrated Database. ReinDB is an initiative towards minimizing the brown energy consumption of databases. According to the research of Chen and Liu, ReinDB runs on a database server powered by both green and brown energy sources. Workloads with predefined slack times are supplied to database server with power management and workload scheduling to avoid slack time violations. They further proposed green aware optimizations to dynamically shift workloads on database server, thereby improving the efficiency of both green and brown energy usage. As a part of operation, battery is also used for workload shifting purpose. A simulator is used for evaluating ReinDB, which takes solar energy trace and workload trace as input and replays the traces after application of different execution strategies on simulated battery and database server.

This implementation proved a success in achieving optimization effectiveness, thereby reducing brown energy usage up to 53% to 57%. It opened doors for further research on green databases towards achieving Zero-emission databases.

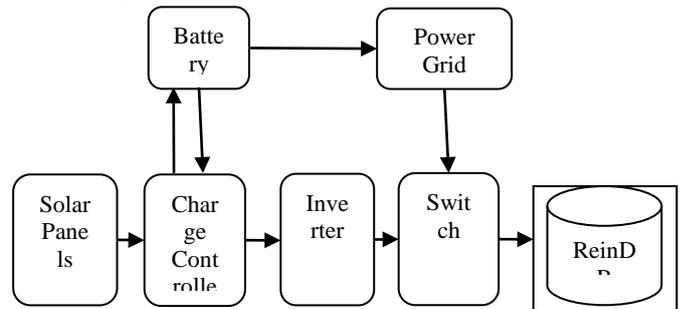


Figure 2. PROPOSED ReinDB RUNNING ON SOLAR POWERED DATABASE SERVER

**V. FUTURE EXTENSIONS [12, 13]**

ReinDB is an idea, which gave new research directions in the GREEN DATABASE area as listed below:

**1. Green aware database system design**

Research in the area of Database system is not focused only on database workload scheduling and

hardware settings; rather it should address other issues like implementation of green query operator, query optimization and its execution. For further research, existing system components must be reviewed and new components must be proposed. Two areas in Database Management Systems (DBMS) attract researchers: achieving query optimization and designing query or task scheduler. Apart from these areas, there are other challenges to be dealt with like designing integrated solar panels and battery provisioning.

## 2. Green Database for IOT applications

The proposed design of ReinDB system depends on the workload distribution and green supply prediction. This work can be extended to automate the monitoring on brown and green energy supply. The atomicity feature of green database will enable it to be used for advanced IOT applications for data storage.

## 3. Computation with Green energy supply

The computational costs within a data center include applying techniques for running optimized queries at larger scale rather than on a single database server. Alternate means of supplying renewable energy are water and heat. We have to consider the other features as well for continuous green energy supply like economics and charging/discharging efficiency as we cannot rely on batteries only for data centers.

## 4. Using Green Database with Power Grid

The electricity supply from Power Grid is a mix of green and brown energy. The proportion of these two supply sources depend on the area or domain where the electricity is getting consumed. Smart grids are the best alternatives to the users to decide upon this ratio. With the use of smart grids, users would be able to adjust the required computational efforts with actual green energy supply

## VI. CONCLUSION

Rate of increase in pollution is heading us towards the global warming, which is a real threat to the environment and to the human species. Green Technology is an initiative towards minimizing the use of brown energy and promoting green energy application. Use of Green Database system would prove to be a revolution in the era of technology that would aid in monitoring the supply of green energy for execution over database servers. Further, optimization can be achieved for less execution time and better efficiency using green energy supply. Works did so far have shown satisfactory results for small scale implementation. In future, the green database servers are supposed to be implemented for large scales like for clusters and in data centres.

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