Indian Journal of Science and Technology, Vol 9(30), DOI: 10.17485/ijst/2016/v9i30/93118, August 2016
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Green Database Design Model in Software Development Life Cycle Phase

M. Mohankumar[1*] and M. Anand Kumar[2]

[1]Department of Computer Science, Karpagam University, Coimbatore – 641021, Tamil Nadu, India; Mohankumar07@gmail.com
[2]Department of Information Techonology, Karpagam University, Coimbatore – 641021, Tamil Nadu, India; anand2kumarm@gmail.com

Abstract

Background/Objectives: This paper proposes to introduce a Green Software Database Design Model and to create the awareness to overcome the energy consumption issues while designing the database in the prevailing state of the world. **Methods/Statistical Analysis:** The main aspect of the work is to contemplate the energy consumption during the design phase of the database. **Findings:** This approach is concerned with the database designing using Green Computing Technique to reduce the power utilization pattern of server at different workload conditions. The energy consumption database design is subsequently designed to estimate the collision of software applications based on their source utilization. **Improvement/Application:** The work is validated on the side of the desktop and server side. This experiment demonstrates the effectiveness of the database design that provides the relevant information about the energy utilization of the software application design on the database in software engineering.

Keywords: Database Design, Energy Consumption, Green Software Engineering, Software Application, Software Engineering

1. Introduction

In the earlier period of Green Information Technology was practiced with the application of ecological restraint on hardware design to moderate it is straight negative effect[1]. On the other hand, in the past few years, the energy utilization techniques traversed the hardware level to software level[2]. Software could be useful to improve the Green Competence of the Information Technology (IT) infrastructures[3]. Software applications play a vital role in determining the energy consumption of the hardware. In this context, Green software can assist to get better energy competence of the IT hardware directly, where the software energy competence is defined as the energy to complete a specific job per unit of the time. At this point, many state of the art indoctrination techniques[4] and design strategy increase the energy efficiency. When comparing to the programming techniques, the design of the database plays an important role in energy efficiency.

In contrast, the software engineering progression and the database designer must be more concerned with the green software issues. The previous software progress models and the business aspects of the software do not clearly treat the detection of the green limitation to articulate the impact of software on the environment[5]. Software improvement life cycle models want to be modified to help while: (1) modeling and designing, (2) analyzing the scenarios for long term change, (3) and software testing the green competence. The work considers the database design and model of the database. There is a lot of mock up tools are available for the software design, but in the position of the database design such tools are unavailable to show the database flow in the software application. In the real scenario, only the front end tools consume a small amount of energy consumption in the process of coding and designing, but 50% of the process depends on the database. Therefore the database design accordance with

*Author for correspondence

the green aspect is very essential to give more absorption in future.

In addition, the analysis of these green constraints is a critical job to estimate the design of a DB and its execution. It introduces a vital role of database design in the green software engineering approach. To analyze the various aspects the database design, (DMV) Dynamic Management View the tool is established to calculate the excellence and estimate the green competence of a database[6]. The design method involves the trade-offs in which the decisions are to pick up the apparent triumph of the software and in some stage. It may decrease in general sustainability through other ways. It attempts to implement the green based model in software engineering approach in designing a database. The ultimate aim of this model is to prove each and every phases of the software development and process of designing in implementing the green based analysis of a software application which yields success of the green based software engineering approach[7]. In US, the departments of Energy estimates that the data center facilities use the energy up to 100 to 200 times more than the normal office buildings[8]. The designing of the software systems comes with a special set of tasks on society which is more broader than those to express in the existing codes of ethics for the computing professionals.

2. Green Database Design Approach

Green database refers to the storage area of the data with minimal result to the surroundings. Apart from this, it considers[9] Green Data Management which expresses the efficiency of the implemented data management strategies to perform input and output operations at a low level energy consumption than the Green Data Communication, and it expresses the competence of energy management policies, when the data receive and sends data over the communication network. In the **Figure 1,** a simple model is approached for the green database that includes the participation of green constraints in the diverse activities of the database design[10]. It needs to create DBMS with energy competence as the first class performance goal[11]. Making of good design is an attain talent to a trainee or inexperienced software developer, no matter how fairly capable they are but in designing the database only the experienced database designers are capable to involve the designing process. Table 1 shows the Green Database Design Internal /External Characteristics.

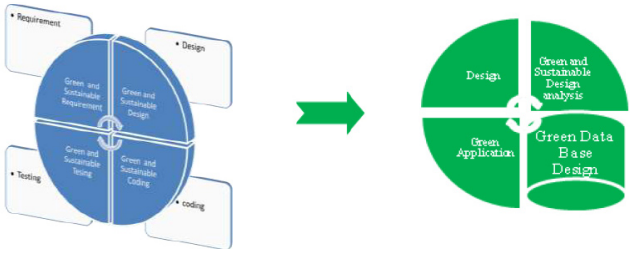


Figure 1. Green and Sustainable Database Design Model.

Table 1. Green Database Design Internal /External Characteristics

Uniqueness	Sub uniqueness
Functional Fitness	Function exactness, Function appropriateness
Performance Competence	Time Performance, Resource Utilization, Capacity
Maintainability	Reusability, Analyzability, Testability
Usability	Learning Ability , Operate Ability
Security	Confidentiality, Integrity, Non redundancy

3.Green Database Design and Metrics

The extensive research activities take place only in the data centers which are based on the models of Green approaches[12]. But it is only useful for the huge volume of record sending and receiving companies. When considering the medium and small size project, the data center approach is not suitable because it is costlier and virtualization of a database rate[13] is also high. Hence the Green database design model is executed only for a medium size project based companies[14]. The Energy management becomes a serious feature in designing and operating of Database Management Systems (DBMS). During a design the designer should consider the greenness of the software because the energy efficiency is so important like the database design for software[15]. Software engineer plays a significant role in reducing the power utilization of the application while they write, data base designer and data base administrator also possibley can reduce the power consumption of the application by the help of normalization of query and procedure[16]. Present center of attention areas on improving the data center energy competence are

the energy competent application design and application co-design. When one thinks the design of the database that is required will give more importance for the below table points. The proposed solution resolves the power awareness of the database as in the Table 2. Only the setback database management system needs to be revisited or redesigned and the initial efforts are to be invested[17]. In the design stage approximately each and every one of the actions are energy associated and most of the investigator are paying attention on the energy utilization and energy competent and only in other aspects. But this work gives an accurate solution in the green design point of view[18]. When a design is created on the basis of the satisfactory stage of sustainability, then one bestows the star credit for those companies. This method is corresponding to the Capability Maturity model stage process of the repeatable 2nd phase. It is equal to the routine method in all the way through the design of the forms; database, architecture-the developer, database administrator so, the Architect needs to work for this procedure and convene the customers' satisfactory level.

Based on the above said parameters as shown in the Table: 2, when the hardware setting is different from the Power Management and Energy Utilization, they may also differ from one to one. The same in software setting, the Query Management and Optimization give different energy utilization, and even the architecture varies in the energy consumption and utilization. These aspects raise the following research questions:

- How the queries are executed in the different hardware settings in Green DB?
- What are the energy saving possibilities in the Green DB Design?
- What are the procedures involved in employing the energy efficiency via Green Computing and Green Database System?
- How could be these query determinants are best-implemented for the energy efficiency and Green Database Design?

Table 2. Common Parameters Details

Parameters	Description
Hardware	Hardware Optimization
	Power Management
Software	Software Optimization
	Query Management and Optimization
Architecture	Architecture Maneuvering
	Distributed System

4. Objectives

The aim of the paper is to accomplish the behaviourness in queries in a normal system and in a server system the with the different hardware and software settings of the database design moreover about the ways of producing the results[19]. Software engineering educators have the responsibility to integrate new research insights in teaching, and thereby improve the knowledge of future generation of software engineers about the importance of the Go Green motto in the software designing. Therefore it is considered as an improved solution to show the benefits of energy efficiency through the Green database design[20]. The selection of the best way to partition the data in the distributed environment is a critical physical database design problem[21]. Dramatic performance improvements are achieved through the distributed execution of queries across many nodes. Query Optimization for such system is a challenging and important problem. This study obtains certain queries based on the I/O operations like CPU related, and memory related and for the further development of the research.

Algorithm: Code Optimization Algorithms

1. Algorithm related to I/O Operations

Step1 : Input Database file ; Output : Average Byte Transfer
For Each Drive perform Steps 2 to 4

Step2 : Calculate number of Reads. If No. of Reads=o then exit
Else count io_stall_read per number of reads (Readings: Milliseconds)

Step 3: Calculate number of writes. If No. of writes=0 then exit
Else count io_stall_read per number of writes (Readings: Milliseconds)

Step4: WHEN (number of reads = 0 AND number of writes = 0) THEN exit
ELSE Calculate the Latency (io_stall/(number of reads + number of writes))

Step5 : Based on Latency calculate average byte transfer . Based on byte transfer useful evidence of
Performance is identified

Step6: From Step 2 to 4 Perform

Step7 : Calculate File size (in MB)

Step8: Identifies the database files that have most Input and output bottleneck on the entire instance

Step 9: Calculate the percentage of Read, Write (Size in Bytes)

Step10 : Input : Stored Procedures; For all Stored Procedures Perform

1. Calculate the Average Input and output (qs.total logical reads + qs.total logical writes)
2. Calculate Execution Count
3. Discover the most expensive statements for input and output by SP

Step 11 : Select the database name; Calculate number of bytes read + number of bytes written

1. Calculate total size in MB.
2. Find the database that uses most Input and output resources on the instance

Outcome: The outcome of the algorithm is finding out the maximum code which is optimized or not, track whether there is any unwanted read and write in I/O.

2. Algorithm related to CPU

Step 1 : Select the Process based on Process id

Step 2 : If Process name is Database Name then Perform the following

1. Select the database name
2. Calculate the CPU Time in MS
3. CPU Percentage for each database

Step3: If Process name is SQL Server Process then Perform the following

1. Select the SQL Server Process
2. Calculate the CPU Time in MS
3. CPU Percentage for each database

Step 4: For each Stored Procedure Perform

1. Calculate Total Worker time
2. Calculate Average worker time

Based on 1 & 2 Calculate Total Elapsed time, Average Elapsed Time

Step 5: For all database Perform

1. Calculate Total worker time
2. Calculate Min Worker Time
3. Calculate Minimum Average Time
4. Calculate Execution Count

Outcome: The outcome of the algorithm is finding out the maximum code is optimized or not based on the CPU Metrics.

3. Algorithm related to Memory

Step 1: Select Total Physical Memory. Based on perform the following

1. Calculate the available_physical_memory
2. Calculate total_page_file
3. Calculate available_page_file
4. Calculate system_memory_state

Step 2: Select Physical Memory in use (Current State) then

1. Check the condition if Process=0 then Exit (Memory is available)
2. Else
3. If Process =1 then Physical memory is low

Step 3: For each server

1. Check the Memory grant pending

Step 4: For each Memory Clerk type

1. Calculate Total Memory usage
2. Calculate Buffer size (MB), Row count, Compression type

Outcome: The outcome of the algorithm is finding out the maximum code is optimized or not based on the Memory. From the Total memory, 85% will be used by SQL Server. If the percentage increases, then there is a certain Bottleneck that to be identified and rectified.

5. Experimental Evaluation

This section describes the experimental planning in two different servers, one is the main server and another is a normal server, both have two different configuration settings, in that server, it shows how the optimization queries behave and the results are going to be shown in the graph[22]. Modern servers are far from the energy proportional because the idle power can constitute a major portion of the total power consumption. Table 3 shows the server details and Table 4 shows the Experimental Practice:

The attention of the energy consumption of software could be much higher in order to identify and implement the additional potentials. For example, in this application, Input and Output Queries, CPU Performance Related Queries, and Memory Utilization Related Queries are in different scenario, and shows how both the servers are behaving the different queries with the help of the Input and Output data (Read/Write), CPU data (resource utilization in user time, system time, and idle time), and Memory data (Available memory usage in MB).

Table 3. shows the server details

Normal server	Green Server
Processor: Intel (R) xeon ® CPU E5620@ 2.40GHz 2.40GHz	Intel® Core ™ i7-3770 CPU@ 3.40GHz 3.40GHz
Installed Memory Ram:16.0GB	32.0 GB(31.8 GB usable)
System Type:64 bit operating system	64 bit operating system
Windows server 2008 R2 Enterprise	Windows 7 ultimate

Table 4. shows the Experimental Practice

Logical Name	Make use of Competent Queries
Category	Databases design
Explanation	Web oriented applications about the amount absorb and make use of a database, classically, the intranet web based development application are used by the educational institution for the attendance details of the students attendance and the entry by the individual staff based on their class allotment, and mark entry for internal examination; They do analysis and probing the operations and lots of records in a database. Therefore, the conventional concert bottleneck of web applications comes up to the database. It is often caused by the interpretation operations of a huge number of records inserted in to database, whose complication requires an classy data dispensation time by the database
Basis	Regularly, database queries executes the multifaceted operations such as ordering or indexing. Those operations are done to increase the application recital at the expense of energy competence. Hence, restricting the consumption of indexation mechanisms or needless ordering operations can lessen the energy spending of our queries
Keywords	Database Design, Coding, Query

5.1 I/OPs Calculation

1/ ((seek time/1000) + (Latency/1000)=I/Ops

Energy consumption=Power (watt) X I/OPS

A critical analysis of the Green database system for energy efficiency and Green computing. Reduction in Input / Output operations per second (I/Ops) directly leads to reduction in the energy consumption which is shown in the above formula. An average latency is the time taken by the disk that is accessed rotate the position under read/write head. Mean while the average seeking time would be the time (ms) taken for the hard drive's read/write and locate itself over the read/write track[23]. The project manager does the detailed planning, estimation, analyses budget, time and effort required to develop an application. The requirements of the customers are delivered to them within the schedule and scope. IT service delivery organization uses suitable software languages or package implementation techniques to convert the specifications into a workable software application software.

Cost can be reduced by improving the query optimization time whereby the processing time can be improved and obtained through the setup of the server which is shown below

Cost estimation, c:

C= (Query optimization X time) X processing Time

5.2 CPU Utilization

U = 100% - (%of time spent in idle task)

% time in idle task = (average period of background task with no load) * 100%/ (avg.period of background task with some load)

%time in idle task = (BG loop count measured during 25 ms) *100%/ (BG loop count expected in an unloaded CPU)

Actual % = Scaled Percent * (100%)/max value 8 bit value

5.3 Basic Model of System Capacity

[24]There are three variables that form the basic model of system capacity. These variables are Observation time (T), the amount of time that the server is monitored for actively Busy time (B), the amount of time that the server is active during the observation time Completions (C), the number of transactions completed during the observation period With these three variables, can calculate the six significant values[25]. The author proposes a method to optimize the power consumption and also would not occur interference and latency of the information flow however the several simultaneous information flows in the network.

5.4 Capacity Planning Data Formulas

Table 5. shows the process and formula

Process	Explanation	Procedure
CPU Consumption	The percentage of CPU competence used during a specific period of time	U=B/T
Operation the whole time of the system	The standard number of transactions completed during a particular phase of time	X=C/T
Average Examine Time	The average time to entire transaction	S=B/C
Transaction Ability of the System	The number of transactions the server deal with	Cp=1/S
Average queue extent	The average number of transactions in queue	Q=U/(1-U)
Average reply time	The average time to react to a transaction	R=(QA∫A∫AA-S)+S

Here is an instance of useing these formulas to size a server. Suppose the server is examined for 60 seconds (T), time duration for the 90 fulfilled connections (c), and the server is really busy and giving out that workload for 48 seconds

5.5 Capacity Planning Resource Formula Results

Table 6. shows the examples of calculation

Source	Procedure	Outcome
CPU Consumption	U=B/T	48/60=80 Percent Utilization
Transaction all through the system	X=C/T	90/60=1.5 transactions/sec
Average Overhaul Time	S=B/C	48/90=53 seconds
Transaction Competence of the System	Cp=1/S	1/53=1.875 transactions/sec
Average queue extent	Q=U/(1-U)	8/(1-8)=4 transactions
Average reply time	R=(QA∫A∫AA-S)+S	3= QA∫A∫AA-53)+53=2.12 seconds

The CPU consumption was at 80% and handled an usual of 1.5 transactions per second. The average service time for these communication were.53seconds, and communication was completed in an average time of 2.12 seconds. On average, there were four communications waiting to be processed at any given point of time during the study period, and the server had the competence to process 1.875 communications per second. Traditionally, the problem of energy utilization optimization is considered separately at dissimilar layers of the protocol stack. At Network Layer, inefficient routing of packets can lead to waste of energy[26]

Step 1: Bytes Transfer Information in Drives

The first step is to selecte the I/O operations related queries, how they behave while try to run the four queries continuously in a normal server, it is tried to check the Average Bytes/ read, write, and transfer speed in the normal server and green database designed server in the three drives are D, E, and C respectively. The Figure 2 shows the result for byte transfer information in drives.

Step 2: CPU Utilization for Different Application

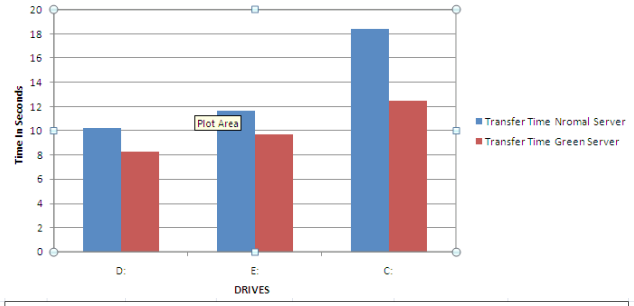
The second step is to describe the CPU utilization related queries; nearly five different application databases are taken; it helps to decide which database is using the most CPU possessions on the occurrence. This query is checked with five different applications and in that the following result in milliseconds are resulted and the subsequent figure 3 gives the clear idea about the CPU utilization

Step 3: Memory Usage in Different Database Design

The third step describes the memory usage in five different databases in the same application. Each database has different types of record volume; it should be the highest consume memory in hard disk and it shows the details in the following bar graph which gives the clear idea about the memory usage. It is important to analyze the algorithm energy efficiency (in theory), and its implementation in the energy efficiency (in practice) because nowadays there is an alert about the impact in terms of memory usage and execution time. The figure 4 shows the Memory Usage in Different Database Design

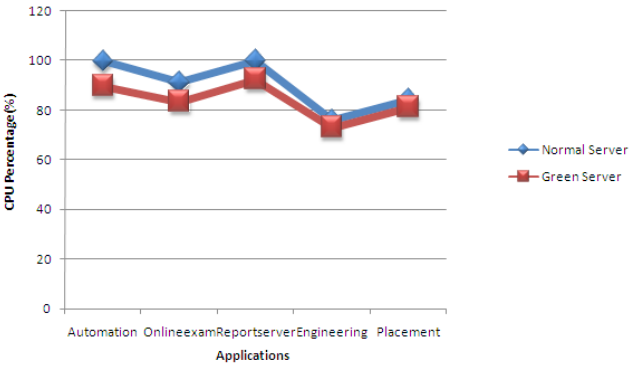
6. Discussion

This paper depicts the advantages of these queries in the Green and Sustainable Database design using



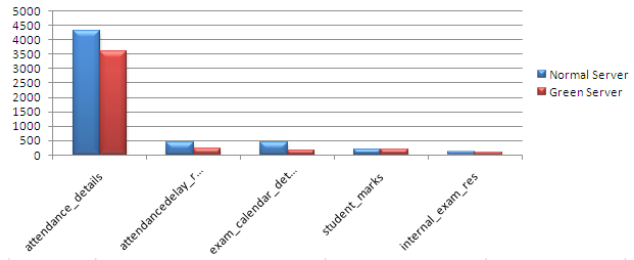
I/O Operations						
S.No	I/O Operation	Avg.Bytes/Read	Avg.Bytes/Write	Avg.Bytes/Transfer	Transfer Time Nromal Server	Transfer Time Green Server
1	D:	37561	3741	37369	10.245	8.245
2	E:	38083	19954	37646	11.678	9.678
3	C:	68632	45176	59758	18.456	12.456

Figure 2. Average Bytes/Read Write and Transfer Details in Drives.



CPU Utilization In Different DataBase						
		Normal Server		Green Server		
S.No	Database Name	CPU Time (ms)	CPU Percent	CPU Time (ms)	CPU Percent	
1	Automation	57684011588	99.75	49878999566	89.76	
2	Onlineexam	47684011134	91.23	42109456798	83.54	
3	Reportserver	67998734234	99.87	61323456734	92.45	
4	Engineering	16784356732	76.04	13284356731	73.04	
5	Placement	32459876544	84.07	29459834784	81.23	

Figure 3. Different application CPU utilization.



Memory Usage (MB)			
		Normal Server	Green Server
S.No	Database Name	Memory Usage (MB)	
1	attendance_details	4297.2	3592.45
2	attendancedelay_reason	448.89	220.98
3	exam_calendar_detail	448.53	171.02
4	student_marks	202.13	195.34
5	internal_exam_res	102.67	98.34

Figure 4. Different database memory usage.

the GBMSSE approaches in SDLC with regard to the traditional SDLC. If the database designer implements this approach, it will diminish the carbon discharge during the development instance; additionally, it will augment the competence of the artifact with no disturbing the environment dimension. Besides it will give a sustainable software product to the world. This work is meant for the betterment of the world from natural calamities and it is taken for consideration as a serious threat for the survival of human being and proceeds for further research in this specified field.

7. Conclusion

In this article, Green Database design is introduced in the software development life cycle. Green competence as database eminence in order to aim the procedure of the energy optimization techniques throughout the database design period to consolidate the green practice queries for the period of the implementation of database design. To calculate approximately the energy usage of software on diverse information technology platforms, the power utilization mock-up is build to healthy and variety of hardware configurations and servers. This move towards to remove the blare that can be created by other operations in the applications, which means that the provided energy practice can be consistent enough to estimate the green aspects of the database design. The 2nd improvement of the conventional model is it flexibly estimates the energy utilization at different database in server. This work enlightens about the initial phase of the software engineering design is not concentrating on the sustainable software engineering in the database design without utilizing the green technologies which definitely lead to the environmental threats. So it is to be identified that the initial step is to be forwarding the software development companies by insisting that they should attempt to apply the Green Database design approaches by means of the green technology in each of their database design. If this approach is implemented certainly it will diminish the ecological collision and also boost the positive economic impact.

8. References

1. Capra E, Francalanci C, Slaughter SA. Measuring application software energy efficiency. IT Prof. 2012; 14(2):54–61. Doi:10.1109/MITP.2012.39.

2. Sierszecki K, Mikkonen T, Steffens M, Fogdal T, Savolainen J. Green software: Greening what and how much? IEEE Softw. 2014; 31:64–8. Doi:10.1109/MS.2014.
3. Zhang C, Hindle A. The impact of user choice on energy consumption. IEEE Softw. 2014; 31(3):69–75. Doi:10.1109/MS.2014.27.
4. Gong L, Xie J, Li X, Deng B. Study on energy saving strategy and evaluation method of green cloud computing system. 2013 8th IEEE Conference on, Industrial Electronics and Applications (ICIEA). 2013. P. 483–8. Doi:10.1109/ICIEA.2013.6566417.
5. Dick M, Naumann S. Enhancing software engineering processes towards sustainable software product design. Proceedings of the 24th International Conference EnviroInfo: Integration of Environmental Information in Europe, 2010. P. 706–15.
6. Chaudhary S, Murala DP, Shrivastava VK. Green Data Base. Global Journal of Business Management and Information Technology. 2011; 1(2):105–11 © Research India Publications. Available from: http://www.ripublication.com
7. Bener AB, Miranskyy A, Raspudic S. Deploying and Provisioning Green Software, in IEEE Software. 2014 May-Jun; 31(3):76–8. Doi: 10.1109/MS.2014.59.
8. Sahin C, Cayci F, Clause J, Kiamilev F, Pollock L, Winbladh K. Towards power reduction through improved software design, Energytech, 2012 IEEE, Cleveland, OH. 2012; 1–6. Doi: 10.1109/EnergyTech.2012.6304705.
9. Wilde T, Auweter A, Shoukourian H. The 4 Pillar Framework for energy efficient HPC data centers, Computer Science - Research and Development. 2013; 1. Doi: 10.1007/s00450-013-0244-6.
10. Mardamutu K, Aik Joon RAL, Jegatheesan J, Ponnusamy V, Leong YM. A Critical Analysis of Green Database System for Energy Efficiency and Green Computing. International Symposium on Mathematical Sciences and Computing Research 2013 (iSMSC 2013), Perak, MALAYSIA. Paper ID.:CS_07. 2013 Dec 6-7.
11. Procaccianti G, Fernandez H, Lago P. Empirical evaluation of two best practices for energy-efficient software development. Journal of Systems and Software. 2016 Jul; 117:185–98. ISSN 0164-1212, Available from: http://dx.doi.org/10.1016/j.jss.2016.02.035. (http://www.sciencedirect.com/science/article/pii/S0164121216000777)
12. Betz S, Becker C, Chitchyan R, Duboc L, Easterbrook S, Penzenstadler B, Seyff N, Venters CC. Sustainability Debt: A Metaphor to Support Sustainability Design Decisions 4th International Workshop on Requirements Engineering for Sustainable Systems (RE4SuSy),ISSN:1613-0073,Ottawa, Canada. 2015 Aug.
13. Choudhary S. A Survey on Green Computing Techniques. (IJCSIT) International Journal of Computer Science and Information Technologies. 2014; 5(5):6248–52. ISSN:0975-9646.
14. Lang W, Kandhan R, Patel JM. Rethinking Query Processing for Energy Efficiency: Slowing Down to Win the Race. IEEE Data Eng Bull. 2011. Available from: adrem.ua.ac.be
15. Becker C, Chitchyan R, Duboc L, Easterbrook S, Penzenstadler B, Seyff N, Colin C. Venters. 2015. Sustainability design and software: the karlskrona manifesto. Proceedings of the 37th International Conference on Software Engineering - Volume 2 (ICSE '15), IEEE Press, Piscataway, NJ, USA, 2015; 2. p. 467–76.
16. Shankar S, Nehme R, Aguilar-Saborit J, Chung A, Elhemali M, Halverson A, Robinson E, Subramanian MS, DeWitt D, Galindo-Legaria C. Query optimization in microsoft SQL server PDW. Proceedings of the 2012 ACM SIGMOD International Conference on Management of Data (SIGMOD '12). ACM, New York, NY, USA. 2012. p. 767–76.
17. Mohan Kumar M, Anand Kumar M. An Empirical Study on Green and Sustainable Software Engineering. Advances in Software Engineering and Systems. Available from: http://www.wseas.us/e-library/conferences/2015/Dubai/SEPADS/SEPADS-11.pdf ISBN: 978-1-61804-277-4.
18. Mohan Kumar M, Anand Kumar M. A Green It Star Model Approach For Software Development Life Cycle. International Conference on Recent Trends in Engineering Science And Management (ICRTESM -2015). Jawaharlal Nehru University, New Delhi – India. 2015 Mar 15. ISSN (online): 2348 – 7550.
19. Nehme R, Bruno N. Automated partitioning design in parallel database systems. Proceedings of the 2011 ACM SIGMOD International Conference on Management of data (SIGMOD '11). ACM, New York, NY, USA, 2011. p. 1137–48. DOI=http://dx.doi.org/10.1145/1989323.1989444
20. Cheng Chen , Bingsheng He , Xueyan Tang , Changbing Chen , Yubao Liu," Green Databases Through Integration of Renewable Energy" 6th Biennial Conference on Innovative Data Systems Research(CIDR 13),jan6-9-,2013,doi=10.1.1.366.2184 Asilomar, California, USA.
21. Rashid M, Ardito L, Torchiano M. Energy Consumption Analysis of Algorithms Implementations. ESEM, 2015, 2015 ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM), 2015 ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM). 2015; 1–4. Doi:10.1109/ESEM.2015.7321198.
22. Kern E, Dick M, Naumann S, Filler A. Labelling Sustainable Software Products and Websites: Ideas, Approaches, and Challenges. booktitle = Atlantis Press. publisher = Atlantis Press. ISBN 978-94-62520-92-9. 2015; 82–91.
23. Nirmalraj D, Santhosh N. Model to Predict Schedule Variance in Software Application Development Projects. Indian Journal of Science and Technology. 2016 Feb; 9(7). Doi: 10.17485/ijst/2016/v9i7/85751.

24. Available from: https://technet.microsoft.com/en-us/library/cc181325.aspx
25. Gupta M, Singh P, Rani S. Optimizing Physical Layer Energy Consumption for Reliable Communication in Multi-hop Wireless Sensor Networks. Indian Journal of Science and Technology. 2015 Jul; 8(13). Doi:10.17485/ijst/2015/v8i13/54605.
26. Zayandehroodi H, Hamzehbabaei, Eslami M. Optimization of energy consumption in cooperative wireless network using quadratic programming. Indian Journal of Science and Technology. 2015 Dec; 8(35). Doi:10.17485/ijst/2015/v8i35/87396.